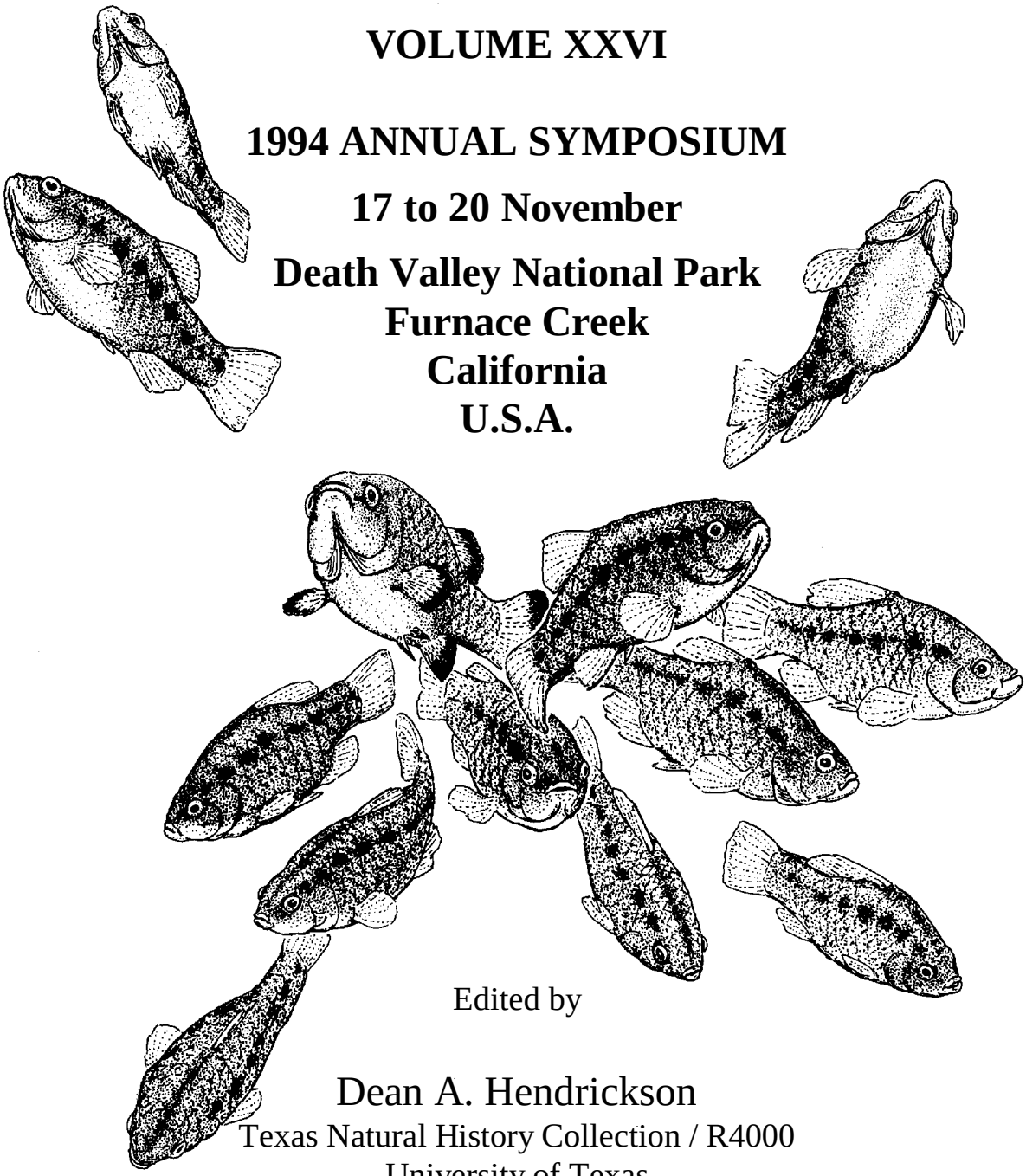
Proceedings of the Desert Fishes Council



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MISSION

The mission of the Desert Fishes Council is to preserve the biological integrity of North America's desert aquatic ecosystems and their associated life forms, to hold symposia to report related research and management endeavors, and to effect rapid dissemination of information concerning activities of the Council and its members.

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Membership in the Desert Fishes Council is open to any person or organization interested in or engaged in the management, protection, or scientific study of desert fishes, or some related phase of desert fish conservation. Membership includes subscription to the Proceedings of the Desert Fishes Council. Annual dues are $25 (regular: domestic or foreign), $15 (student), $35 (family: 1 Proceedings), >$35 (sustaining) and $1000 (patron: single payment). Send dues payments and general contributions along with address information (including affiliation, voice, fax, and e-mail) and indication of permission to include this information in a published directory of the Desert Fishes Council to: Paul C. Marsh, Membership Chair, Center for Environmental Studies, Arizona State University, Tempe, AZ 85287-3211 USA (602/965-2977 FAX 602/965-8087/ Internet ICPCM@ASUVM.INRE.ASU.EDU

ABOUT PROCEEDINGS OF THE DESERT FISHES COUNCIL

It is the policy of the Council to publish in the annual Proceedings of the Desert Fishes Council papers, abstracts, discussion summaries, business items, resolutions, and other material submitted for presentation, whether actually presented at the Annual Symposium or not. The Proceedings are published and delivered to all members of the Desert Fishes Council and subscribing libraries in the year following the Annual Symposium. All contributions are published as received following automated electronic processing designed to standardize format only. Authors are responsible for their own technical editing and for any errors caused by failure to follow Instructions to Authors (published in each volume). Proofs are not provided to authors for review prior to publication, and neither abstracts nor full papers are subjected to peer review. Resolutions are published exactly as passed by the membership in the business meeting of the annual symposium. The Translation Subcommittee of the Proceedings Committee accepts responsibility for errors in translations to Spanish for those abstracts they translate. This committee provides original translations of all abstracts and resolutions when translations are not provided by authors, and edits all Spanish abstracts provided by authors. Translations to English of all abstracts received only in Spanish are done by the editor and reviewed by the Translations Subcommittee.

The Desert Fishes Council offers extensive information on the **World Wide Web** about itself and the organisms and ecosystems it strives to protect: **http://www.utexas.edu/depts/tnhc/.www/fish/dfc/dfc_top.html**

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HUBBS,C. (Department of Zoology, The University of Texas at Austin, Austin, 78712, TX, U.S.A.)

Further on *Gambusia* cannibalism

Más sobre el canibalismo de *Gambusia*

KEYWORDS: predation; cannibalism; mosquitofish; geographic variation; Poeciliidae

ABSTRACT

Gambusia predation on newborn poeciliids is about 70% for females and 30% for males = half of the young survive for a month isolated with a predator. Predation is very high when adults of *Gambusia nobilis*, *Gambusia gaigei*, *Gambusia heterochir*, *Gambusia geiseri*, or *Gambusia longispinis* are used and low when *Gambusia affinis* or *Gambusia speciosa* are used as predators. Three species have had multiple populations studied; *G. affinis*, *G. nobilis*, and *G. geiseri*. The first two show much more interpopulation variation than does *G. geiseri*.

CLAVES: predación; canibalismo; pez mosquito; variación geográfica; Poeciliidae

RESUMEN

La predación en poecilidos recién nacidos es de aproximadamente 70% en hembras y 30% para machos = la mitad de los jóvenes sobreviven un mes aislados con un depredador. La predación es muy alta cuando los adultos de *Gambusia nobilis*, *Gambusia gaigei*, *Gambusia heterochir*, *Gambusia geiseri*, o *Gambusia longispinis* son usados y poco cuando *Gambusia affinis* o *Gambusia speciosa* son usadas como predadores. Tres especies han tenido múltiples poblaciones estudiadas; *G. affinis*, *G. nobilis*, y *G. geiseri*. Las primeras dos muestran mucho más variación interpoblacional que *G.geiseri*.

REYNOSO-MENDOZA,F.*; BARJAU-GONZALEZ,E. (Museo de História Natural, Universidad Autónoma de Baja California Sur, A.P. 219-B, La Paz 23080, Baja California Sur, México)

Fishes of the continental waters of Baja California Sur, México, in the collection of the Natural History Museum of the Universidad Autónoma de Baja California Sur

Peces de aguas continentales de Baja California Sur, México, en la colección del Museo de Historia Natural de la Universidad Autónoma de Baja California Sur

KEYWORDS: ichthyological collections; museums; Baja California Sur; México; freshwaters; fishes; fish collections

ABSTRACT

The Ichthyological Collection in The Natural History Museum of the Universidad Autónoma de Baja California Sur, up to date, has specimens from the ponds or "tinajas" of eight arroyos of the State of Baja California Sur. These are of the families: Cyprinidae, Cyprinodontidae, Poeciliidae, Mugilidae, Gobiidae, Eleotridae, Cichlidae.

CLAVES: Colecciones ictiológicas; museos; Baja California Sur; México; aguas continentales; peces; Colecciones de peces

RESUMEN

La Colección Ictiológica del Museo de Historia Natural de la U.A.B.C.S. hasta la fecha cuenta con ejemplares de peces colectados en las pozas o tinajas de ocho arroyos del Estado de Baja California Sur, que corresponden a las familias Cyprinidae, Cyprinodontidae, Poeciliidae, Mugilidae, Gobiidae, Eleotridae, Cichlidae.

ALDER,L.*; CROWL,T.A. (LA and TAC - Ecology Center and Department of Fisheries and Wildlife, Utah State University, Logan, UT)

Energy flow in the Green River, upper Colorado River basin: A foodweb approach

Flujo de energía en el Río Green, Cuenca Alta del Río Colorado: la cadena alimenticia

KEYWORDS: community dynamics; foodweb dynamics; predation; competition; non-native fishes; Utah; Colorado River; Green River

ABSTRACT

The Upper Colorado River is dominated by non-native fishes which we suggest negatively impact the survival of Colorado squawfish. These impacts result from competition for food as well as direct predation, especially on YOY and juvenile (2 - 5 year) squawfish. Cage experiments suggest that smallmouth bass, small channel catfish and green sunfish are particularly problematic. Given the excessive domination (both in terms of densities and biomass) of the foodweb by non-native fishes, we hypothesize that the overall energy balance in the upper basin system has been altered dramatically. We suggest that most of the energy (at all levels) now flows through the non-native components of the foodweb and that a few species in particular represent resource sinks. As a first step toward testing this hypothesis, we present a foodweb model developed from three years of data. These data represent quantitative assessments of the entire fish community, including densities, biomass, body length/gape size relationships and stomach analyses collected in a 70 mile reach of the Green River. The results estimate a previously unquantified measure of native and non-native fish distribution and density in this river section.

CLAVES: dinámica de comunidades; dinámica de la cadena alimenticia; depredación; competencia; peces no nativos; Utah; Río Colorado; Río Green

RESUMEN

El Alto Río Colorado esta dominado por peces no nativos de los cuales nosotros sugerimos impactos negativos sobre la sobrevivencia del charal del Colorado. Estos impactos resultan de la competencia por el alimento, así como por la predación directa sobre los peces del año y juveniles (2 - 5 años) del charal del Colorado. Los experimentos en el acuario sugieren que la lobina boca pequeña (smallmouth bass), los bagres de canal pequeños, y la mojarra verde (green sunfish) son particularmente problemáticos. Dada la excesiva dominancia (en términos de densidades y biomasa) de la cadena alimenticia por peces no nativos, nosotros hipotetizamos que el balance general de energía en el sistema de la cuenca alta ha sido alterado dramáticamente. Sugerimos que la mayoría de la energía (a todos los niveles) ahora fluye a través de los componentes no nativos de la cadena alimenticia y que unas pocas especies en particular representan recursos que disminuyen. Como un primer paso para probar esta hipótesis, presentamos un modelo de cadena alimenticia desarrollado en base a tres años de datos. Estos datos representan evaluaciones cuantitativas de la comunidad completa de peces, incluyendo densidades, biomasa, tamaño de la longitud del cuerpo y abertura de la boca y análisis estomacales colectados en un brazo de 70 millas del Río Verde. Los resultados estimaron un valor, no cuantificado previamente, de distribución y densidad de peces no nativos y nativos, en esta sección del río.

BALTZLY,M.*;HENDRICKSON,D.A. (MB - Arizona Public Service, Tempe, Arizona; DAH - Texas Natural History Collections, University of Texas, Austin, Texas)

The new Desert Fishes Council World Wide Web server on Internet

La nueva oferta del Consejo de Peces del Desierto en la Red Mundial en Internet

KEYWORDS: World Wide Web; Internet; electronic publishing; Proceedings of the Desert Fishes Council; fish photographs; public education; Desert Fishes Council

ABSTRACT

The Desert Fishes Council has moved into the world of electronic publishing on the Internet. Dr. John Rinne (U.S. Forest Service, Flagstaff, Arizona) has allowed the first author to scan his well-known collection of fish photographs into digital format. They have been variously cropped and enhanced, and can now be viewed in different formats or downloaded by anyone in the world with Internet access. The second author is converting the Proceedings (starting with Vol. 24 [1992 meeting]) to hypertext format, so they may be browsed, searched or downloaded. All future DFC Proceedings will be published on WWW at the same time final hard copy is sent to the printer. The World Wide Web (WWW) allows anyone who has obtained free, public domain client software (readily available on Internet), primarily one called Mosaic, to browse effortlessly through multimedia files (graphics, video, sound, formatted text) that are stored on computers around the globe. Multimedia presentations can combine real-time sound, graphics and video with text. Exploration of WWW and the DFC system using Mosaic is facilitated by hypertext links, which offer the simplicity of "point and click" movement through the "cyberspace" of WWW.

The Texas Memorial Museum of The University of Texas at Austin is providing storage space for these large DFC files at no charge as a pilot project for other WWW projects at UT, and can likely continue to provide this service for the forseeable future if it receives the useage and growth that are predicted. All DFC members are encouraged to provide additional text, graphics and other files for inclusion in the system. Growth of the Internet has been phenomenal, and as more and more people throughout the world obtain access to it, these electronic files will allow DFC to better reach a far larger audience than was formerly possible. DFC members and others using materials provided here will be better equipped to educate the public regarding the plight of desert fishes. The system should also improve communications among ourselves and with others regarding fish conservation efforts throughout the world, and eventually should lead to reduced costs of publishing the Proceedings.

CLAVES: World Wide Web; Internet; publicaciones electrónicas; Proceedings del Consejo de los Peces del Desierto; fotografías de peces; educación pública; Consejo de los Peces del Desierto

RESUMEN

El Consejo de Peces del Desierto se ha movido dentro del mundo de las publicaciones electrónicas sobre Internet. Dr. John Rinne (U.S. Forest Service, Flagstaff, Arizona) facilito su bien conocida colección de fotografías de peces al primer autor del presente trabajo para que las convierta a formato digital. Estas fotos pueden ser ahora vistas en diferentes formatos o cargados por cualquiera en el mundo con acceso al Internet. Estas versiones electrónicas de las fotos pueden ser también fácilmente obtenidas, editadas o resaltadas en varias formas. El segundo autor esta convirtiendo los proceedings (empezando con el volumen 24 [reunión de 1992]) a un formato de hipertexto, de esta forma pueden ser revisados, buscados o cargados. Todos los futuros Proceedings del Consejo de Peces del Desierto pueden ser publicados sobre el WWW al mismo tiempo que las impresiones finales son enviadas a la impresora. El World Wide Web (WWW) permite a cualquiera quien ha obtenido sin compromiso, un software comercial del dominio público (fácilmente disponible en Internet), principalmente uno llamado

Mosaico, revisar con el menor esfuerzo a través de los archivos de multimedia (gráficos, video, sonido, textos formateados) los cuales están almacenados en las computadoras de todo el mundo. Las presentaciones con multimedia pueden combinar sonidos reales, gráficos y videos con el texto. La exploración del sistema WWW y del DFC es facilitada por enlaces de hipertextos, los cuales ofrecen el simple movimiento "point and click" mediante el "Cyberspace" de WWW.

El Museo Memorial de Texas de la Universidad de Texas en Austin esta proporcionando gratis el espacio de almacenaje para aquellos grandes archivos del DFC como un proyecto piloto por otros proyectos del WWW, y esta dispuesto a continuar a proporcionar este servicio si el sistema del DFC recibe el uso y crecimiento predichos. Todos los miembros del DFC están motivados no solo a usar el sistema, sino también a ayudar a su crecimiento proporcionando textos adicionales, gráficos y otros archivos. Debido a que el formato de página es esencialmente equivalente que aquellas páginas de especies en peligro en la revista Environmental Biology of Fishes (EBF - el cual actualmente esta solicitando contribuciones de nuevas páginas), los autores pueden simultáneamente someter su trabajo para publicación en los sistemas DFC WWW y EBF.

El crecimiento de Internet ha sido fenomenal, y mientras más y más gente obtiene acceso en todo el mundo, estos archivos permitirán al DFC mejorar el alcance a una audiencia más lejana de lo que fue antes posible. Muchas escuelas públicas de educación básica y secundaria en los E.U. están usando el Internet, y esta pronto será un muy importante recurso educacional. Los miembros del DFC y otras personas que están usando el material proporcionado en WWW por DFC estará mejor equipado para educar con respecto a la difícil situación de los peces del desierto. El sistema deberá también facilitar las comunicaciones entre nosotros mismos y con otras personas en relación a los esfuerzos de conservación a través del mundo, y eventualmente conduciría a reducir los costos de publicación de los Proceedings.

NAKAGAWA,P.A.; SOLTZ,D.L.*; SANDERS,B.M. (PAN and BMS - Molecular Ecology Institute and Department of Biological Sciences, CSULB, Long Beach, CA; DLS - Department of Biological Sciences, CSULB, Long Beach, CA)

Cellular stress response and adaptation in the Amargosa pupfish, *Cyprinodon nevadensis*

Adaptación y respuesta al estrés celular del pez perrito de Amargosa, *Cyprinodon nevadensis*

KEYWORDS: heat-shock or stress proteins; thermotolerance

ABSTRACT

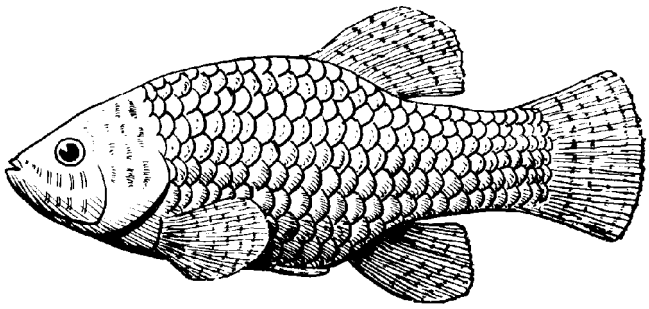
Exposure to elevated temperatures results in the induced synthesis of a suite of highly conserved proteins, referred to as heat-shock or stress proteins. Synthesis of stress proteins may be involved in acquired thermotolerance, a phenomenon in which exposure to a conditioning heat- shock confers thermal protection to a subsequent, more severe heat-shock that otherwise would be lethal. The role of stress proteins in organismic adaptation was examined in two subspecies of *Cyprinodon nevadensis* which occupy different habitats: *Cyprinodon nevadensis amargosae* inhabits a river with large seasonal temperature fluctuations, whereas *Cyprinodon nevadensis nevadensis* lives in a thermal spring with a relatively constant temperature. These studies demonstrated that both subspecies express thermotolerance. In addition, differences between the two subspecies were found in: 1) the ability to induce stress proteins and 2) the isoforms of stress70 expressed. Further, the accumulation of stress proteins was observed to be

tissue-specific within both subspecies. These data suggest that stress proteins may confer thermotolerance to these subspecies and play a role in adaptation to their respective habitats.

CLAVES: proteína de estrés o de shock calorico; termotolerancia

RESUMEN

Exposiciones a elevadas temperaturas resultan en la inducción de la síntesis de un grupo de altamente conservadas proteínas, conocido como shock calórico ó proteínas de estrés. La síntesis de proteínas de estrés puede involucrar el desarrollo de termotolerancia, un fenómeno en el cual la exposición a condiciones de shocks de calor confiere protección térmica para subsecuentes y más severos shocks de calor que de otra forma serían letales. El papel de las proteínas de estrés en la adaptación de organismos fue examinada en dos subespecies de *Cyprinodon nevadensis* los cuales ocupan diferentes hábitats:*Cyprinodon nevadensis amargosae* habita en ríos con grandes fluctuaciones de temperatura estacionales, en cambio *Cyprinodon nevadensis nevadensis* vive en manantiales termales con una temperatura relativamente constante. Estos estudios han demostrado que ambas subespecies expresan termotolerancia. En suma las diferencias entre las dos subespecies fueron encontradas en: 1)La habilidad para inducir el estrés proteínico 2)la isoforma de estrés 70 expresada.además la acumulación de las proteínas de estrés fue observada para tejidos específicos en ambas subespecies. Estos datos sugieren que el estrés proteínico puede conferir termotolerancia a estas subespecies y jugar un papel en la adaptación a sus respectivos hábitats.



NOTICE

Desert Fishes Council welcomes members' contributions of textual and image files for electronic publication on the Internet as part of the DFC World Wide Web pages (http://www.utexas.edu/depts/tnhc/.www/fish/dfc/dfc_top.html). All types of electronic files containing information of potential interest to researchers, and/or the general public, and which contribute toward the DFC's mission of information disemination relevant to desert fishes and their habitats are acceptable. All contributions are appropriately credited. Many pre-existing documents are suitable for publication here, and can be readily converted by DFC volunteers to the appropriate format. Photos and other graphics can be scanned from either slides or prints (preferable). Contact Dean Hendrickson (512) 471-9774, FAX (512) 471-9775, deanhend@mail.utexas.edu (or Texas Natural History Collections / R4000, University of Texas, Austin, TX 78712-1100) to contribute, or with questions.

***WHITE,R*;WITHERS,D.; KANIM,N.; STUBBS,K.; KLAHR,T.; HANLON,J.** (U.S. Fish & Wildlife Service, Region 1; RW-Oregon Ecological Services State Office, Portland; DW-Nevada Ecological Services State Office, Reno; NK, KS-Sacramento Ecological Services Field Office, Sacramento, CA; TK-Idaho State Office, Boise; JH- Carlsbad Ecological Services Field Office, Carlsbad, CA)

U.S. Fish and Wildlife Service, Region 1, report on conservation actions undertaken during 1993 for federally listed and candidate fishes and other aquatic species in California, Idaho, Nevada, and Oregon

U.S. Fish and Wildlife Service, Región 1, reporte sobre las acciones de conservación desarrolladas durante 1993 para los peces candidatos y enlistados federalmente y otras especies acuáticas en California, Idaho, Nevada, y Oregon

KEYWORDS: California; Idaho; Nevada; Oregon; U.S. Fish and Wildlife Service; endangered and threatened fishes; recovery plans; consultations; listings; critical habitat

ABSTRACT

The Fish and Wildlife Service Region One Ecological Services Field and State offices have conducted a variety of listing, recovery, status review, and consultation activities related to desert fishes and other aquatic species this year. These offices include the Oregon State Office (OSO), the Klamath Basin Ecosystem Restoration Office (ERO), the Nevada State Office (NSO), the Sacramento Field Office (SFO), the Carlsbad Field Office (CFO), and the Idaho State Office (ISO). The Oregon State Office developed draft recovery plans for the Warner sucker, *Catostomus warnerensis*, and Foskett Spring speckled dace, *Rhinichthys osculus* ssp.; proposed critical habitat for the Lost River sucker, *Deltistes luxatus*, and the shortnose sucker, *Chasmistes brevirostris* of the upper Klamath basin; assisted in the development of a"warranted but precluded" finding on the Bull trout, *Salvelinus confluentus*; listed the Oregon chub, *Oregonichthys crameri* as endangered; and conducted consultations on Federal projects impacting Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*, Warner sucker, and the shortnose sucker. The ERO provided interagency coordination to arrange Klamath River Basin ecosystem restoration activities at a funding level averaging $1.67 million per year over the next three years. The NSO produced or will produce in the next year draft or final recovery plans for: White River spinedace, *Lepidomeda albivallis*, Big Spring spinedace, *Lepidomeda mollispinis pratensis*, Moapa dace *Moapa coriacea*, Lahontan cutthroat, Railroad Valley springfishes, desert dace, *Eremichthys acros*, Pahranagat roundtail chub, *Gila robusta jordani*, White River springfish, *Crenichthys baileyi baileyi*, and Hiko White River springfish, *Crenichthys baileyi grandis*. The NSO also reports on a fire impacting Moapa dace; recovery activities at Ash Meadows National Wildlife Refuge; the contracting of a habitat management plan for Ash Meadows naucorid, *Ambrysus amargosus*; an Environmental Impact Statement to assess the potental impacts of the Truckee River Operating Agreement, with benefits to cui-ui, *Chasmistes cujus*, is under development; and the development of conservation agreements for the two candidate Amargosa toad, *Bufo nelsoni* and Oasis Valley speckled dace, *Rhinichthys osculus ssp.*. The SFO reports involvement in pre-listing recovery efforts for Cowhead Lake tui chub, *Gila bicolor vaccaceps*, the Goose Lake fishes, McCloud River redband trout, *Oncorhynchus mykiss ssp.*, Eagle Lake rainbow trout, *Oncorhynchus mykiss aquilarum*, Volcano Creek golden trout, *Oncorhynchus mykiss aguabonita*, and Kern River rainbow trout, *Oncorhynchus mykiss gilberti*. The SFO also received a petition to list the Eagle Lake Rainbow Trout, assisted with the Bull trout finding, reclassified the McCloud River redband trout as a Category 1 candidate, conducted consultations on Lahontan cutthroat trout, Paiute cutthroat trout, *Oncorhynchus clarki selenirus*, Little Kern golden trout, *Oncorhynchus mykiss ssp*, Owens tui chub, *Gila bicolor snyderi*, Lost River sucker, shortnose sucker, and Modoc sucker, *Catostomus microps*. The CFO pursued recovery actions for several populations of the unarmored threespine stickleback, *Gasterosteus aculeatus williamsoni*, and initiated an extensive study on the impacts

of contaminants on the Salton Sea populations of the desert pupfish, *Cyprinodon macularius*. The ISO suffered a setback when the listing of the Bruneau Hot Springsnail, *Pyrgulopsis bruneauensis*, was reversed by court order. The ISO also received a petition to list the interior redband trout, *Oncorhynchus mykiss gairdneri*, in the Kootenai drainage, and has initiated a status survey of all redband forms in southwest Idaho. The ISO has additionally been involved in recovery and conservation planning activities for the Bonneville cutthroat trout, *Oncorhynchus clarki utah*, the Bull trout, and assisted with the Bull trout finding.

CLAVES: California; Idaho; Nevada; Oregon; U.S. Fish and Wildlife Service; peces en peligro y amenazados; planes de recuperación; consultas; listas; hábitat crítico

RESUMEN

Las Oficinas Estatales y de Campo de Servicios Ecológicos, de la Región Uno de el Fish and Wildlife Service, han conducido una variedad de propuestas, recuperación, revisión de estatus, y actividades de consulta relacionadas a los peces del desierto y otras especies acuáticas este año. Estas oficias incluye la Oregon State Office (OSO), The Klamath Basin Ecosystem Restoration Office (ERO), Nevada State Office (NSO), Sacramento Field Office (SFO), Carlsbad Field Office (CFO), e Idaho State Office (ISO). The Oregon State Office desarrolló un borrador de plan de recuperación para el matalote de Warner, *Catostomus warnerensis*, y el Foskett Spring speckled dace, *Rhinichthys osculus* spp.; propuso hábitat crítico para el matalote del Río Perdido (Lost River sucker), *Deltistes luxatus*, y el matalote nariz corta (shortnose sucker), *Chasmistes brevirostris* de la cuenca Alta del Klamath; asistió en el desarrollo de las conclusiones del reporte "warranted but precluded" sobre la trucha toro, *Salvelinus confluentus*; sobre el charal de Oregon, *Oregonichthys crameri* en peligro; y condujo consultas sobre proyectos federales que impactan sobre la trucha Lahontan cutthroat, *Oncorhynchus clarki henshawi*, el matalote Warner, y el matalote nariz corta. El ERO proporcionó coordinación de interagencias para las actividades de restauración del ecosistema de la Cuenca del Río Klamath, con fondos que promediaron $1.67 millones de dólares por año en los siguientes tres años. El NSO produjo o producirá en el siguiente año un borrador o plan final de recuperación para: el White River spinedace, *Lepidomeda albivallis*, Big Spring spinedace, *Lepidomeda mollispinis pratensis*, Moapa dace *Moapa coriacea*, Lahontan cutthroat, Railroad Valley springfishes, desert dace, *Eremichthys acros*, Pahranagat roundtail chub, *Gila robusta jordani*, White River Springfish, *Crenichthys baileyi baileyi*, y Hiko White River springfish, *Crenichthys baileyi grandis*. La NSO también reportó sobre un incendio que impactó sobre el Moapa dace; actividades de recuperación en Ash Meadows National Wildlife Refuge; la contratación de un plan de manejo de hábitat para el naucorido de Ash Meadows, *Ambrysus amargosus*; Los estatutos de Impacto Ambiental para evaluar los impactos potenciales del Acuerdo de Operación de Truckee River, con beneficios para cui-ui, *Chasmistes cujus*, esta en desarrollo; y el desarrollo de acuerdos de conservación para dos especies candidatas, Amargosa Toad, Bufo nelsoni y Oasis Valley speckled dace, *Rhinichthys osculus ssp.*. La SFO reporta su involucramiento en esfuerzos de recuperación para el Cowhead Lake Tui Chub, *Gila bicolor vaccaceps*, los peces del Lago Goose, McCloud River redband trout, *Oncorhynchus mykiss aquilarum* trucha Volcano Creek golden, *Oncorhynchus mykiss aguabonita*, y la trucha arcoiris del Río Kern, *Oncorhynchus mykiss gilberti*. El SFO también recibió también recibió una petición para enlistar la trucha arcoiris del Lago Eagle, asesoró con las conclusiones para la Trucha toro, recategorizando a la trucha banda roja del lago McCloud en la categoría de candidato 1, condujo consultas sobre la trucha Lahontan cutthroat, la trucha Paiute cutthroat, *Oncorhynchus clarki selenirus*, trucha Little Kern golden, *Oncorhynchus mykiss ssp*, charal Owens tui, *Gila bicolor snyderi*, matalote Lost River, Matalote shortnose, y matalote Modoc, *Catostomus microps*. El CFO impulsó las

acciones de recuperación para varias poblaciones de el unarmored threespine stickleback, *Gasterosteus aculeatus williamsoni*, e inició un estudio extensivo sobre los impactos de la contaminación sobre las poblaciones de Salton sea, del pez perrito del desierto, *Cyprinodon macularius.* La ISO sufrió un retroceso cuando la propuesta sobre el Bruneau Hot Springsnail, *Pyrgulopsis bruneauensis*, fue rechazada por orden de la corte. La ISO también recibió una petición para enlistar a la trucha banda roja del interior, *Oncorhynchus mykiss gairdneri*, en el drenaje de Kootenai, y ha iniciado una evaluación del estatus de todas las formas de truchas banda roja en el Suroeste de Idaho. El ISO adicionalmente ha estado involucrado en actividades planeación de la conservación y recuperación para la trucha Bonneville cutthroat, *Oncorhynchus clarki utah*, la trucha toro, y asesoró con las conclusiones sobre la trucha toro (Bull trout).

CONTRIBUTED PAPER

Actions are listed by the lead office for a given species or issue.

OREGON STATE OFFICE - Recovery Planning: An agency/technical draft of the recovery plan for the threatened Warner sucker, *Catostomus warnerensis*, was once again submitted to the Region 1 office for review. Previous drafts have become outdated prior to finalization by continued research in the Warner Basin on this species funded through a partnership among the Service, the Bureau of Land Management (BLM), the Oregon Department of Fish and Wildlife (ODFW), and The Nature Conservancy (TNC). The Warner Basin is located in Oregon, with portions of the watershed extending into both California and Nevada. An agency/technical draft recovery plan for the threatened Foskett Spring Speckled Dace, *Rhinichthys osculus* ssp., also of the Warner Basin, was submitted to the Region for review as well.

Pre-Listing - As reported at last year's DFC Meeting, the Summer Basin tui chub is currently being studied by researchers at Oregon State University to determine if recently discovered populations represent the original form of this species. The Summer Basin tui chub was recently re-classified from C1 to C2 candidate status following a determination by the Regional Office that there was insufficient information to support a listing. The results of the Oregon State University investigation of genetic and morphometric taxonomic characteristics is expected to be completed in late 1995.

Listing - Critical habitat for the Lost River sucker, *Deltistes luxatus*, and shortnose sucker, *Chasmistes brevirostris*, of the Upper Klamath River Basin of Oregon and California was proposed in September of this year. A public comment period was opened on the proposed rule, its attendant Biological Support Document, and on the Draft economic analysis report prepared by ECO Northwest, of Eugene, Oregon. A final rule is due by court order before the end of the calendar year, but that deadline will likely not be met.

In response to petitions to list the Bull trout, *Salvelinus confluentus*, the Service published a warranted but precluded finding in June of 1994. This finding means that the Bull trout is warranted for listing, but higher priority listing actions preclude preparation of a proposed rule. This also requires that the Service review the status of the species on a yearly basis. It also resulted in the elevation of the Bull trout from C2 to C1 candidate status.

The listing of the Willamette River's endemic Oregon Chub, *Oregonichthys crameri*, was finalized in mid-October of 1993. Last year's Region 1 report to the Desert Fishes Council erroneously stated that a decision on the listing package for the Oregon Lakes tui chub, *Gila bicolor oregonensis*, was expected from the Washington, D.C., office. The Oregon Lakes tui chub has not, in fact, been petitioned for listing and remains a category 2 candidate species. The Service regrets any confusion caused by mixing up these two similarly named species. Critical habitat for the Oregon chub has not yet been proposed.

Consultation - The Oregon State Office completed a total of 16 formal consultations on listed fishes, 15 of which were non-Jeopardy biological opinions. These consultations included 2 consultations on 2 grazing allotments impacting Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*, 5 consultations on a total of 36 grazing allotments impacting Warner sucker, 4 consultations covering 11 grazing allotments impacting shortnose sucker, *Chasmistes brevirostris*, and 2 consultations covering 2 timber sales impacting the shortnose sucker. The one Jeopardy biological opinion was a reinitiation of the July 22, 1992, biological opinion on Long Term Operations of the Bureau of Reclamation's Klamath Project that focused on modifications of the Bureau's actions at Clear Lake Reservoir.

The Klamath Basin Ecosystem Restoration Office (ERO) The Klamath Basin Ecosystem Office (ERO) opened September 1993. The Office was established to provide interagency coordination, holistic planning, restoration, and outreach. ERO has had support and staff from the Fish and Wildlife Service, Bureau of Reclamation, Forest Service, and Bureau of Land

Management. ERO will conduct $1.5 million inrestoration projects for FY 94, $1.5 million in fiscal year 1995 and $2.0 million in fiscal year 19 96. Initial holistic planning has centered on development of seamless Geographic Information System (GIS) data for the basin and making data layers available to all management entities. Basin wide scoping meetings have been hold to identify citizen concerns. ERO is unique in that it is the first national attempt to holistically plan and manage an ecosystem. Other national efforts center on coordination of current activities. ERO's emphasis is on long range ecosystem planning that will restore form and function and prevent future listings. ERO's presence in the Basin has sparked other conservation efforts and promoted more cooperation between all entities.

NEVADA STATE OFFICE - Recovery plans for endangered White River spinedace (*Lepidomeda albivallis*), threatened Big Spring spinedace (*Lepidomeda mollispinis pratensis*), and threatened desert tortoise (*Gopherus agassizii*) were approved in 1994. Copies of these recovery plans are available by contacting the Nevada State Office in Reno. Final recovery plans for endangered Moapa dace (*Moapa coriacea*) and threatened Lahontan cutthroat trout (LCT) (*Oncorhynchus clarki henshawi*) have been submitted for approval. The public comment period for the draft Railroad Valley springfish recovery plan closed in August 1994. Comments will be incorporated and the final document prepared for approval by March 1995. Draft recovery plans for endangered Steamboat buckwheat (*Eriogonum ovalifolium williamsiae*), threatened desert dace (*Eremichthys acros*), and three endangered fishes in Pahranagat Valley, including Pahranagat roundtail chub (*Gila robusta jordani*), White River springfish (*Crenichthys baileyi baileyi*), and Hiko White River springfish (*Crenichthys baileyi grandis*, will be available for public comment by late 1994.

In June 1994 a fire devastated the Moapa National Wildlife Refuge (NWR), severely impacting the endangered Moapa dace and other endemic aquatic species resident in the springs and their outflow streams. Immediate efforts were made to clean fire debris from the streams and restore habitat structure and shading to encourage recolonization by native species. Subsequent surveys revealed that at least 500 Moapa dace were killed during the fire. The entire population numbers approximately 3,800 individuals, but the refuge provided the majority of the spawning habitat for this species. The status of this fish will be closely monitored over the next few years. The National Biological Survey has been contracted to investigate the status and distribution of endemic aquatic biota of the Muddy River ecosystem, which includes one endangered fish, three candidate fish, and four candidate invertebrates.

During 1994, approximately 100 wild horses were removed to prevent destruction of the unique aquatic and terrestrial habitats within the Ash Meadows NWR. A fence will be constructed around the perimeter of the refuge to prevent future movement of horses from other areas into Ash Meadows. Approximately 200 acres of tamarisk were treated with herbicide in the Carson Slough and south of Point-of-Rocks Spring in Ash Meadows NWR. Conditions were ideal for the aerial application of the herbicide, and refuge staff are optimistic of a significant kill, although results will not be readily apparent until spring 1995. A habitat management plan for the threatened Ash Meadows naucorid (*Ambrysus amargosus*) is being developed for the Fish and Wildlife Service under contract. Ash Meadows NWR staff are continuing to remove all interior fences and debris, and they have installed new visitor facilities and revegetated closed roads. A baseline contaminants study has been proposed for the Ash Meadows NWR, but it has not yet been funded. Of specific concern is determining the origin of concentrations of PCP's in one spring on the refuge.

The Nevada Ecological Services State Office is preparing an Environmental Impact Statement to assess the potential impacts of the Truckee River Operating Agreement (TROA), required under Public Law 101-618 (Truckee-Carson-Pyramid Lake Water Rights Settlement Act). TROA will provide drought storage for the cities of Reno and Sparks, Nevada, in Federal reservoirs without infringing on entitled water rights. TROA must also enhance spawning flows in the Truckee River for endangered cui-ui (*Chasmistes cujus*) and threatened LCT.

Nevada Ecological Services State Office is continuing to work with the Bureau of Land Management, The Nature Conservancy, Nevada Division of Wildlife, and private landowners near Beatty, Nevada, to implement recovery actions and develop conservation agreements for the Amargosa toad (*Bufo nelsoni*) and Oasis Valley speckled dace (*Rhinichthys osculus* ssp.), candidates for listing as threatened or endangered.

SACRAMENTO FIELD OFFICE - Pre-Listing - The Sacramento office initiated or cooperated in pre-listing recovery efforts for Cowhead Lake tui chub, Goose Lake fishes, McCloud River redband trout, Eagle Lake rainbow trout, Volcano Creek golden trout, and Kern River rainbow trout. The Forest Service is initiating Conservation Agreements for some of these species impacted by grazing allotments, etc.

Through consultation with the California Department of Fish and Game, U.S. Forest Service, and private landowners, the stocking of hatchery rainbow trout has been stopped in the upper McCloud River drainage and efforts to improve habitat conditions have been initiated or expedited.

Listing - The McCloud River redband trout was recommended for re-classification from C2 to Cl. Two petitions for listing the Eagle Lake rainbow trout were received and a draft positive 90 day finding was submitted to the regional office. Information on bull trout in California was sent to the Olympia office for use in the warranted but precluded one year finding released on this species.

Consultation - Four formal consultations for 15 Forest Service grazing allotments were completed that affected Lahontan cutthroat trout, Paiute cutthroat trout, Little Kern golden trout, and Owens tui chub. Grazing standards were developed with the help of the U.S. Forest Service, Oregon State and Nevada State offices of the U.S. Fish and Wildlife Service. Informal consultations (that will become formal consultations) on several other allotments that affect Lost River, shortnose, and Modoc suckers resulted in reduced impacts from grazing.

One formal consultation was completed for Forest Service timber harvests in Modoc sucker watersheds. Consultations on three private timber harvests that may affect Lahontan cutthroat trout were also completed.

CARLSBAD FIELD OFFICE - The unarmored threespine stickleback (UTS) recovery team has been active this past year. The Service provided input on two projects. The recovery team reviewed a proposal by the Natural Heritage Foundation (NHF) to create an artificial refugium with the use of secondary treated effluent. The proposal, however, lacked important details such as water quality, vegetational treatment of effluent, discharge from the ponds, water flows, etc. This proposed project was located on Baldwin Lake, near Big Bear Lake, in the San Bernardino Mountains.

The recovery team also received water quality and invertebrate information collected last year for several potential refugia on the San Bernardino National Forest (SBNF) for the Shay Creek population of UTS. One location, Juniper Springs, best represented the Shay Meadow location where this population currently exists. The SBNF is in the process of preparing a Biological Assessment and Biological Evaluation for the use of Juniper Springs as a refugium for the Shay Creek population. The recovery team assessed the physical setting of Juniper Springs and suggested that the pond be fenced with range fencing encompassing a large portion of the meadow surrounding the pond to improve water quality. Cattle currently utilize the pond for water and the meadow for grazing. The pond exhibits evidence of high levels of nutrients. The meadow downstream of the pond also has great potential for enhancement as habitat with some minor excavations to create meandering channels through the meadow.

A desert pupfish study by the Contaminants Branch began in June 1994 with collections of sailfin mollies to serve as surrogates for the endangered desert pupfish. In June 1994, seven drains that had a history of use by both desert pupfish and sailfin mollies were sampled. A sufficient number of mollies were collected for chemical analysis in three of the drains. Desert pupfish were not observed in any of the drains sampled in June. Fish surveys and collections continued during July-September 1994. This sampling schedule included the months of August- September when the Imperial Irrigation District (IID) surveyed agricultural drains for desert pupfish. The IID Survey Team was able to provide samples from a total of 10 drains. The Service is submitting a total of 32 samples of sailfin mollies from 13 drains for chemical analysis. Of greatest interest are selenium, boron and pesticide levels in the tissues of these fish. This study is part of the Salton Sea National Irrigation Water Quality Program.

IDAHO STATE OFFICE - In an unprecedented decision, an Idaho district judge removed the Bruneau Hot Springsnail (*Pyrgulopsis bruneauensis*) from the endangered species list on December 14, 1993. The district court set aside the January 1993 listing of the snail as endangered because of procedural and due process violations. However, the district court affirmed the scientific basis for the listings concluding that "the Fish and Wildlife Service articulated a rational connection between the factors identified and the choice made." An appeal of the district court decision was filed in May 1994 by the Land and Water Fund of the Rockies (LAW Fund); a decision of this appeal is expected later this year. Also, the LAW Fund submitted a petition to re-list the springsnail early in 1994 which the Service is currently reviewing.

Monitoring of Bruneau Hot Springsnail populations and the regional ground water aquifer continues throughout 1994.

The Service received a petition to list the interior redband trout (*Oncorhynchus mykiss gairdneri*) in the Kootenai drainage as a threatened or endangered species on April 4, 1994. The 90-day finding for this listing petition, prepared by the Idaho State office, is currently under review by the Service. The Idaho State Office has also received notice that a petition to list the desert redband trout is likely to be filed in the near future. In response to this notice, the Idaho State Office is initiating a status review of the redbands of southwest Idaho.

The Idaho State Office is: (1) working with the Caribou National Forest to implement management measures that protect the remaining pure-strain populations of the Bonneville cutthroat trout (*Oncorhynchus clarki utah*) in Idaho, (2) convened an interagency working group to develop a Conservation Agreement for long-term protection, and (3) participating with Region 6 (Service) in a status review of the sub-species throughout its range. This species of cutthroat trout is native to the Bonneville basin, similar to the Yellowstone cutthroat trout. Differences are mainly in larger, more evenly distributed spots on the sides of the body and in generally fewer scales in the lateral series. Found primarily in small headwater streams, they generally

range in size from 2 to 9 in., with lake populations reaching 30 in.

The Bonneville cutthroat trout is included as a category 2 candidate (C2) species in the November 21, 1991 Animal Notice of Review (56 FR 58804). In Idaho, only a few pure-strain stream and one lake populations of the species remain. This species has declined dramatically throughout its historic range, especially in Idaho. This decline has paralleled the introduction of non-native trouts and continued habitat alteration and destruction of preferred habitats from grazing and logging practices. Remaining stream populations occur on the Caribou National Forest primarily within in the Thomas Fork drainage; most are located within the Montpelier Elk Valley Cattle Allotment. The Caribou National Forest in cooperation with the Caribou Livestock Association, Idaho Soil Conservation Commission, and Idaho Department of Fish and Game have finalized a Conservation Agreement (CA). The CA is being routed for signature to the cooperating agencies.

In March 1985, the Service (Region 6) prepared a Proposed rule to list the Bonneville cutthroat trout as threatened with critical habitat. In subsequent discussions of the proposed rule with the Forest Service and Idaho, Utah, and Wyoming Fish & Wildlife staff, the Service determined that further information was needed prior to any listing decision. As a prototype for two CA's being finalized for this species, the Service will be closely monitoring the implementation and compliance of this CA. In Idaho, the Caribou Livestock Association represents 17 livestock permittee for the Montpelier Elk Valley cattle allotment. The Association intends to sign the CA.

The Idaho State Office initiated a letter to the Regional office requesting that regional coordination of bull trout issues be conducted out of the Idaho State Office. This request also means establishment of a regional coordinator for these issues. The Idaho Department of Fish and Game is considering the establishment of a comparable position for Idaho. The intent of these two positions will be to work with all entities to implement the April 4, 1994 Conservation Strategy for Bull Trout (CSBT).

The CSBT, which was written by a interagency team from Idaho, has been recognized as a key document for recovery by all State Fish and Wildlife agencies, the U.S. Forest Service, and the BLM Districts that are affected by the species candidate status. Other State Fish and Game agencies, the Forest Service, and BLM are adopting the CSBT and modifying it to local conditions. It remains to be seen just how pervasive implementation will be done. By implementing the CSBT through a sub-basin approach, manageable Conservation Agreements can be developed that will allow for annual compliance and review. This will put the Service in a very strong position to judge whether threats are being reduced and the inadequacy of existing regulatory mechanisms are being addressed when conducting the annual review of the status of bull trout under a Cl category. In Idaho, the Idaho Department of Fish and Game does not want to loose its authority to manage fish resources in streams and rivers where bull trout are found. The BLM and Forest service do not want to address another listed fish species which has a broad range in Idaho. All these agencies appear to be motivated to implement the CSBT.

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Agency Report for the Utah Field Office, Fish and Wildlife Service

Reporte de Agencia para la Utah Field Office, Fish and Wildlife Service

KEYWORDS: consultation; Utah; Conservation Agreement; Virgin spinedace; June sucker; least chub; Bonneville cutthroat trout

ABSTRACT

The Utah Field Office of the Fish and Wildlife Service continued to be involved in desert fishes conservation activities. Numerous consultations were completed in the Virgin River basin, and a draft Conservation Agreement was drafted regarding the Virgin spinedace *Lepidomeda mollispinis mollispinis*. June sucker *Chasmistes liorus liorus* experienced another drought during spawning in 1994, and Service negotiations were beneficial in securing minimum flows during spawning activities in the lower Provo River. Additionally, a consultation was completed with the Bureau of Reclamation regarding operations of the Provo River Project which will result in guaranteed minimum flows during June sucker riverine occupation. The Agency/Public review draft of the June sucker Recovery Plan will be available this fall. A listing package for the least chub *Iotichthys phlegethontis* was submitted to Region 6 for finalization. The Service is working with the Utah Division of Wildlife Resources in developing a Conservation Agreement for Bonneville cutthroat trout *Oncorhynchus clarki utah*. Numerous consultations were completed in the Colorado and Green River basins.

CLAVES: consulta; Utah; Acuerdo de Conservación; Virgin spinedace; matalote de Junio; least chub; trucha Bonneville cutthroat

RESUMEN

La Utah Field Office de el Fish and Wildlife Service continúa involucrada en las actividades de conservación de los peces del desierto. Numerosas consultas fueron completadas en la cuenca del Río Virgin, y un borrador de acuerdo de conservación fue esbozado en torno al Virgin Spinedace *Lepidomeda mollispinis mollispinis*. El Matalote de Junio (June sucker) *Chasmistes liorus liorus* experimentó otro pequeño período de lluvias durante el desove de 1994, y las

negociaciones del Servicio fueron benéficas para asegurar los flujos mínimos durante las actividades de desove en el Bajo Río Provo. Adicionalmente, una consulta fue completada con el Buró de Reclamaciones en relación a las operaciones del Proyecto Río Provo, el cual resultará en garantizar los flujos mínimos durante la ocupación riberina del matalote de Junio. La Agencia/Público revisó un borrador del Plan de Recuperación del matalote de Junio el cual estará disponible en este otoño. Una lista de propuestas para el least chub *Iotichthys phlegethontis* fue sometida a la región 6 para finalización. El Servicio esta trabajando con la Utah Division of Wildlife Resources en desarrollar un Acuerdo de Conservación para la Bonneville cutthroat trout *Oncorhynchus clarki utah*. Numerosas consultas fueron completadas en las cuencas del Río Colorado y Green.

MINCKLEY,C.O. (U.S. Fish and Wildlife Service, Arizona Fisher Resouce Office, Parker, Arizona)

Summary of Arizona Fishery Resource Office activities, 1994

Sumario de actividades de la Oficina de Recurso Pesquero de Arizona, 1994

KEYWORDS: Colorado River; Arizona; California; Grand Canyon

ABSTRACT

The following is a summary of 1994 activities for the three Arizona Fishery Resource Offices. Additional activities for AESO and Fish Health are anticipated but had not been received prior to the development of this summary. They will be presented if received.

PINETOP OFFICE - During June, approximately five miles of Ord Creek, on the Fort Apache Indian Reservation were renovated to remove brook trout and to prepare the stream for introduction of pure Apache trout. This was conducted by the AZFRO staff, members of the White Mountain Apache Game and Fish Department, YCC members and volunteers. Additionally, the staff of the Pinetop Fish Health Center conducted disease surveys on the creek during the renovation. Currently, electroshocking surveys are assessing the success of the renovation.

This summer fish migration barriers were constructed on Big Bonito and Squaw Creek by the YCC crew and volunteers of the White Mountain Apache Tribe. Work was also started on a fish migration barrier on Flash Creek, and minor repairs were made to barriers on Paradise and Ord Creeks.

Members of AZFRO and the Pinetop Fish Health Center sampled streams throughout the Fort Apache Indian Reservation to determine the genetic purity of Apache trout. Based on this work, it was discovered that the genetic pool of the Big Bonito Creek stock is in jeopardy. This resulted in the drafting and implementation of the Apache Trout Contingency Plan in conjunction with the Apache Trout Recovery Team. This fall, Flash Creek fish, which represent the final remaining pure stock of Apache Trout from the Big Bonito drainage, will be taken into the Alchesay/Williams Creek National Fish Hatchery for propagation and restocking to the drainage after renovation.

FLAGSTAFF FISHERY RESOURCE OFFICE - The Flagstaff office conducted two spring and two summer sampling trips into the Little Colorado River to assess/monitor stream habitat and habitat use by humpback chub and other native fishes. Humpback chub appeared to commence spawning in mid-winter; appearance of a broad range of YOY fishes suggested a protracted spawning season. Surveys were also conducted in Grand Canyon tributaries (Paria, Bright Angel, Shinumo; Tapeats, Deer, Kanab, Havasu) to assess/monitor stream habitat and habitat use by native fishes.

A pilot study of cryopreservation of razorback sucker sperm was also carried out during the Lake Mohave roundup, March 1994. Successfully fertilized eggs in the field with cryopreserved milt. Conducted pilot study on cryopreservation of bonytail chub sperm at Dexter NFH in May; eggs were successfully fertilized with cryopreserved sperm. We are preparing to conduct a pilot study on humpback chub in 1995.

Finally, a draft final report on GCES contracted studies was completed on June 30. A final version is expected by 1 October.

PARKER FISHERY RESOURCE OFFICE - Razorback suckers - To date, a total of 90 razorback suckers have been released into Colorado River waters from isolated growout facilities. This includes 86 from the high levee pond growout facility at Cibola NWR and 4 from Pittsburgh Point Cove on Lake Havasu. During a two week period in March 230 razorback suckers were taken in the annual research on Lake Mohave by Service personnel. 24% were recaptures.

During March-April an estimated 110,000 razorback sucker eggs were fertilized and delivered to Willow Beach National Fish Hatchery. Currently, it is estimated that 10,000 fish ranging from one to 12 inches are being held at the hatchery. These fish were collected from several different areas on Lake Mohave at different times of the month. One to one matings were performed and a standard quanity of eggs were taken (25 ml) each time. These fish were produced to determine if retrofitting of this hatchery to a warm water facility would make it feasible to produce native fish.

Additionally, during February and March personnel from the Service participated in harvesting wild razorback sucker larvae from Lake Mohave with other members of the native fish group. In conjunction with this 1200 larvae were transferred to the Parker FRO and held and reared to replenish the broodstock at Dexter NFH. Two hundred two-four inch fish were delivered to Dexter in October 1994.

During 1994 no bonytail chubs were produced from the Office Cove as it was breached shortly after establishment allowing fish to escape into the lake and non-indigenous fish to enter the cove. When it was poisoned, no native fish were taken. However, a total of 58 adult bonytail chub have been removed from the Hassayampa River Preserve (The Nature Conservancy) and released into Lake Havasu during 1994. Six thousand 1-2 inch fish were produced from 44,000 fry provided to the Parker FRO in April of 1994 and introduced into two facilities on Lake Havasu.

During 1994, as part of the efforts of the Lake Havasu Native Fish Project in partnership with Bureau of Land Management and other agencies, three additional barriered habitats were developed on Lake Havasu for native fish. Additionally, a isolated habitat was developed adjacent to Lake Havasu. Two facilities in operation on Lake Havasu in 1993 were also re- poisoned to prepare them for receiving bonytail chubs in October.

One isolated facility has also been developed on Imperial NWR. In addition to this four ponds on the La Paz County golf course have been developed for native fish.

The Pinetop Fish Health Office examined fishes for disease from No Entry Cove and from the Hassayampa River Preserve. Nothing of significance was found. However, upon examination of two bonytail chub which died subsequent to the initial examination, the Asian tapeworm was found.

In summary, twelve native fish isolated habitats are in place along the lower Colorado River, below Davis Dam. These include the following sites on or adjacent to Lake Havasu: Pittsburgh Point Cove No Entry Cove Office Cove - Bill Williams River NWR Twin Cove South - Havasu NWR Twin Cove North - Havasu NWR Bulkhead Cove. In addition:
Four ponds on the La Paz County golf course High Levee Pond - Cibola NWR Hidden Lake - Imperial NWR. Currently all are stocked with bonytail chub produced by Dexter National Fish Hatchery and Technology Center. The total acreage is estimated at 25 acres.

Besides these activities, Parker FRO has produced the Little Colorado Spinedace Recovery Plan which was published in the Federal Register on 23 September 1994. The Lower Basin Management Plan for Indigenous Big River Fishes was also produced and is currently under review.

CLAVES: Río Colorado; Arizona; California; Gran Cañón

RESUMEN

El siguiente es un sumario de las actividades de 1994 de las tres Oficinas de Recurso Pesquero de Arizona. Actividades adicionales de la AESO y Fish Health están anticipadas pero no fueron recibidas previo al desarrollo de este sumario. Estas serán presentadas si se reciben.

PINETOP OFFICE - Durante Junio, aproximadamente cinco millas de Ord Creek, en la Reservación India del Fuerte Apache fueron renovadas para remover la trucha de arroyo y para preparar el arroyo para la introducción de trucha Apache pura. Esto fue llevado a cabo por el personal de la AZFRO, miembros del Departamento de Caza y Pesca White Mountain Apache, miembros de la YCC y voluntarios. Adicionalmente, el personal del Centro de Salud Piscícola de Pinetop condujo estudios de enfermedad en el arroyo durante la renovación. Constantemente, estudios de electropesca están determinando el éxito de la renovación.

Este verano se construyeron barreras de migración de peces sobre el Arroyo Big Bonito and Squaw por el personal de la YCC y voluntarios de la Tribu Apache de White Mountains. Se inició también el trabajo sobre una barrera de migración en el Arroyo Flash, y se hicieron reparaciones menores en los arroyos Paradise y Ord.

Miembros de la AZFRO y del Centro de Salud Piscícola de Pinetop muestrearon arroyos a través de toda la Reservación India del Fuerte Apache para determinar la pureza genética de la trucha Apache. Con base en este trabajo, se descubrió que el pool genético del grupo del Arroyo Big Bonito esta en peligro. Esto tuvo como resultado el borrador y la implementación del Plan de Contingencia de la Trucha Apache en conjunción con el Equipo de Recuperación de la Trucha Apache. Esta otoño, peces del Arroyo Flash el cual representa el último grupo puro remanente de la Trucha Apache del drenaje del Big Bonito, serán tomado en la Granja Nacional de Peces del Arroyo Alchesay/Williams para la propagación y reubicación en el drenaje después de la renovación.

OFICINA DEL RECURSOS PESQUEROS DE FLAGSTAFF - La Oficina de Flagstaff condujo dos viajes muestreos de verano y dos de primavera al Pequeño Río Colorado para evaluar/monitorear hábitat de corriente y uso del hábitat por el charal jorobado y otros peces nativos. El charal jorobado parece comenzar a desovar a mitad del invierno; la aparición de un amplio rango de peces jóvenes de un año sugirió una estación alargada de desove.

También se llevaron a cabo estudios en los tributarios del Gran Cañón (Paria, Bright Angel, Shinumo; Tapeats, Deer, Kanab, Havasu) para evaluar/monitorear el hábitat de corriente y uso del hábitat por peces nativos.

Un estudio piloto de criopreservación de esperma del matalote jorobado se realizó también durante el muestreo del Lago Mohave, en Marzo de 1994. Huevos exitosamente fertilizados en el campo con esperma criopreservado. Se llevó a cabo un estudio piloto sobre criopreservación de esperma de charal elegante en el Dexter NFH en Mayo; los huevos fueron fertilizados exitosamente con esperma criopreservado. Nos preparamos para conducir un estudio piloto de charal jorobado en 1995.

Se completó un reporte borrador final sobre los estudios contratos de GCES en Junio 30. Una versión final se espera para el 1 de Octubre.

OFICINA DE RECURSO PESQUERO DE PARKER - Matalote Jorobado - A la fecha, se han liberado un total de 90 matalotes en las aguas del Río Colorado en instalaciones de crecimiento aisladas. Esto incluye 86 de la presa alta Levee en Cibola NWR y 4 de Pittsburgh Point Cove en el Lago Havasu. Durante un período de dos semanas en Marzo se tomaron 230 matalotes jorobados en la investigación anual en el Lago Mohave por personal del Servicio. El 24% fueron recapturas.

Durante Marzo-Abril un estimado de 110,000 huevos de matalotes jorobados fueron fertilizados y entregados a la Granja Nacional de Peces Willow Beach. Normalmente, es estimado que 10,000 peces que varían de una a 12 pulgadas están siendo mantenidos en la granja. Estos peces fueron colectados de varias áreas diferentes en el Lago Mohave en fechas diferentes en el mes. Se realizaron desoves de uno en uno y se tomó una cantidad estándar de huevos (25 ml) cada vez. Estos peces fueron producidos para determinar si la readecuación de esta granja a una instalación de agua caliente haría factible el producir peces nativos.

Adicionalmente, durante Febrero y Marzo el personal del Servicio participó en la cosecha de larvas de matalotes jorobados silvestres del Lago Mohave con otros miembros del grupo de peces nativos. En conjunción con esto, 1200 larvas fueron transferidas al Parker FRO, donde fueron llevadas a juveniles y mantenidas para reponer los grupos de reproductores en NFH Dexter. 200 de 2-4 pulgadas fueron entregados en Dexter en Octubre de 1994.

Durante 1994 no se produjeron charales elegantes en la Office Cove pues fue dividida poco después del establecimiento, permitiendo a los peces escapar hacia el lago y a los peces no indígenas entrar. Cuando fue envenenada, se tomaron peces no nativos. Sin embargo, un total de 58 charales adultos han sido removidos de la Reserva del Río Hassayampa (del Nature Conservancy) y liberados en el Lago Havasu durante 1994. Seis mil peces de 1-2 pulgadas fueron producidos de 44,000 pececillos proporcionados al Parker FRO en Abril de 1994 e introducidos en dos instalaciones en el Lago Havasu.

Durante 1994, como parte de los esfuerzos del Proyecto de Peces Nativos del Lago Havasu en cooperación con el Bureau of Land Management y otras agencias, se desarrollaron tres hábitats obstruidos adicionales en el Lago Havasu para peces nativos. Adicionalmente, un hábitat aislado fue desarrollado junto a Lago Havasu. Dos lugares accesibles en operación en el Lago Havasu en 1993 fueron también re-envenenadas para prepararlas para recibir charales elegantes en Octubre. Un lugar disponible aislado ha sido también desarrollado en el Imperial NWR. En suma a esto, cuatro presas en el campo de golf del Condado de la Paz han sido desarrolladas para peces nativos.

La Oficina de Salud Piscícola de Pinetop examinaron peces para detectar enfermedades de No Entry Cove y de la Preservación del Río Hassayampa. No se encontró significancia. Sin embargo en la examinación de dos charales elegantes que murieron después del examen inicial, se encontró un gusano asiático (Asiatic tapeworm).

En resumen, doce hábitats aislados de peces nativos están situados a lo largo del Río Colorado, hacia abajo de la Presa Davis. Estos incluyen los siguientes sitios en o adyacentes al Lago Havasu: Pittsburgh Point Cove, No Entry Cove, Office Cove - Bill Williams
River NWR, Twin Cove South - Havasu NWR, Twin Cove North - Havasu NWR Bulkhead Cove. En suma: Cuatro pozas en el campo de golf del Condado de La Paz High Levee Pond - Cibola NWR Hidden Lake - Imperial NWR. Actualmente todas están pobladas con charales elegantes de la Granja Piscícola Nacional y Centro Tecnológico de Dexter. El área total se estima en 25 acres.

Además de estas actividades, Parker FRO ha producido el Plan de Recuperación del Little Colorado Spinedace el cual fue publicado en el registro federal del 23 de Septiembre de 1994. Un Plan de Manejo para los peces indígenas de la Cuenca Baja del Río Big fue también producido y actualmente esta bajo revisión.

MONTOYA,E.* (EM - Navajo Nation, Fish and Wildlife Department, Natural Heritage Program, Window Rock, AZ)

Navajo Natural Heritage Program's Little Colorado River basin data bases

Base de datos de la cuenca del Pequeño Río Colorado, del Navajo Natural Heritage Program

KEYWORDS: Little Colorado River basin; data base; annotated bibliography; GIS; Navajo Natural Heritage Program; Navajo Fish and Wildlife Department

ABSTRACT

The Navajo Natural Heritage Program is in the process of developing data bases on the Little Colorado River (LCR) basin. Currently, a draft version of an annotated bibliography in dBase format has been developed under a Cooperative Agreement with the Bureau of Reclamation-Glen Canyon Environmental Studies. There are 1799 citations in the data base. A Geographic Information System (GIS) data base on the LCR basin is also being developed utilizing Arc- Info. This includes aspects of hydrology, biology, and geology, including endangered, threatened, and sacred flora and fauna. This also includes current and projected LCR basin threats. Current sources include data base searches, requests to tribal, federal, state, local, and private agencies, as well as personal contacts and interviews. This LCR data base is available as a reference to help in the decisions affecting the LCR basin. The LCR annotated bibliography is available to all agencies who request a copy; Attn: Ruby Hale and/or Mike Tremble.

CLAVES: cuenca del Pequeño Río Colorado; base de datos; listado bibliográfico; Sistema de Información Geográfico; Navajo Natural Heritage Program; Navajo Fish and Wildlife Department

RESUMEN

El Navajo Natural Heritage Program está en el proceso de desarrollo de la base datos de la cuenca del Pequeño Río Colorado (Little Colorado River (LCR)). Recientemente una versión de borrador de un listado bibliográfico en formato dBase, ha sido desarrollado bajo un Acuerdo Cooperativo con el Buró de Reclamación de Estudios Ambientales Glen Canyon. Hay 1799 citas en la base de datos. Una base de datos en Sistema de Información Geográfica (GIS) en la cuenca del LCR, está comenzando a desarrollarse utilizando Arc-Info. Esta incluye aspectos de hidrología, biología y geología, flora y fauna en peligro, amenazada y sagrada. Esta además incluye amenazas actuales y proyectadas de la cuenca LCR. Las fuentes recientes incluyen la búsqueda de base de datos solicitudes a las tribus, agencias federales, estatales, locales y privadas, así como también contactos personales como entrevistas. Esta base de datos del LCR esta disponible como una referencia para ayudar en las decisiones que afecten la cuenca del LCR. El listado bibliográfico del LCR esta disponible para todas las agencias que soliciten una copia; atención Ruby Hale y/o Mike Tremble.

PROPST,D.L. (New Mexico Department of Game and Fish, Santa Fe, NM)

Native fish research and management in New Mexico during 1993 and 1994

Investigación y manejo de peces nativos en Nuevo México durante 1993 y 1994

KEYWORDS: New Mexico; Pecos River; Rio Grande; San Juan River; Zuni River; Gila River

ABSTRACT

Research and management of native fishes in New Mexico during the past two years concentrated on the Pecos, Rio Grande, San Juan, Zuni, and Gila basins. Work on the Pecos River mainly involved research to characterize the inter-relationships of reservoir controlled river flows and the fish community, and particularly to characterize the dynamics of Pecos bluntnose shiner, *Notropis simus pecosensis*, populations. The imperiled status of Rio Grande silvery minnow, *Hybognathus amarus*, prompted a long-term effort in the Rio Grande to resolve its taxonomic status and characterize its distribution, status, life history, and response to variable reservoir controlled flow regimes. Research on the San Juan River included evaluating effects of variable flows on the tailwater trout and macroinvertebrate communities below Navajo Dam and characterizing the fish communities of secondary channels and investigating their seasonal and annual dynamics. The main impetus for San Juan research is to develop strategies for recovery of Colorado squawfish, *Ptychocheilus lucius*, and razorback sucker, *Xyrauchen texanus*, in the basin. During the past two years the status and distribution of Zuni bluehead sucker, *Catostomus discobolus yarrowi*, was determined and studies have been initiated to characterize its biology. Annual monitoring of fish communities at six permanent sites in the Gila-San Francisco drainage, initiated in 1983, continued. While the status of loach minnow, *Rhinichthys cobitis*, seems to have remained fairly stable at most sites, that of spikedace, *Meda fulgida*, appears to have declined. The permanent site on East Fork Gila River enabled monitoring of one of two "viable" populations of roundtail chub, *Gila robusta* in the basin. During 1993-1994, White Creek was renovated and stocked with Gila trout, *Oncorhynchus gilae*, fertilized eggs were obtained from McKnight Creek for development of a brood stock to aid recovery efforts, Gila trout were re-established in Main Diamond Creek (type locality), several streams inventoried to assess suitability for renovation, eight populations monitored, and 150 individuals evacuated from Spruce Creek during a wildfire which threatened the population. Local opposition to several planned recovery activities forced

postponement of needed actions. Status of Gila trout has improved since 1989, when proposed downlisting was postponed because natural events severely reduced two wild populations and eliminated another, to the point that downlisting may be soon recommended.

CLAVES: Nuevo México; Río Pecos; Río Grande; Río San Juan; Río Zuni; Río Gila

RESUMEN

La investigación y manejo de peces nativos en Nuevo México durante los pasados dos años se concentraron en las cuencas del Pecos, Río Grande, San Juan, Zuni, y Gila. El trabajo en el Río Pecos incluyó principalmente investigaciones para caracterizar la interrelación de los reservorios que controlan los flujos con la comunidad de peces, y particularmente para caracterizar la dinámica de la población del Pecos bluntnose shiner, *Notropis simus pecosensis*. El estatus del Río Grande silvery minnow (especie en peligro), *Hybognathus amarus*, requiere de esfuerzos a largo plazo en el Río Grande para determinar su estatus taxonómico y caracterizar su distribución, estatus, historia natural, y respuesta a los regímenes del flujo variable del reservorio. La investigación en el Río San Juan incluye la evaluación de los efectos de la variación de los flujos sobre la trucha y las comunidades de macroinvertebrados que viven abajo de la cuenca de la presa Navajo, y caracteriza las comunidades de peces de canales secundarios y el estudio de la dinámica estacional y anual. El principal interés de la investigación del San Juan es el desarrollo de las estrategias para la recuperación del charal del Colorado *Ptychocheilus lucius*, y el matalote jorobado, *Xyrauchen texanus*, en la cuenca. Durante los pasados dos años el estatus y distribución del Zuni bluehead sucker, *Catostomus discobolus yarrowi*, fue determinado y los estudios han iniciado para caracterizar su biología. El monitoreo anual de la comunidad del pez en seis sitios permanentes en el cuenca del Gila-San Francisco, inició en 1983 y aún continúa. Mientras que el estatus del loach minnow, *Rhinichthys cobitis*, aparenta tener remanentes lejanamente estables en la mayoría de los sitios, como el spikedace, *Meda fulgida*, aparenta tener un decremento. En un sitio permanente en East Fork Gila River se habilitó el monitoreo de una de las dos poblaciones viables del charal aleta redondeada, *Gila robusta* en la cuenca. Durante 1993-1994, White Creek fue recuperado y poblado con un grupo de trucha de Gila, *Oncorhynchus gilae*, los huevos fertilizados fueron obtenidos de Mcknight Creek para desarrollar el pie de cría, para complementar los esfuerzos de recuperación, la trucha de Gila fue re-establecida en Main Diamond Creek (localidad tipo), algunos arroyos fueron monitoreados para evaluar la disponibilidad de recuperación, ocho poblaciones fueron monitoreadas, y 150 individuos evacuados de Spruce Creek durante un incendio forestal que amenazaban la población. La oposición local a varias actividades de recuperación planeadas, llevaron a posponer las acciones que se necesitaban. El estatus de la trucha del Gila ha mejorado desde 1989 cuando la propuesta de quitarlo como especie enlistada fue pospuesta debido a eventos naturales que reducieron dramáticamente a dos poblaciones y eliminaron a otra, a tal grado que dicha propuesta pueda ser recomendada para después.

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Utah's Native Fish Program: A review of activities in 1994

Programa de Peces Nativos de Utah: Una revisión de las actividades en 1994

KEYWORDS: Utah; native fishes

ABSTRACT

The native fish program within the Utah Division of Wildlife (UDWR) is divided into four major components: (1) native fish (not federally listed), (2) Virgin River fish, (3) June sucker, and (4) Colorado River Fish (Upper Basin and San Juan). During 1994, UDWR was restructured and these programs were added with sportfish programs into a new Aquatic Section. Despite a significant reduction in force, efforts in the native fish programs have generally been maintained. In some cases, the program has expanded. Activities within each component are summarized and highlights are presented.

CLAVES: Utah; peces nativos

RESUMEN

El programa de peces nativos en The Utah Division of Wildlife (UDWR), está dividida en cuatro componentes principales: (1) peces nativos (no federalmente enlistados), (2) peces del Río Virgin, (3) June sucker (matalote de Junio), y (4) peces del Río Colorado (cuenca alta y San Juan). Durante 1994 la UDWR fue re-estructurada y estos programas fueron sumados en los programas de pesca deportiva en una nueva Sección Acuática. A pesar de una significante reducción de fuerza de trabajo, los esfuerzos en los programas de peces nativos generalmente han sido mantenidos. En algunos casos el programa se ha expandido. Las actividades en cada componente se presentan en forma sumaria y enfatizada.

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California Department of Fish and Game Agency Report - 1994

Reporte de Agencia del California Department of Fish and Game - 1994

KEYWORDS: California; springsnails; desert pupfish; Shoshone pupfish; Owens Valley; Klamath basin; Goose Lake; Death Valley; genetics

ABSTRACT

GOOSE LAKE FISHES - Goose Lake is a large, shallow, alkaline lake on the Oregon- California border. Recent drought and agricultural diversion in the arid Goose Lake Basin caused the lake to dry completely the past three years. The Basin contains the following endemic Species of Special Concern: Goose Lake lamprey (*Lampetra tridentata* ssp.), Goose Lake redband trout (*Oncorhynchus mykiss* ssp.), Goose Lake tui chub (*Gila bicolor thalassina*) and Goose Lake sucker (*Catostomus occidentalis lacusanserinus*).

The Department participates in the Goose Lake Fishes Working Group. The Group provides a mechanism for conflict resolution between resource managers and landowners, and is developing a cooperative plan to hopefully preclude the need to list these species. The Department had a field crew at Goose Lake for the past two field seasons. In 1993, the crew habitat-typed one of the major tributaries, Willow Creek and its tributaries. In 1994, the various habitat types were surveyed for species composition. The lake's remnant trout population is gone, but may be recolonized by remaining stream populations. Relatively good numbers of suckers and chub were found. Lamprey were not very abundant. Some of the tributaries included exotic brown trout and fathead minnows.

MODOC SUCKER - Until 1973 the Modoc sucker (*Catostomus microps*) was known only from its type locality, Rush Creek in Modoc County, where it was first collected in 1898. It is now known to occur in nine streams. Until surveys of six of the streams by the USFWS (Scoppettone et al.) in 1992, this federal- and state-listed endangered species was thought to be on the brink of extinction. The 1992 survey indicated that the species is relatively secure in five of the six streams surveyed. Department activities include ongoing review of timber harvest plans and flow monitoring at some sites.

SHORTNOSE AND LOST RIVER SUCKERS - California populations of the shortnose sucker (*Chasmistes brevirostris*) and Lost River sucker (*Deltistes luxatus*) continue to be in peril. Major populations of these federal- and state-listed species occur in the Clear Lake Reservoir watershed in the upper Klamath River and Lost River systems of extreme northeastern California. Recent drought conditions have reduced the habitat available and long-term effects are unknown. In October 1992, Clear Lake reservoir reached the lowest elevation since 1935 and was only 5% of the reservoir's total capacity. Populations in small reservoirs above Clear Lake may have been eliminated due to desiccation during the summer of 1992. Some of these populations may have been reestablished via spawning runs in the spring of 1993, but significant upstream migration may have been precluded by low downstream discharge in Willow Creek, a major tributary. Suckers captured in 1992 and early 1993 exhibited signs of stress, possibly due to low lake levels. The condition factors improved by late summer 1993.

The Department contracted with the National Biological Survey (Gary Scoppettone) to determine the population density, food habits, age class structure, daily and seasonal movement patterns and seasonal limnological conditions in Clear Lake Reservoir and the other major California population site, Tule Lake.

The Department also let a contract to determine the genetic status and taxonomic relationships of suckers in the Klamath basin. Dr. Don Buth at UCLA has presented the following preliminary results:

1. A set of loci has been determined that will identify the four species and allow recognition of putative hybrids.

2. To date, no allozyme evidence for hybridization between shortnose suckers and Klamath largescale suckers has been revealed in the Clear Lake Reservoir sample. More specimens need to be examined.

3. To date, no allozyme evidence for hybridization between shortnose suckers and Klamath smallscale suckers has been revealed in the Copco Lake sample. More specimens need to be examined. Final results are not available due to administrative delays.

LAHONTAN AND PAIUTE CUTTHROAT TROUT - Within the last five years the Department has successfully restored Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) to five streams with the California portion of the Lahontan Basin. This effort has increased the amount of occupied or restored habitat from 17 stream miles to 36, and the total number of populations to 14. A century ago, this federally- listed threatened fish occupied an estimated 1,000 miles of habitat in California. The closely related Paiute cutthroat trout (*Oncorhynchus clarki seleniris*), a federally-listed threatened subspecies, has been adversely affected by introgression with introduced rainbow trout (*Oncorhynchus mykiss*). This has resulted in the loss of Paiute cutthroat trout from all but two tiny tributaries of its endemic habitat, Silver King Creek. Repeated chemical treatments have eradicated introgressed fish from the Silver

Creek drainage. As a result, pure Paiute cutthroat trout have been restocked or restored to eight stream miles within the drainage.

UNARMORED THREESPINE STICKLEBACK - The Recovery Plan for the unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*) indicates that this state- and federally listed subspecies is restricted to the Santa Clara River drainage in Los Angeles County and the San Antonio Creek drainage in Santa Barbara County and an introduced population in San Felipe Creek, San Diego County. Recent allozyme analysis by Dr. Don Buth at UCLA further restricts the range of *G. a. williamsoni* to the Santa Clara River drainage. The San Antonio Creek form may be unique. The Santa Clara River population suffered losses due to an oil spill after the January 1994 Northridge earthquake. Development pressures are increasing as is the number of water rights applications.

The recently discovered undescribed Shay Creek unarmored threespine stickleback is still restricted to one pond at Shay Meadow and an introduced population at Sugarloaf Meadow, both in the San Bernardino National Forest, San Bernardino County. The Shay Meadow population is highly vulnerable to water withdrawals, so the Recovery Team is actively pursuing another transplant site. Juniper Springs, also in the San Bernardino National Forest, was identified as a potential site by Dr. Jonathan Baskin while under contract to the Department.

OWENS VALLEY FISHES - In 1983, the Department, BLM and the USFWS funded a contract to produce a recovery plan for listed aquatic, wetland and riparian species of the Owens Valley floor, including the Owens tui chub (*Gila bicolor snyderi*) and Owens pupfish (*Cyprinodon radiosus*). A management plan will also be produced to include non-listed species of concern such as Owens speckled dace (*Rhinichthys osculus* ssp.), Owens sucker (*Catostomus fumeiventris*) and springsnails (Hydrobiidae). The Los Angeles Department of Water and Power, the valley's major landholder, is cooperating with the contractors to date. The contractors (Sada et al.) expect to have a draft recovery plan completed by late spring 1995.

Existing populations of Owens pupfish are again in bad shape. Due to ongoing problems with habitat maintenance and non-native piscivores, numbers have plummeted at all but two refugium locations. Desert Pupfish

Spring and summer monitoring found most natural and refugium populations of desert pupfish (*Cyprinodon macularius*) to be thriving. However, monitoring of Salton Sea tributary irrigation drains by the Department and the local irrigation district found fewer pupfish than 1993 and higher numbers of non-native fishes like mollies and tilapia.

OTHER PUPFISHES - Collections and laboratory work continue for the Department's contract with Dr. Bruce Turner, who is assessing the molecular genetics of Death Valley drainage *Cyprinodon*, with emphasis on the Shoshone pupfish (*Cyprinodon nevadensis shoshone*). Dr. Turner has agreed to include samples in his analysis from any other California pupfish populations we can provide for him, i.e., *Cyprinodon macularius* and *C. radiosus*. Results should be available by summer 1995.

CLAVES: California; caracol de manantial; pez perrito del desierto; pez perrito Shoshone; Valle Owens; Cuenca Klamath; Lago Goose; Death Valley; genética

RESUMEN

PECES DEL GOOSE LAKE - El Goose Lake es un lago grande, poco profundo, alcalino sobre el límite de Oregon y California. Sequías recientes y desviación de aguas agrícolas en la cuenca árida del Lago Goose provocaron que el lago se secara completamente los pasados tres años. La cuenca contiene las siguientes especies endémicas de interés especial: la lamprea del Lago Goose (*Lampetra tridentata ssp.*), trucha de banda roja del Lago Goose (*Oncorhynchus mykiss ssp.*), el charal Goose Lake tui (*Gila bicolor thalassina*) y el matalote del Lago Goose (*Catostomus occidentalis lacusanserinus*).

El Departamento participó en el grupo de trabajo de peces del Lago Goose. El Grupo proporcionó un mecanismo para la resolución del conflicto entre el manejo de recursos y propietarios, mediante el desarrollo de un plan cooperativo para excluir la necesidad de enlistar estas especies. El Departamento tuvo un personal de campo en el Lago Goose Lake durante las pasadas dos estaciones. En 1993, el personal tipificó el hábitat de uno de los tributarios mayores, el Willow Creek y sus tributarios. En 1994, los varios tipos de hábitat fueron registrados para composición de especies. La población remanente de trucha del lago desapareció, pero puede ser recolonizada por poblaciones remanentes de la corriente. Un número relativamente bueno de matalotes y charales fueron encontrados. Las lampreas no fueron encontradas muy abundantemente. Algunos de los tributarios incluyeron exóticos como la trucha café y fathead minnows.

MATALOTE MODOC (MODOC SUCKER) - Hasta 1973 el modoc sucker (*Catostomus microps*) fue conocido solamente en su localidad tipo, Rush Creek en Modoc County, donde fue primeramente colectado en 1898. Ahora se sabe que ocurre en nueve arroyos. Hasta las evaluaciones de seis arroyos por el USFWS (Scoppettone et al.) en 1992, estaba al borde de la extinción según las listas federal y estatal. El recorrido de 1992 indicaba que la especie esta

relativamente segura en cinco de las seis corrientes registradas. Las actividades del Departamento incluía revisar los planes de aprovechamiento forestal y el monitoreo de flujos en algunos sitios.

MATALOTE NARIZ CORTA Y DEL RÍO LOST (SHORTNOSE Y LOST RIVER SUCKERS) - Las poblaciones en California del shortnose sucker (*Chasmistes brevirostris*) y Lost River sucker (*Deltistes luxatus*) continúan estando en peligro. Las poblaciones mayores de esta especie enlistada federal y estatalmente ocurren en el embalse del Lago Clear en los sistemas de la cuenca superior del Río Klamath y Río Lost del extremo noreste de California. Condiciones de sequía reciente han reducido el hábitat disponible y los efectos a largo plazo son desconocidos. En octubre de 1992, el embalse del Lago Clear alcanzo la elevación más baja desde 1935 y fue solamente el 5% de la capacidad total del embalse. Las poblaciones en pequeños embalses arriba del Lago Clear habían sido eliminados debido a la desecación durante el verano de 1992. Algunas de estas poblaciones pudieron restablecerse vía corrida de la freza en primavera de 1993, pero una migración significativa no pudo efectuarse por la baja descarga río abajo en Willow Creek, un tributario mayor. Los matalotes capturados en 1992 y principios de 1993 exhibieron signos de estrés, posiblemente debido a los bajos niveles del lago. Las condiciones de los factores mejoraron para fines de verano de 1993.

El Departamento fue contactado por el National Biological Survey (Gary Scoppettone) para determinar la densidad de población, hábitos alimenticios, estructura por clases de edad, patrones de movimiento diarios y estacionales y condiciones limnológicas estacionales en el embalse del Lago Clear y el sitio de la otra población principal de California, Lago Tule.

El Departamento también realizó un contrato para determinar el estatus genético y relaciones taxonómicas del matalote en la cuenca Klamath. El Dr. Don Buth en UCLA ha presentado los siguientes resultados preliminares:

1. Un juego de loci ha sido determinado que puede identificar las cuatro especies y permitir el reconocimiento de los supuestos híbridos.

2. A la fecha, ninguna evidencia de alozima para hibridización entre shortnose suckers (matalote nariz corta) y Klamath largescale suckers (matalote escamas grandes del Klamath) ha sido revelada en la muestra del embalse del Lago Clear. Necesitan examinarse más especímenes.

3. A la fecha, la muestra del Lago Copco, no han revelado la existencia de evidencias de alozimas por hibridación entre el matalote shortnose (matalote nariz corta) y el matalote Klamath smallscale (matalote de escamas pequeñas del Klamath). Es necesario examinar más evidencias. Los resultados finales aún no están disponibles debido a retrasos administrativos.

TRUCHAS CUTTHROAT, LAHONTAN Y PAIUTE - En los últimos cinco años el Departamento ha restaurado exitosamente la Trucha Lahontan cutthroat (*Oncorhynchus clarki henshawi*) en cinco arroyos de la porción de California de la Cuenca Lahontan. Este esfuerzo ha incrementado la cantidad de hábitats ocupados o restaurados de 17 a 36 millas de arroyos, y el número total de poblaciones a 14. A un siglo de distancia, este pez enlistado federalmente ocupó aproximadamente 1,000 millas de hábitats en California. Estrechamente relacionada, la trucha Paiute cutthroat (*Oncorhynchus clarki seleniris*), una subespecie enlistada federalmente en peligro de extinción, ha sido afectada adversamente por la introgresión con la trucha arcoiris (*Oncorhynchus mykiss*). Esto ha resultado en la pérdida de la trucha Paiute cutthroat de todos menos dos delgados tributarios de su hábitat endémico, el Silver King Creek. Tratamientos químicos repetidos han erradicado los peces afectados por la introgresión del drenaje del Silver Creek. Como resultado, la trucha Paiute Cutthroat ha sido ha sido reintroducida o restaurada en ocho millas de arroyos en el drenaje.

UNARMORED THREESPINE STICKLEBACK - El Plan de Recuperación para Unarmored Threespine Stickleback (*Gasterosteus aculeatus williamsoni*) indica que esta subespecie estatal y federalmente enlistada como amenazada, esta restringida al drenaje del Río Santa Clara en el Condado de los Angeles y el drenaje del San Antonio Creek en el Condado de Santa Barbara, y una población introducida en San Felipe Creek, en el Condado de San Diego. Análisis recientes de alozimas por el Dr. Don Buth en la UCLA, restringen el rango de *G. a. williamsoni* al drenaje del Río Santa Clara. En esencia, el San Antonio Creek quizás sea el único. La población del Río Santa Clara sufrió pérdidas debido al derrame de petróleo ocasionado por el terremoto de Northridge en Enero de 1994. Las presiones del desarrollo se están incrementando así como el número de solicitudes de derechos de agua.

El recientemente descubierto Shay Creek unarmored threespine stickleback esta hasta ahora restringido en la poza de Shay Meadow y una población introducida en Sugarloaf Meadow, ambas en San Bernardino National Forest, Condado de San Bernardino. La población de Shay Meadow es altamente vulnerable a la remoción de agua, debido a esto el Equipo de Recuperación esta activamente promoviendo otros sitios de trasplantes. Juniper Springs, también en el San Bernardino National Forest, fue identificado como un sitio potencial por el Dr. Jonathan Baskin mientras se encuentra bajo contrato por el Departamento.

PECES DEL VALLE OWENS - En 1983, el Departamento, BLM y el USFWS financiaron un contrato para realizar un Plan de Recuperación para las especies acuáticas de humedales y riparias enlistadas del Valle Owens, incluyendo el charal Tui de Owens (*Gila bicolor snyderi*) y el pez perrito del Owens (*Cyprinodon radiosus*).

Un Plan de Manejo también será producido para incluir especies no enlistadas de interés tales como el Owens speckled dace (*Rhinichthys osculus* ssp.), el matalote de Owens (*Catostomus fumeiventris*) y los caracoles de manantiales (Hidrobiidae). El Los Angeles Department of Water and Power, el responsable principal del valle, esta cooperando con los consultores a la fecha. Los consultores (Sada et al.) esperan tener un primer borrador completo del plan de recuperación, para finales de la primavera de 1995.

Las poblaciones existentes del pez perrito de Owens están de nuevo en malas condiciones. Debido a problemas con el mantenimiento del hábitat y piscívoros no nativos, han decaído en todos, menos en dos localidades de refugio.

PEZ PERRITO DEL DESIERTO (DESERT PUPFISH) - Los monitoreos de primavera y verano encontraron en recuperación la mayoría de las poblaciones naturales y de refugios del pez perrito del desierto (*Cyprinodon macularius*). Sin embargo, los monitoreos en los drenajes de irrigación tributarios del Salton Sea, por el Departamento y el distrito de irrigación local, encontraron menos peces que en 1993 y números más altos de peces no nativos como mollies y tilapias.

OTROS PECES PERRITO (PUPFISH) - Las colecciones y el trabajo de laboratorio continúan mediante el convenio del Departamento con el Dr. Bruce Turner, quién esta evaluando la genética molecular del *Cyprinodon* del drenaje del Death Valley, con énfasis en el pez perrito Shoshone (*Cyprinodon nevadensis shoshone*). El Dr. Turner ha acordado incluir muestras en su análisis de cualquier otra población de peces perrito de California que nosotros podamos proporcionarle, como *Cyprinodon macularius* y *C. radiosus*. Los resultados podrían estar disponibles para el verano de 1995.

GARRETT,G.P.* (Texas Parks and Wildlife Department)

Agency Report for the Texas Parks and Wildlife Department

Reporte de Agencia de Texas Parks and Wildlife Department

KEYWORDS: Rio Grande; Río Conchos; Chihuahuan Desert; Balmorhea; Texas; México; ciénega

ABSTRACT

The Department continues its efforts in desert fishes conservation. The four major ecoregions of the Rio Grande have been surveyed for fish community structure and analysis continues. These data will be used to aid in proper management decisions for this unique resource as well as provide guidelines for environmental protection and mitigation as economies develop on both sides of the border. The Chihuahuan Desert Fishes Survey is underway and we have recently completed a 1,300 mile round-trip through Chihuahua, México, collecting fishes in the Rio Conchos drainage to determine status of several Federal Category 2 species. Construction has now begun on what will become a functional desert ciénega at Balmorhea State Park. This will not only provide proper, secure habitat for two endangered fishes, but will also provide a natural area for other indigenous flora and fauna.

CLAVES: Río Grande; Río Conchos; desierto Chihuahuense; Balmorhea; Texas; México; ciénega

RESUMEN

El Departamento continúa su esfuerzo en la conservación de los peces del desierto. Las cuatro ecorregiones mayores del Río Grande, han sido evaluadas mediante la estructura de comunidades, y los análisis aún continúan. Estos datos serán usados para apoyar las decisiones de manejo apropiadas para estos recursos únicos, así como para proveer una línea para la protección ambiental y la mitigación como el desarrollo económico en ambos lados de la frontera. Los muestreos de peces del Desierto Chihuahuense, están en proceso y recientemente se han completado un recorrido de 1,300 millas por Chihuahua, México, colectando peces en la Cuenca del Río Conchos, para determinar el estatus de diversas especies de la categoría Federal 2. La construcción ha empezado ahora sobre lo que será una ciénega funcional del desierto en el Parque Estatal Balmorhea. Esta no solamente proveerá un hábitat propio, seguro para dos peces en peligro, si no también proveerá una área natural para otra flora y fauna indígena.

HEINRICH,J.E. (Nevada Division of Wildlife, Region III, Las Vegas, NV)

Status of Nevada fishes

Estatus de los peces de Nevada

KEYWORDS: dace; Nevada; Pahranagat Valley; poolfish; razorback sucker; roundtail chub; speckled dace; spinedace; springfish; tui chub

ABSTRACT

The Nevada Division of Wildlife has begun to enlarge the native fish program to fit the demand of needs across the State of Nevada. During fiscal year 1994 a seasonal native fish survey crew was active in the northern portion of the state and funding is now available for a full time position in the northern region. The native fish program continues monitoring, status evaluation, and program coordination for all species and sub-species of endemic fish within the geographic boundaries of the state of Nevada. Currently, 57 are listed by the United States Fish and Wildlife Service (FWS). Of these 57 listed species; twenty (20) have been listed as endangered and five (5) species have been listed as threatened. Major program effort continues to concentrate on the federally listed species. Summaries of activities from priority species follow:

WHITE RIVER SPRINGFISH *Crenichthys baileyi baileyi* - Numbers of springfish at Ash Spring have done well since the resort went into bankruptcy. In 1994, from mark-and-recapture estimates, numbers of springfish were estimated to be at a very respectable 49,000 fish in Ash Spring. One and two year old fish dominate the population. Ash Spring is still available for purchase. The outflow of this spring (Burns Ranch) contains the only population of Pahranagat roundtail chub, *Gila robusta jordani*. The last dive estimate in September 1993, tallied 153 adults, and 457 juveniles. Recently, the Burns Ranch was sold, hopefully the new owners will be as cooperative as the previous owners.

HIKO WHITE RIVER SPRINGFISH *Crenichthys baileyi grandis* - Populations were monitored at Hiko, Crystal, and Blue Link Springs.

The Hiko population was monitored by a mark-and-recapture effort through a independent contract with Mr. John Pedretti. Numbers were 11,340 + -1750 fish. The springfish at Crystal Spring remain at a severely depressed level, the current dive estimate was only 68 fish.

WHITE RIVER SPINEDACE *Lepidomeda albivallis* - Estimates continue to indicate less than 50 fish remain in a single spring on State lands at the Kirch Wildlife Management Area. Several projects continue at this location to secure habitats for this threatened fish. A contract with the National Biological Survey will continue at this site to gather habitat requirement information and assist in recovery of this species. Pahrump poolfish, *Empetrichthys latos latos*- Census work was conducted on the three populations of Pahrump poolfish at Corn Creek, Spring Mountain Ranch State Park, and Shoshone Ponds Refuguim. Populations within the Las Vegas area were monitored by John Pedretti through contract agreements. All populations are stable at 5,660, 15,040, and 2,900, respectively.

VIRGIN RIVER FISHES - In October of 1993, 1,500 woundfin, *Plagopterus argentissimus*, were received from Dexter National Fish Hatchery and Technology Center. These fish were tagged and released into Nevada reaches of the Virgin River. Along with small numbers of resident native fish, a high of 23 marked fish were captured by a Bio/West crew in February. During woundfin surveys, small numbers of adult Virgin Fiver roundtail chubs, *Gila robusta seminuda*, were found in the river below Mesquite, Nevada.

RAZORBACK SUCKER *Xyrauchen texanus* - Involvement with several recovery activities continue on Lake Mead and Lake Mohave. On Lake Mead, in 1994, with the help of Bio/West personnel, sampling efforts were expanded to all areas of the Overton Arm and Boulder Basin in hopes of finding additional aggregations of fish. This was quite time consuming and produced no additional fish. Over the season only 4 fish were captured, all just outside the Las Vegas Bay Marina. Most curious of these fish was a young 14 inch fish. Efforts over the last 4 years on Lake Mead have resulted in 50 razorback suckers captured, tagged, and released.

BIG SPRINGS SPINEDACE *Lepidomeda mollispinis pratensis* - Good numbers of individuals were again found throughout areas of desingated critical habitat. Forty young fish were taken to the University of Nevada, Las Vegas under the direction of Fran Taylor for research on habitat preferences and behavior in hopes that information gained can also be applied to the White River spinedance.

RAILROAD VALLEY SPRINGFISH *Crenichthys nevadae* - Catch per unit effort values for Railroad Valley in 1994 were comparable to past years. Populations at all springs remained stable. Populations in the Duckwater Valley;

Big Warm Spring, and Little Warm Spring, continue to be depressed. The isolated introduced populations at Sodaville and at Hot Creek Canyon remain at stable levels although they have shown slight impacts form recent gavitat alterations and development.

RELICT DACE *Relictus solitarius* - With the addition of a summer survey crew working on this species, an additional 5 sites of historic distribution have been documented, to bring the total to 24 sites. These are dace populations that have not been surveyed since 1980. Ruby Valley, Butte Valley, Steptoe Valley, Goshute Valley, and Spring Valley surveys have now been completed.

MUDDY (MOAPA) RIVER - Surveys again concentrated on distribution and abundance of the Moapa roundtail chub, *Gila robusta ssp*. Chub and springfish populations seem to be very healthy. After a serious fire on the Moapa Valley National Wildlife Refuge the Moapa dace, *Moapa coriacea*, appears to have maintained numbers in the Warm Springs area.

VIRGIN RIVER SPINEDACE *Lepidomeda mollispinis mollispinis* - After completion of the 1994 survey it was again substantiated that these fish are no longer found in Nevada waters. Surveys have been done consecutively for the last 5 years without success. The NDOW is co-operating in development of a conservation agreement for this subspecies and the native fish program is supporting the initial planning of experimental reintroductions in historic habitats below Schroeder Reservoir.

TUI CHUB *Gila bicolor* - Collections of all tui chub populations within Nevada were made in 1994 and submitted to Phil Harris at Oregon State University. Under the direction of Dr. Douglas Markle, (mt) DNA techniques will be used to assess tui chub taxonomy in Nevada and describe genetic population structure.

CLAVES: dace; Nevada; Valle Pahranagat; peces de pozas; matalote jorobado; charal aleta redondeada; speckled dace; spinedace; springfish;charal tui

RESUMEN

El Nevada División of Wildlife ha comenzado a aumentar los programas de peces para ajustarse a la demanda de necesidades a lo largo del estado de Nevada. Durante el año fiscal 1994 un equipo de evaluación estacional de peces nativos se encontraba activo en la porción Norte del estado y actualmente hay fondos disponibles para el puesto de tiempo completo en la región norteña. El programa de peces nativos continúa monitoreando, evaluando el estatus y coordinando el programa para todas las actividades u subespecies de peces endémicas dentro de los confines del Estado de Nevada. En la actualidad 57 se encuentran enlistados por el United States Fish and Wildlife Service (FWS). De esas 57 especies enlistadas: veinte (20) se encuentran enlistadas como en peligro de extinción y cinco (5) como amenazadas. El mayor esfuerzo del programa continúa concentrado en las especies enlistadas federalmente. A continuación se presentan resúmenes de las actividades en especies prioritarias:

SPRINGFISH DEL RÍO WHITE *Crenichthys baileyi baileyi* - Las cantidades de springfish han mejorado en Ash Spring desde que quebró el balneario. En 1994, con base a los estimados de captura-recaptura, se estimó que las cantidades de springfish se encontraban en el muy respetable nivel de los 49,000 peces en Ash Spring. La población se encuentra dominada por peces de uno y dos años. Ash Spring se encuentra aún disponible para su compra. La corriente de este manantial (Rancho Burns) contiene la única población del charal aleta redondeada Pahranagat *Gila robusta jordani*. La última evaluación en Septiembre de 1993, mostró 153 adultos y 457 juveniles. El Rancho Burns fue vendido recientemente, esperamos que los nuevos dueños sean tan cooperadores como los anteriores.

SPRINGFISH DEL RÍO HIKO WHITE *Crenichthys baileyi grandis* - se monitorearon las poblaciones en los manantiales Hiko, Crystal y Blue Link.

La población de Hiko se monitoreo por medio de captura-recaptura llevada a cabo por medio de un contrato independiente con el Sr. John Pedretti. Se estimó un número de 11,340 (+-1750) peces. Los springfish en el manantial Crystal se encuentran a un nivel fuertemente deprimido, resultando en un número de 68 en la presente evaluación.

SPINEDACE DEL RÍO WHITE *Lepidomeda albivallis* - Los estimadores continúan indicando que quedan menos de 50 peces en un sólo manantial en terrenos nacionales, en Kirch Wildlife Management Area. En ésta localidad, se continúan muchos proyectos para asegurar los hábitat para este pez amenazado. En este sitios se continuará un contrato con el National Biological Survey para reunir información de requerimientos de hábitat y ayudar en la recuperación de ésta especie.

PAHRUMP POOLFISH *Empetrichthys latos latos* - El trabajo de censado se llevó a cabo en las tres poblaciones de Pahrump poolfish en Corn Creek, Spring Mountain Ranch State Park y Shoshone Ponds Refuge. Las poblaciones dentro del área de Las Vegas fueron monitoreadas por John Pedretti a través de acuerdos contractuales. Todas las poblaciones se encontraron estables a 5,660, 15,040 y 2,900, respectivamente.

PECES DEL RÍO VIRGIN - en Octubre de 1993 se recibieron 1,500 woundfin *Plagopterus argentissimus* de Dexter National Fish Hatchery and Technology Center. Esos peces fueron etiquetados y liberados en la porción de Nevada del Río Virgin. Junto con unos cuantos peces nativos residentes, una alta de 23 peces marcados fueron capturados por un equipo de Bio/West en Febrero. Durante las evaluaciones del woundfin se encontraron unos pocos adultos del charal aleta redondeada del Río Virgin, *Gila robusta seminuda*, en la parte río abajo de Mesquite, Nevada.

MATALOTE JOROBADO *Xyrauchen texanus* - Se continúa el involucramiento con diversas actividades de recuperación en el Lago Mead y en el Lago Mohave. En el Lago Mead, en 1994, con la ayuda del personal de Bio/West, se expandieron los esfuerzos de muestreo para todas las áreas del Overton Arm y de la cuenca de Boulder, con la esperanza de encontrar agrupaciones adicionales de estos peces. Esta actividad consumió gran cantidad de tiempo y no arrojó presencia adicional de peces. a lo largo de la temporada se capturaron cuatro peces, todos en las inmediaciones de Las Vegas Bay Marina. Lo mas curioso de esos peces fue un juvenil de 14 pulgadas. Los esfuerzos a lo largo de los últimos cuatro años en el Lago Mead han dado como resultado la captura, etiquetado y liberación de 50 matalotes jorobados.

SPINEDACE DE BIG SPRINGS *Lepidomeda mollispinis pratensis* - Se encontró nuevamente una buena cantidad en áreas designadas como hábitat crítico. Se llevaron 40 peces juveniles a la University of Nevada, en Las Vegas, bajo la dirección de Fran Taylor, para llevar a cabo investigación concerniente a preferencia de hábitat y comportamiento, con la esperanza de que la información obtenida pueda ser utilizada en el spinedace del Río White.

SPRINGFISH DE RAILROAD VALLEY *Crenichthys nevadae* - Los valores de captura por unidad de esfuerzo para Railroad Valley en 1994 son comparables con los de años pasados. Las poblaciones en todos los manantiales se mantienen estables. Las poblaciones en Duckwater Valley, Big Warm Spring y Little Warm Spring continúan en declive. Las poblaciones aisladas introducidas en Sodaville y en Hot Creek Canyon se mantienen en niveles estables, aunque han manifestado ligeros impactos por recientes alteraciones al hábitat y desarrollos.

RELICT DACE *Relictus solitarius* - Con la adición de un equipo de evaluación de verano trabajando con esta especie, se han documentado cinco sitios de distribución histórica, lo cual da un total de 24 sitios. Estas son poblaciones de dace que no han sido monitoreadas desde 1980. Las evaluaciones de Ruby Valley, Butte Valley, Steptoe Valley, Goshute Valley y Spring Valley no han sido completados.

RÍO MUDDY (MOAPA) - Nuevamente se concentraron las evaluaciones en la distribución y abundancia del charal Moapa aleta redondeada, *Gila robusta* spp. Las poblaciones del charal y del springfish parecen estar muy saludables. Después de un serio incendio en el Moapa Valley National Wildlife Refuge, el Moapa dace, *Moapa coriacea*, parece haber mantenido sus números en el área de Warm Springs.

EL SPINEDACE DEL RÍO VIRGIN *Lepidomeda mollispinis mollispinis* - Después de las evaluaciones de 1994 se sostiene nuevamente que este pez no se encuentra en las aguas de Nevada. Las evaluaciones han sido hechas consecutivamente por 5 años sin éxito. El NDOW esta cooperando en desarrollar un acuerdo de conservación para esta subespecie y el programa de peces nativos esta apoyando la planeación inicial de reintroducciones experimentales en hábitats históricos abajo del Reservorio Schroeder.

EL CHARAL TUI *Gila bicolor* - Colecciones de todas las poblaciones del charal Tui en Nevada fueron hechas en 1994 y remitidas a la Universidad Dr. Phil Harris del Estado de Oregon. Bajo la dirección Dr. Douglas Markle, técnicas de ADNmt serán usadas para evaluar la taxonomía del charal Tui en Nevada y describir la estructura genética de la población.

SCHLESER,D.M.; LOISELLE,P.V.* (DMS - The Dallas Aquarium, Fair Park, Dallas, TX; PVL - The Aquarium for Wildlife Conservation, Surf Ave. and West 8th St., Brooklyn, NY)

Maximizing options, minimizing regrets - The A.Z.A. breeding program for endangered desert fishes

Maximización de opciones, minimización de lamentos - El programa A.Z.A. de reproducción de peces en peligro del desierto

KEYWORDS: agency-public aquarium collaboration; captive breeding programs; cyprinodonts; goodeids; Mexican fishes; poeciliids; reintroduction

ABSTRACT

Captive breeding programs have played a useful role in the conservation of endangered terrestrial organisms and most zoos in North America have long been involved in such undertakings. The involvement of public aquaria in comparable efforts on behalf of endangered aquatic organisms, by way of contrast, dates from a resolution passed at the 1989 meeting of the Association of American Zoos and Aquariums, calling for the establishment of captive breeding programs for the endangered fishes of Lake Victoria, the deserts of North America and the Appalachian region. On the basis of input solicited at the 1989 meeting of the DFC, the desert fish program, focusing upon species native to northern Mexico, was initiated later that year. Eight A.Z.A. member institutions initially opted to participate in this program. That number has now increased to sixteen. In addition to maintaining breeding populations of designated species, fourteen participants have committed display space to desert fishes and used such exhibits to advocate conservation of their habitats.

The program initially included three endangered *Xiphophorus* and ten goodeid species already under culture at the Aquarium for Wildlife Conservation in New York and the Belle Isle Aquarium in Detroit. A memorandum of understanding signed in 1991 between the Aquarium for Wildlife Conservation and the Universidad Autónoma de Nuevo León in Monterrey brought captive-bred founder stock of the Sandia Valley and El Potosi cyprinodonts and of the goodeid *Allotoca maculata* from the Centro para la Reprodución de los Peces del Desierto en Peligro de Extinción into the program. The Dallas Aquarium has played a key role on the large-scale propagation and subsequent dissemination of these species. Seventeen Mexican fishes are currently being managed under breeding protocols intended to promote long-term maintenance of genetic diversity.

The goal of this *ex situ* breeding program is reestablishment of viable populations of the species under culture within their historic range. In the near term this seems unlikely for most of the Mexican species under management. However, collaborative projects involving American species such as those undertaken by the Dallas Aquarium and the Texas Department of Parks and Wildlife to restore populations of *Gambusia senilis*, *Cyprinodon pecosensis* and *Cyprinodon eximius* demonstrate that such a goal is attainable. The expertise and material resources that A.Z.A. member institutions can contribute to the conservation of North American desert fishes are significant. As management agencies come to appreciate value of their potential contributions to this endeavor, the number of such joint projects should increase.

CLAVES: colaboración entre acuarios y agencias públicas; programas de reproducción en cautiverio; cyprinodóntidos; goodeidos; peces mexicanos; poecilidos; reintroducción

RESUMEN

Los programas de reproducción en cautiverio han jugado un papel importante en la conservación de organismos terrestres en peligro y la mayoría de los zoológicos en Norteamérica han estado involucrados por largo tiempo en tales cuestiones. El involucramiento de los acuarios públicos en esfuerzos comparables de conservación de organismos acuáticos en peligro, en contraste, data desde una resolución tomada en la reunión de 1989 de la Asociación de Acuarios y Zoológicos Americanos, que llamó al establecimiento de programas de reproducción en cautiverio para peces en peligro del Lago Victoria, los desiertos de Norteamérica y la región de los Apalaches. En esta base de acuerdo a la solicitud de 1989 por parte del DFC, el programa de peces del desierto enfocado a especies nativos del norte de México fue iniciado después del año. Ocho instituciones de la A.Z.A., inicialmente optaron por participar en este programa. Este número ahora se ha incrementado a 16. En adición al establecimiento de poblaciones reproductivas de especies designadas, 14 participantes han acordado en mostrar espacios para peces del desierto y usarlos como exhibidores para promover la conservación de sus hábitats.

El programa inicialmente incluyó tres especies en peligro *Xiphophorus* y tres especies de goodeidos para mantener en cultivo en el Aquarium for Wildlife Conservation en Nueva York y el Belle Isle Aquarium en Detroit. Una carta de entendimiento firmada en 1991 entre el Aquarium for Wildlife Conservation y la Universidad Autónoma de Nuevo León en Monterrey, trajo un stock fundador para reproducción en cautiverio de ciprinodontidos del Sandia Valley y el Potosí y del goodeido *Allotoca maculata* del Centro para Reproducción de los peces del desierto en peligro de extinción, hacia el programa. El Acuario de Dallas ha jugado un papel principal en la propagación a gran escala

y subsecuente diseminación de estas especies. Diecisiete peces mexicanos actualmente están siendo manejados bajo proyectos de reproducción que intentan promover a largo plazo el mantenimiento de la diversidad genética.

Los objetivos de este programa de reproducción *ex situ* es el restablecimiento de poblaciones viables de las especies bajo cultivo, en sus rangos históricos. En el corto plazo esto significa que la mayoría de las especies mexicanas estarán bajo manejo. Sin embargo, los proyectos de colaboración que involucran especies americanas como aquellas llevadas por el Acuario de Dallas y el Texas Department of Parks and Wildlife para restaurar poblaciones de *Gambusia senilis*, *Cyprinodon pecosensis* y *Cyprinodon eximius* demostraron que tal meta es alcanzable. Los expertos y recursos materiales que las instituciones miembros del A.Z.A. con que pueden contribuir a la conservación de los peces del desierto de Norteamérica son significativos. Así cuando las agencias de manejo llegan a apreciar el valor de sus contribuciones potenciales a esta causa, el número de proyectos conjuntos se podrá incrementar.

FUTURE MEETINGS

1995 - Reno, Nevada, U.S.A.

1996 - La Paz, Baja California, México

1997 - Death Valley National Park, Furnace Creek, California, U.S.A.

***SJOBERG,J.C.** (Nevada Division of Wildlife, Region III, Las Vegas, NV)

Historic distribution and current status of the razorback sucker in Lake Mead, Nevada-Arizona

Distribución histórica y situación actual del matalote jorobado en el Lago Mead, Nevada-Arizona

KEYWORDS: razorback sucker; Lake Mead; Nevada; historic distribution; status; Colorado River

ABSTRACT

Although occupancy of Lake Mead by razorback suckers (*Xyrauchen texanus*) has been documented since the reservoir's formation, the majority of management emphasis and research interest has focused on the larger extant population in Lake Mohave immediately downstream. Most literature references to the Lake Mead razorback population are anecdotal and historic observation records are scattered and poorly organized. A review of Nevada Department of Wildlife (NDOW) and other agency field records documented observation or collection of 66 adult razorback suckers in the period 1952 to 1980, with the largest number of collection sites in the Overton Arm and Greg Basin/Grand Wash areas of the reservoir. No agency capture records have been located for the period 1980 to 1989. Intensive sampling efforts for razorback suckers by NDOW since 1990 have resulted in the capture of 49 razorback suckers at three locations, all in the February through April period. Gill net sampling lakewide in 1991 through April 1994 included 328 net nights at 62 locations, and trammel net sampling at 17 locations for 232 net nights.

CLAVES: matalote jorobado; Lago Mead; Nevada; distribución histórica; estatus; Río Colorado

RESUMEN

No obstante de que la ocupación del lago Mead por parte del matalote jorobado ha sido documentada desde la formación de los reservorios, la mayor parte del interés sobre manejo e investigación se ha enfocado hacia la población mas extensa en el lago Mohave inmediatamente arroyo-abajo. La mayor parte de las referencias literarias sobre el matalote del lago Mead son registros de tipo anecdótico y los registros históricos son dispersos y pobremente organizados. Una revisión del Departamento de Vida Silvestre de Nevada (NDOW) y otros registros de campo de las agencias observados y documentados o colecciones de 66 matalotes adultos en el período de 1952 a 1980, con el numero más amplio de sitios de colectas en el Overton Arm y el área de Greg Basin / Grand Wash en el reservorio. No se han localizado registros de captura por la agencia para este período de 1980 a 1989. Esfuerzos de muestreo intensivo para los matalotes por NDOW desde 1990 han resultado en la captura de 49 matalotes jorobados en tres localidades, todos en los períodos de Febrero a Abril. El muestreo con agalleras a lo amplio del lago en 1991 hasta abril de 1994 incluye 328 redes nocturnas en 62 localidades y el muestreo con transmallos en 17 localidades por 232 redes nocturnas.

CONTRIBUTED PAPER

Because of a lack of recruitment and loss of adult fish over time, mainstem reservoir populations of the razorback sucker *Xyrauchen texanus* in the lower Colorado River basin are considered to be generally absent with the exception of Lake Mohave, which has a large but rapidly declining adult population estimated at not more than 25,000 individuals. The presence of the large Lake Mohave population has logically focused research and recovery efforts on that reservoir and little recent effort has been placed on quantifying the status of other relict reservoir populations. This presentation summarizes current knowledge on the status of razorback suckers in Lake Mead.

Jonez and Sumner (1954) reported razorback suckers as widespread throughout Lake Mead during their studies in the early 1950's, with particular concentrations observed in inflow areas and along gravel shores during the spawning period. Field notes from NDOW biologists in the 1950's mention occasional observations of "hundreds" of suckers in pelagic areas of the Boulder Basin, and near the mouth of the Muddy River in the upper Overton Arm. Although sightings of adult razorback suckers in Lake Mead were reported as common through at least the early 1970's (Allan and Roden, 1978), almost all reports are anecdotal and few documented collections or observations exist in published literature or agency field records. A review of NDOW and Arizona Game and Fish field records documented collections or observations of 66 adult razorback suckers in the period 1952 to 1980. These observations occurred at 25 locations in all four major areas of the lake, and from a variety of methods.

Eight adult razorback suckers were reported as killed in the Boulder Basin by deep water detonations in June 1962 (Melander, 1962) and may indicate use of deeper pelagic lake zones outside of the spawning period. The detonations occurred at a 200-foot depth one mile north of Saddle Island, and also killed approximately 1,000,000 juvenile and adult game fish.

The majority of known collection sites (23 of 36) for razorback sucker during the 1952-1980 period are concentrated in the Overton Arm and Gregg's

Basin/Grand Wash portions of the lake. An additional eight records are from the Temple Bar area immediately adjacent to the lower Gregg's Basin. These areas, along with Las Vegas Wash, represent inflow areas and tend to be more productive than the relatively sterile central Virgin and Boulder basins. Sampling efforts represent a broad base of sites, times and methods throughout most areas of the reservoir. Thirty of 44 documented NDOW contacts occurred in the November to May period when razorbacks are most likely to be found in shallow water littoral zones. All of the NDOW records outside of that winter/spring time frame occurred near or above Temple Bar.

No records of collections or contact with razorback sucker could be found in available agency field records between 1980 and 1990. Extensive gill and trammel netting was conducted on Overton Arm during the 1986-1988 period by the University of Nevada, Las Vegas, in conjunction with the cooperative nutrient enhancement project, including sites where historic collections of adult razorbacks had occurred. No records of razorback sucker captures were found in field data files from those efforts. The lack of observations or contacts incidental to other routine sport fish sampling activities indicates a probable reduction in occurrence when compared to the more frequent observations through the early 1970's. However, changes in agency sampling techniques in the 1980's, such as use of mid-water and meter-net trawling and decreased use of conventional net surveys, may have significantly decreased the opportunity to contact or observe adult razorback suckers for much of this period.

Current dedicated Lake Mead razorback survey efforts began in April 1990 when NDOW personnel observed an apparent spawning aggregation of approximately 15 adult suckers in the Blackbird Point area of Las Vegas Wash. Three adult razorbacks were collected using electrofishing equipment and apparent spawning behavior was observed. Specific sampling efforts were not conducted in 1991, although a single adult razorback sucker was captured at Bark Bay on Overton Arm in March during spring gill net surveys.

Intensive trammel net surveys targeted specifically at razorback suckers in known areas of occurrence were initiated in spring 1992. Efforts were concentrated at Blackbird Point, near Las Vegas Wash, and Echo Bay on Overton Arm, based on 1990 collections and reports of recent observations. A total of 25 adult razorback suckers were captured at the two locations, 12 at Blackbird Point and 13 at Echo Bay.

Efforts for 1993 were expanded to include historic collection locations and other sites thought to have characteristics of preferred razorback spawning habitat, primarily the presence of well-washed coarse gravel or cobble substrate and exposure to limited wave action to reduce siltation. A total of 92 trammel net nights of survey were conducted at 21 sites in all four primary basins. The majority of sets were placed in the January through April period. A total of 21 adult razorback suckers were captured during 1993, all at the Blackbird Point (11) and Echo Bay (10) sites. All captures occurred in trammel net sets during the months of February and April. In 1994 a total of 113 trammel net nights of sampling effort were conducted at 40 sites lakewide. A total of five razorback suckers were captured, all at the Blackbird Point site.

Adult razorback suckers captured in Lake Mead since 1990, with only two exceptions, have been marked to facilitate identification in the event of recapture. Initially five fish were tagged using Floy brand T-lock anchor tags. Beginning in March 1992 all adult fish were tagged using PIT tags provided by the Bureau of Reclamation. Through 1994 a total of 42 adult fish were marked by NDOW personnel using PIT tags. A total of six recaptures of PIT tagged fish were documented in 1993, from fish tagged in 1992 or 1993, three at Blackbird Point and three at the Echo Bay site.

Observations of the historic population of razorback suckers in Lake Mead appear to closely follow predicted trends for captive populations in lower basin mainstem reservoirs. Jonez and Sumner (1954) reported razorbacks as abundant and widespread throughout the lake with particular seasonal occurrence in inflow and potential spawning areas. In the early 1950's the impoundment was 15 to 20 years old and a logical assumption is that entrapment of resident adult fish from dam closure or a high level of survival and recruitment of juvenile fish from spawning at the time of impoundment would result in retention and observation of relatively large numbers of older-aged adult fish at the time of their studies. Jonez and Sumner specifically mentioned observations of fish in the 290 mm to 620 mm or larger size range, and that at no time were fish smaller than 290 mm observed in Lake Mead. Although their length estimates appear to be based only on visual observations, and age estimation of adult razorbacks based on length measurements is highly subjective, it is probable that most of the adult fish observed by Jonez and Sumner dated to a period at or near the time of reservoir filling. Their lack of observations of smaller adult fish supports the presumption that significant recruitment to the population was not occurring during this period. Both anecdotal and documented observations throughout the historic period indicate that adult fish were broadly distributed throughout the reservoir, including upper lake areas to Paiute Point and throughout the Overton Arm. A decline in anecdotal observations of adult fish after the mid-1960's correlates with the predicted longevity of the species and indicates a probable loss of the original cohort of adult fish to old age in the 1970's and 1980's.

However, infrequent but consistent captures of adult razorbacks in Lake Mead from the late 1960's through 1993 clearly indicate the presence of a second younger cohort of fish in the lake, since adults currently being contacted would need to be greater than 55 years

old to predate significant impoundment, considerably in excess of any reasonable projections of species longevity. This occurrence could logically result from either survival and recruitment in the reservoir of juvenile fish at some point, or movement into the impoundment of adult or juvenile fish from adjacent riverine habitats upstream. The majority of captured fish, based on limited knowledge of adult razorback growth patterns, appear to have been in the 20 to 30 year age ranges at the time of capture. Variability in individual fish growth makes it virtually impossible to determine known age for adult specimens from capture measurements, or if these observed fish represent a single annual cohort or represent moderate survival and recruitment over a span of years. Interpretation of the available data does indicate probable recruitment of the existing population in the early-1960's to mid-1970's. Of particular interest is the capture by AGFD in 1967 of six adult fish averaging 231 mm TL (McCall, 1979). Age estimation using available growth history curves indicates a probable age for these fish at time of capture of three to five years (McCarthy and Minckley, 1987). Although exact capture locations were not available these fish were collected in upper portions of the lake in or near Arizona.

Three primary events in the mid-1960's affected hydrologic characteristics of Lake Mead and associated upstream riverine habitats. The closure of Glen Canyon Dam in 1963 significantly modified hydrologic and limnologic characteristics of the Colorado River downstream to Lake Mead. Displacement downstream of resident adult and juvenile razorback suckers from occupied river and tributary habitats as a result of these changes is at least a probability. Secondly, the reduced inflow into Lake Mead from the upper Colorado River basin as a result of the filling of Lake Powell modified reservoir storage levels and fluctuation patterns for a several-year period, with reservoir surface elevation reduced to as low as 1060 feet, 120 feet below current levels. Increased channelization of upstream portions of the reservoir and temporary exposure of previously submerged spawning habitats were two obvious structural impacts of the storage reduction. Finally, permanent modification of seasonal fluctuation patterns in reservoir storage levels is a continuing impact of Glen Canyon Dam operations, which has had an identified negative impact on spring-spawning sport fish species (Morgensen and Padilla, 1982). The first two of these events correlate closely with presumed recruitment dates for the Arizona specimens collected in 1967.

Based on recent collections and observations, the existing population of razorback suckers in Lake Mead appears to be composed almost entirely of large adult fish, which correlates closely to observations in Lake Mohave. Except for a single 366 mm TL specimen captured in 1994, recently captured fish show a range of 467 to 765 mm TL averaging 563 mm TL, indicating a probable age range of adults as 20 to 30 plus years old and a lack of significant recruitment to the population. This is somewhat less than the estimated average age of Lake Mohave adult razorbacks (Burke and Mueller, 1993), but more accurate age estimation would not be possible without destructive sampling of adult fish. Although localized spawning behavior has been observed since 1990, no direct evidence of successful reproduction, larval emergence, or juvenile survival and recruitment has been observed or documented through the 1994 sampling effort. Current distribution and occupancy, at least during the spawning period, appears to be limited to a small number of sites in the Boulder Basin and Overton Arm, which represents a restriction in distribution compared to historic capture records from the 1960's and 1970's. Contact with adult razorback suckers at recent capture sites represents concentrated sampling effort at known areas of use with species specific methods, primarily trammel nets, so there may be other areas of seasonal occupancy which have not been located. However, intensive lakewide gill net surveys since 1990 have shown a much lower capture rate for adult razorbacks when compared to the same methodology used in the 1970's, which supports the premise that current numbers and distribution of adult fish are very limited. Increased use of trammel net by-sets during lakewide sampling efforts began in 1993 and this will assist in better defining possible occupancy of suitable habitats by razorback suckers in areas of the reservoir where presence has not recently been documented.

LITERATURE CITED

ALLAN, R.C., AND D.L. RODEN. 1978. Fish of Lake Mead and Lake Mohave, Base Fisheries Data Boulder Canyon to Davis Dam. **Biological Bulletin No. 7, Nevada Department of Wildlife, Reno**. 105 pp.

BURKE, T., AND G. MUELLER. 1993. **Native Fish Work Group, 1992 Annual Report**. U.S. Bureau of Reclamation, Boulder City. 48 pp.

JONEZ, A., AND R.C. SUMNER. 1954. Lakes Mead and Mohave Investigations: **A Comparative Study of an Established Reservoir as Related to a Newly Created Impoundment**. Final Completion Report, Dingall-Johnson Project F-1-R. Nevada Fish and Game Commission, Reno. 186 pp.

MCCALL, T.C. 1979. **Fishery Investigation of Lake Mead, Arizona-Nevada, from Separation Rapids to Boulder Canyon, 1978-79**. Final Report to USDI Water and Power Resources Service, Contract No. 8-07-30-X0025. Arizona Game and Fish Department, Kingman. 197 pp.

MCCARTHY, M.S., AND W.L. MINCKLEY. 1987. Age Estimation for Razorback Sucker (Pisces: Catostomidae) from Lake Mohave, Arizona and Nevada. **Journal of the Arizona-Nevada Academy of Science** 21:87-97.

MELANDER, W.C. 1962. **Arizona Game and Fish Department Periodic Resurvey of Waters in District III**, Completion Report, Project F-7-R-5, Work Plan 3, Job B-1. 13 pp.

MORGENSEN, S.A., AND C.O. PADILLA. 1982. **The Status of the Black Bass Fishery in Lake Mead and a Program Toward Restoration and Enhancement**. Final Report to U.S. Bureau of Reclamation, Contract No. 7-07-30-X0028. Arizona Game and Fish Department, Kingman; Nevada Department of Wildlife, Las Vegas. 114 pp.

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Seasonal movements of razorback sucker in the middle Green River, Utah

Movimientos estacionales del matalote jorobado en el Medio Río Green en Utah

KEYWORDS: razorback sucker; telemetry; movements; habitat use; spawning

ABSTRACT

Seven adult razorback sucker *Xyrauchen texanus* were collected over spawning bars in the Middle Green River, Utah, and implanted with radio transmitters in the spring of 1993. Fish habitat use was monitored during the first summer and seasonal movement and spawning fidelity was observed during the second year following spawning. None of the razorback suckers implanted with transmitters moved over 42 km from their wintering sites to spawning sites. Greatest movement occurred during post-spawning and mid-summer location changes, with several movements exceeding 100 km. Most fish spent the summers of 1993 and 1994, and all fish spent the winter of 1993-1994 in Split Mountain Canyon in Dinosaur National Monument. During the first summer most fish occupied deep, slower velocity macrohabitats.

Of the six surviving adult males implanted, four returned to the spawning sites used the previous year. One male spawned at a different site and the remaining male either spawned at a previously unknown spawning location or may not have spawned in 1994. Movement to spawning locations appeared triggered by discharge rather than temperatures, however, greatest movement activity occurred during a combination of rising discharge and maximum daily water temperatures exceeding 14°C.

CLAVES: matalote jorobado; telemetría; movimientos; uso de hábitat; desove

RESUMEN

Siete adultos de matalotes jorobados *Xyrauchen texanus* fueron colectados en las áreas de desove del Medio Río Green, Utah, y marcados con radios transmisores en la primavera de 1993. El uso de hábitat del pez fue monitoreado durante el primer verano y movimiento estacional, la fidelidad del desove fue observada durante el segundo año siguiente al desove. Ninguno de los matalotes jorobados implantados con radio transmisores se movieron mas de 42 km desde sus sitios de invierno a los sitios de desove. Los movimientos más grandes ocurrieron durante el post-desove y a mediados del verano, con varios movimientos que excedieron los 100 km. La mayoría de los peces se mantuvieron el verano de 1993 y 1994, y todos los peces se mantuvieron el invierno de 1993-1994 en Split Mountain Canyon en Dinosaur National Monument. Durante el primer verano la mayoría de los peces se mantuvieron en la profundidad, y en macrohábitats de bajas velocidades.

De los seis machos adultos sobrevivientes con radios, cuatro regresaron a los sitios de desove usados en el año anterior. Un macho desovó en un sitio diferente y los machos restantes desovaron en localidades de desove previamente desconocidas, o pudieron no haber desovado en 1994. Los movimientos a las localidades de desove parecen ser motivadas por descargas más que por la temperatura, sin embargo, los movimientos más grandes ocurren durante una combinación de una elevación de las descargas y temperaturas diarias máximas del agua que exceden los 14°C

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Morphological changes related to growth in razorback sucker, *Xyrauchen texanus*

Cambios morfológicos relacionados al crecimiento en el matalote jorobado *Xyrauchen texanus*

KEYWORDS: morphometrics; allometry; razorback sucker; thin-plate splines

ABSTRACT

Allometric responses in organisms may have extensions to many ecological and evolutionary questions. In catostomids, information regarding allometric changes associated with large size and great age are essentially lacking. Allometric responses in razorback sucker, *Xyrauchen texanus*, have been quantified. Preliminary analyses have indicated marked sexual dimorphic and ontogenetic shape change in this species. Geometric morphometric techniques have been used to clarify and provide directionality to these changes. Analyses involved thin-plate spline functions to

quantify neurocranial and vertebral shape change in razorback suckers. Ecological and evolutionary ramifications are discussed.

CLAVES: morfométricos; alometría; matalote jorobado; thin-plate splines

RESUMEN

Las respuestas alométricas en organismos pueden resultar en algunas preguntas ecológicas y evolutivas. En catostómidos, la información referente a cambios alométricos asociados con gran tamaño y edad son esencialmente escasos. Las respuestas alométricas en el matalote jorobado, *Xyrauchen texanus*, han sido cuantificados. Análisis preliminares indican marcas de dimorfismo sexual y cambio en la forma ontogénica en estas especies. Técnicas de morfometría geométrica han sido usadas para clarificar y dar direccionalidad a estos cambios. Los análisis implican funciones de "thin-plate spline" para cuantificar cambios en la forma neurocranial y vertebral en el matalote jorobado. Las consecuencias ecológicas y evolutivas son discutidas.

[HUBBS STUDENT PAPER COMPETITOR]

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Allozyme variation and population structure in the razorback sucker, *Xyrauchen texanus*

Variación alozimática y estructura de población en matalote jorobado, *Xyrauchen texanus*

KEYWORDS: propagation; allozymes; population structure; razorback sucker

ABSTRACT

The management and recovery of the razorback sucker is going to have to include large-scale propagation. Choice of breeding stock and decisions about release sites must be made from an informed perspective. If genetically divergent stocks exist, they may have to be managed and propagated separately. To address this question, non-lethal tissue samples (muscle and fin) were obtained from razorback suckers from locations throughout its remaining native range in the Colorado River system. Allozyme variation was assessed for the gene products of 38 loci; 17 loci were polyalleleic. All populations were in equilibrium, expressed some heterozygote excess, and had levels of heterozygosity comparable to other catostomid fishes. No obvious pattern of major allelic variation was revealed, although the metapopulation is not in equilibrium. Direct comparison of our extreme geographic samples, Upper Basin Green River vs. Lower Basin Lake Mojave, reveals a low F(st) = 0.029 but with variant alleles shared at only 3 of 10 polyallelic loci. Stock sources could include Green-Yampa Rivers and/or Lake Powell and/or Lake Mojave. We recommend against using the few remaining razorbacks from the Upper Colorado population in a breeding program because of its reduced variation due to genetic drift, which may also have enhanced its proportion of genes introgressed from hybridization with flannelmouth suckers.

CLAVES: propagación; alozimas; estructura de la población; matalote jorobado

RESUMEN

El manejo y recuperación del matalote jorobado tiende a incluir la propagación a gran escala. La elección del linaje reproductivo y las decisiones acerca de los sitios de liberación deben de ser hechas desde una perspectiva informada. Si existen linajes divergentes genéticamente, estos pueden tener que ser manejados y propagados separadamente. Para contestar esta pregunta, muestras no letales de tejido (músculo y aleta) fueron obtenidos de matalotes jorobados en localidades remanentes de su rango distribucional original en el sistema del Río Colorado. La variación alozimática fue evaluada mediante los productos de los genes de 38 loci; 17 loci fueron polialélicos. Todas las poblaciones que estuvieron en equilibrio expresaron algo de exceso heterocigótico, y tuvieron niveles de heterocigocidad comparable a otros catostomidos. No fueron revelados patrones obvios de variación alélica mayor, aunque la metapoblación no esta en equilibrio. La comparación directa de muestras geográficas extremas, Cuenca Alta del Río Green vs Cuenca Baja del Lago Mohave, revelan un bajo F(st)=0.029 pero con alelos variantes repartidos en solamente 3 de 10 loci polialélicos. Las fuentes de los linajes podrían incluir los ríos Green-Yampa y/o el Lago Powell y/o el Lago Mohave. Recomendamos no usar los pocos matalotes remanentes de la población del Alto Colorado en un programa de reproducción, por su reducida variación producto de la deriva genética, lo cual también puede fortalecer su proporción de genes no deseados como producto de la hibridación con el matalote boca de franela (flannelmouth sucker)

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A genetic analysis of artificial propagation of the endangered razorback sucker, *Xyrauchen texanus*

Análisis genético de propagación artificial del matalote jorobado, especie en peligro *Xyrauchen texanus*

KEYWORDS: artificial propagation; hatcheries; genetic structure; heterozygosity; razorback sucker

ABSTRACT

For large scale artificial propagation to be an effective part of the management plans for *Xyrauchen texanus*, hatchery progeny should reflect the genetic structure of the natural population. Stock sources for hatchery propagation at the Dexter National Fish Hatchery were obtained from Lake Mohave in 1981 and 1982. Using 17 allozyme loci which had previously been found to be polymorphic in razorbacks, I examined variation in two different year classes, and compared this variation to that found in the Lake Mohave population. The natural population had an average level of heterozygosity of 0.099. The two year classes, produced in 1987 and 1990, had average heterozygosities of 0.125 and 0.080 respectively, which were not significantly different from Lake Mohave. The 1990 year class had a greatly reduced survivorship compared to previous years, and has been found to have a significantly lower mtDNA haplotype diversity. The use of different molecular data sets in the planning and monitoring of captive breeding programs will be discussed.

CLAVES: propagación artificial; criaderos; estructura genética; heterocigocidad

RESUMEN

Para que la propagación artificial a gran escala sea una parte efectiva de los planes de manejo para *Xyrauchen texanus*, la progenie del criadero debe reflejar la estructura genética de la población natural. Las fuentes del stock para la propagación en criadero en Dexter National Fish Hatchery se obtuvieron del Lago Mohave en 1981 y 1982. Usando 17 loci de alozimas las cuales se había encontrado previamente que son polimórficas para el matalote, examiné la variación en dos clases de talla diferentes, y comparé esta variación con la encontrada en la población del Lago Mohave. La población natural tiene un nivel de heterocigocidad promedio de 0.099. Las dos clases anuales, producidas en 1987 y 1990, tienen heterocigocidades promedio de 0.125 y 0.080 respectivamente, las cuales no fueron significativamente diferentes de las del Lago Mohave. La clase del año 1990 tiene una sobrevivencia fuertemente reducida comparada con los años anteriores y se ha encontrado que tiene significativamente menos diversidad de haplotipo de ADNmt. El uso de diferentes juegos de datos moleculares en la planeación y monitoreo de programas de reproducción en cautiverio serán discutidos.

[HUBBS STUDENT PAPER COMPETITOR]

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Germplasm storage to preserve genetic resources in the razorback sucker and bonytail chub

Almacenaje de germoplasma para preservar recursos genéticos del matalote jorobado y el charal elegante

KEYWORDS: Cyprinidae; bonytail chub; Colorado squawfish; humpback chub; Catostomidae; razorback sucker; genetic management; genetic resources; cryopreservation; germplasm

ABSTRACT

Germplasm storage and gene banking have proven to be valuable tools in agricultural applications and hold great potential for applications in aquaculture. We initiated studies to expand this tool to fishes that are in danger of extinction: bonytail chub (*Gila elegans*) and razorback sucker (*Xyrauchen texanus*). Methodologies for germplasm preservation and storage for razorback sucker and bonytail chub were developed and tested. We developed field techniques to collect, evaluate, refrigerate, and cryopreserve sperm from these endangered species. Cryopreserved sperm was thawed and used to fertilize eggs. Razorback sucker and bonytail chub were successfully produced using cryopreserved sperm.

Future plans include fine tuning developed methodologies and applying the technology to Colorado squawfish (*Ptychocheilus lucius*) and humpback chub (*Gila cypha*). Application of these new methodologies offers great potential for genetic management and recovery of endangered fishes.

CLAVES: Cyprinidae; charal elegante; charal del Colorado; charal jorobado; Catostomidae; matalote jorobado; manejo genético; recursos genéticos; criopreservación; germoplasma

RESUMEN

El almacenaje de germoplasma y los bancos de genes han probado ser una herramienta importante para aplicaciones en agricultura y con gran potencial para aplicaciones en acuicultura. Hemos iniciado estudios para aplicar esta herramienta a peces que están en peligro de extinción, como: el charal elegante (*Gila elegante*) y el matalote jorobado (*Xyrauchen texanus*). Las metodologías para la preservación y almacenaje del germoplasma para el charal

elegante y el matalote jorobado fueron desarrollados y probados. Desarrollamos técnicas de campo para colectar, evaluar, refrigerar, y criopreservar el esperma de estas especies en peligro. El esperma criopreservado fue tomado y usado para fertilizar los huevos. El matalote jorobado y el charal elegante fueron producidos exitosamente usando esperma criopreservado.

Los planes futuros incluyen el desarrollo de metodologías finas y aplicación de la tecnologías al charal del Colorado (*Ptychocheilus lucius*) y al charal jorobado (*Gila cypha*). La aplicación de estas nuevas metodología ofrece gran potencial para el manejo genético y recuperación de peces en peligro.

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Economic consequences of Critical Habitat designation for the Lost River sucker and the shortnose sucker

Consecuencias económicas, de la designación del Hábitat Critico para el matalote del río Lost (Lost River sucker) y el matalote nariz corta (shortnose sucker)

KEYWORDS: economic benefits; economic impacts; critical habitat; Klamath basin; quality of life

ABSTRACT

We have estimated the economic consequences of the proposed critical habitat designation developed by the Fish and Wildlife Service (Service) for two endangered species in the Klamath basin of Oregon and California, the Lost River sucker (*Deltistes luxatus*) and the shortnose sucker (*Chasmistes brevirostris*). The analysis employs an analytical method developed for the Service in the aftermath of the Endangered Species Committee's hearings regarding the northern spotted owl. The study examines the designation's impact on (1) habitat-degrading industries, (2) industries that incur spillover costs when habitat is degraded, (3) those who see the designation as an improvement in the local quality of life, and (4) those who place an intrinsic value on the suckers and their habitat. In addition to developing a worst-case, static estimate of the economic consequences, the study describes the ways in which the local economy will adjust to the designation and mitigate its adverse impacts. The designation's long-run impacts on the local quality of life is especially important, as it is likely to have positive, long-run impacts on the visual aesthetics of riparian and upland areas, the visual and olfactory aesthetics of streams and lakes, the water-related recreation associated with streams and lakes, the safety associated with bodies of water that experience reductions in toxins, the visual aesthetics and recreational opportunities associated with reductions in peak flows and increases in summer flows, and the visual aesthetics and recreational opportunities associated with increased populations of wildlife. The evidence is insufficient to quantify all the benefits and costs, but it appears likely that the overall net effect on national economic welfare is close to zero. With plausible assumptions, one reasonably could conclude that the designation will generate an increase in national economic welfare.

CLAVES: beneficios económicos; impacto económico; habitat crítico; cuenca Klamath; calidad de vida

RESUMEN

Se estimaron las consecuencias económicas de las propuestas de designación de habitat critico por el Fish and Wildlife Service (servicio) para dos especies en peligro en la Cuenca Klamath de Oregon y de California, el Lost River sucker (*Deltistes luxatus*) y el shortnose sucker (*Chasmistes brevirostris*). El análisis emplea un metido analítico desarrollado para el Servicio en el marco de las audiencias del comite de especies en peligro, con respecto al búho manchado norteño. El estudio examina el impacto de la designación sobre 1).- Industrias degradantes del habitat, 2).- Industrias que incurren en costos de derrames cuando el habitat se degrada, 3).- Aquellos que ven a la designación como un mejoramiento en la calidad de vida local 4).- Aquellos que establecen un valor intrínseco a los matalotes y su habitat. Adicionalmente al desarrollo una estimación estática "peor de los casos" de las consecuencias económicas, el estudio describe las formas en que la economía local se ajustara a la designación y mitigara su impacto adverso. El impacto a largo plazo de la designación sobre la calidad de vida local es muy importante, ya que es muy probable que tenga impactos positivos a largo plazo en aspectos estéticos visuales en areas riparias y de tierras altas, la estética visual y olfatoria de arroyos y lagos, las recreaciones relacionadas con el agua asociadas con el arroyos y lagos, la seguridad asociada con cuerpos de agua que experimentan reducción en toxinas, la estética visual y oportunidades recreacionales asociadas con las reducciones en los picos de flujo y aumentos en los flujos de verano, y la estética visual y oportunidades recreacionales relacionadas con el aumento de las poblaciones de vida silvestre. Las evidencias son insuficientes para cuantificar todos los costos y beneficios, pero parece ser muy probable que en su totalidad el efecto neto sobre la seguridad económica nacional es cercano a cero. Con plausibles asumciones, uno razonablemente puede concluir que la designación generara un incremento en el bienestar económico nacional.

KENNEDY,T.B. (TBK - University of Nevada-Reno, Biology Department)

Microhabitat use patterns and assessment of food limitation to Warner sucker larvae in streams of the Warner Valley, Oregon

Patrones de uso de microhábitats y evaluación de la limitación de alimento para larvas del matalote de Warner en arroyos del Valle Warner, Oregon

KEYWORDS: Warner Valley; Oregon; food limitation; larvae; Warner sucker; drift; microhabitat

ABSTRACT

I studied microhabitat use patterns of Warner sucker larvae *Catostomus warnerensis* in Honey Creek during the summers of 1992 and 1993. All larval groups were counted and microhabitat conditions were measured. Over 90% mortality was observed for larvae in both years. I hypothesized that food limitation accounted for this low survival.

In 1993, drift samples were collected using a plankton net in areas where larval groups were observed and in an equal number of randomly selected sites in lower Honey Creek. Potential foods present in the drift in 1993 were assessed by comparison with the list of taxa from gut contents of larvae preserved in 1992. All items were measured as geometric shapes using an ocular stage micrometer, to identify potential prey. To be included as potential prey, minimum dimension of drift items could be no larger than the average gape of drift feeding larvae (1mm). Total volume of available prey collected in the net (cm^3 day^{-1}) was compared to estimated prey requirements for survival (4% of b.w. day^{-1}) and growth (10% of b.w. day^{-1}). This allowed computation of the ratio of prey available to estimated requirements. Preliminary results suggest that prey availability may be limiting to Warner sucker larvae in Honey Creek. These results imply that starvation of sucker larvae may be an important factor in the low success of juvenile recruitment in Warner Valley streams observed for both years (1992 and 1993).

CLAVES: Valle Warner; Oregon; limitantes de alimento; larvas; matalote de Warner; plancton; microhábitats

RESUMEN

Se estudiaron los patrones de uso de microhábitats de las larvas del matalote de Warner *Catostomus warnerensis* en Honey Creek durante el verano de 1992 y 1993. Todas las larvas fueron contadas y medidas las condiciones del microhábitat. Mas del 90% de mortalidad fue observada para las larvas en ambos años. Se hipotetiza que las limitantes de alimento son la causa de esta baja sobrevivencia.

En 1993, fueron colectadas muestras de plancton en áreas donde los grupos larvales fueron observados y en un número equivalente de sitios seleccionados al azar en el bajo Honey Creek. El alimento potencial presente en la red de plancton en 1993, fue evaluado mediante la comparación con la lista de taxa de los contenidos estomacales de larvas colectadas en 1992. Todos las partículas fueron medidas así como su forma geométrica usando un micrómetro ocular, para identificar las presas potenciales. Para ser incluida como presa potencial, la dimensión mínima de la partícula podría no ser más grande que el promedio de apertura bucal de la larva (1 mm). El volumen total de la presa disponible colectada en la red (cm^3 day^{-1}) fue comparado a los requerimientos de presa estimados para su sobrevivencia (45 de b.w. day^{-1}) y crecimiento (10% de b.w. day^{-1}). Estos cálculos sugieren la necesidad de estimar la relación de presa disponible para estimar los requerimientos. Los resultados preliminares sugieren que la disponibilidad de presa podría estar limitando las larvas del matalote de Warner en Honey Creek. Estos resultados implican que la inanición quizás sea un factor importante en las altas tasas de mortalidad observadas en el matalote de Warner.

[HUBBS STUDENT PAPER COMPETITOR]

HOBBES,A.L.*; PROPST,D.L. (ALH and DLP - New Mexico Department of Game and Fish, Santa Fe, NM)

Status and distribution of Zuni bluehead sucker in the Zuni River drainage, New Mexico

Estatus y distribución del matalote cabeza azul del Río Zuni en la cuenca del Río Zuni, Nuevo México

KEYWORDS: Zuni bluehead sucker; Zuni River drainage; New Mexico; status; distribution

ABSTRACT

Zuni bluehead sucker *Catostomus discobolus yarrowi* is a naturally occurring hybrid of bluehead sucker *Catostomus discobolus* and Rio Grande sucker *Catostomus plebeius* endemic to the upper Little Colorado River drainage, New Mexico and Arizona. In New Mexico, its historical distribution was documented in the Zuni River downstream and upstream of the Pueblo of Zuni and moderate numbers were collected in the two principal tributaries, the Rios Nutria and Pescado. Recent collecting efforts indicate that the sucker has declined dramatically in the Rio Pescado and it is absent in several formerly inhabited reaches of the Rio Nutria. The upper Rio Nutria and two headwater tributaries, Aqua Remora and Tampico Spring, support several, numerically small, isolated populations.

Fish occur in largely sediment-free reaches containing bedrock or large boulders, and the size structure of populations in these reaches indicates presence of several year classes and successful reproduction and recruitment. Imperilment of Zuni bluehead sucker is due to efforts during the mid-1900's to eradicate "undesirable" fishes from the Zuni River drainage, poor land management practices, construction of reservoirs, and the introduction of non-native fish species. Zuni bluehead sucker is listed as New Mexico State Endangered, Group 2, and is a candidate for listing by the U.S. Fish and Wildlife Service. Recovery of the subspecies into large portions of its former range is unlikely due to currently degraded watershed conditions. However, cooperation and involvement of private landowners, tribal, state, and federal agencies is helping to ensure conservation of extant populations of the Rio Nutria drainage.

CLAVES: Matalote cabeza azul del Río Zuni; drenaje del Río Zuni; Nuevo México; estatus; distribución

RESUMEN

El Zuni bluehead sucker (*Catostomus discobolus yarrowi*) es un híbrido que proviene en forma natural de bluehead sucker (*Catostomus discobolus* y de Río Grande sucker (*Catostomus plebeius*) endémico de la parte superior de la cuenca del Pequeño Río Colorado (Little Colorado River), en Nuevo México y Arizona. En Nuevo México, su distribución histórica fue documentada en el Río Zuni río arriba y río abajo del Pueblo de Zuni y fueron colectados en cantidades moderadas en los dos principales tributarios, los ríos Nutria y Pescado. Las colectas recientes indican que el matalote ha declinado dramáticamente en el Río Pescado y está ausente en varios recodos que habitaba antiguamente en el Río Nutria. La parte superior del Río Nutria y las cabeceras de dos tributarios Aqua Remora y Tampico Spring, soportan varias poblaciones aisladas, numéricamente pequeñas. Los peces ocurren en grandes extensiones libres de sedimento, que contienen rocas o grandes cantos rodados, y la estructura por tamaños de las poblaciones que alcanza en estos áreas, indica la presencia de varias clases anuales y éxito en reproducción y reclutamiento. El peligro para el Zuni bluehead sucker es debido a los esfuerzos, a mediados de 1900, por erradicar peces "indeseables" de la cuenca del Zuni River, a las prácticas deficientes de manejo de las tierras, a la construcción de embalses y a la introducción de especies no nativas. El Zuni bluehead sucker esta enlistado come especie en peligro en el Estado de Nuevo México, en el grupo 2, y es candidato para enlistarse por el Servicio de Fauna y Pesca de los Estados Unidos. La recuperación de las subespecies dentro de las grandes porciones de su antiguo registro es improbable actualmente debido a las condiciones de degradación de las cuencas. Sin embargo, la cooperación y el involucramiento de propietarios privados, tribus, y agencias estatales y federales, esta ayudando a asegurar la conservación de las poblaciones intactas de la cuenca del Río Nutria.

HUTCHISON,A.M. (AMH - Arizona State University, Department of Zoology, Tempe, AZ)

Inter- and intraspecific relationships of flannelmouth sucker (*Catostomus latipinnis*) based on mtDNA

Relaciones inter- e intraespecíficas del matalote boca franela (*Catostomus latipinnis*) basado en ADNmt

KEYWORDS: mtDNA; restriction mapping; phylogenetics

ABSTRACT

Morphological divergence within *Catostomus latipinnis* has caused some speculation as to the specific status of some its forms. Fifteen restriction enzymes with 6-base recognition sequences were used to analyze variation among five populations of *Catostomus latipinnis* from the Colorado River basin, including 2 populations of the reputed Little Colorado river form (*Catostomus sp.*). Other species (*Catostomus ardens*, *Catostomus insignis*, *Catostomus commersoni* and *Pantosteus plebeius*) were also analyzed to determine relationship (*C. insignis*) (*C. ardens*, *C. commersoni* and *P. plebeius*) to *C. sp.*. Restriction maps were constructed to establish homologous sites among populations analyzed. Data suggest that there is little genetic differentiation among *C. latipinnis* populations and that variation within *C. sp*. populations is similar to variation within populations of *C. latipinnis*.

CLAVES: ADNmt; mapeo de restricción; relaciones filogenéticas

RESUMEN

La divergencia morfológica dentro de *Catostomus latipinnis* ha causado alguna especulación con respecto al estatus especifico de algunas de sus formas. Quince enzimas de restricción con 6-secuencias de reconocimiento básica, fueron utilizadas para analizar la variación entre cinco poblaciones de *Catostomus latipinnis* de la cuenca del río Colorado, incluyendo 2 poblaciones de supuestas formas de *Catostomus sp.* en el Pequeño Río Colorado (Little Colorado River). Otras especies (*Catostomus ardens, C. insignis, C. commersoni* y *Pantosteus plebeius*) también fueron analizadas para determinar sus relaciones, (*C. insignis*), (*C. ardens, C. commersoni* y *P. plebeius*) con *C. sp.*. Mapas de restricción fueron reconstruidos para establecer sitios homólogos entre poblaciones analizadas. Los datos sugieren que existe poca diferenciación genética entre las poblaciones de *C. latipinnis* y que la variación dentro de las poblaciones de *C. sp*. es muy similar a la variacione dentro de las poblaciones de *C. latipinnis*.

[HUBBS STUDENT PAPER COMPETITOR]

DEACON,J.E.*; TAYLOR,F.R. (JED and FRT - University of Nevada Las Vegas, Las Vegas, NV)

Diel oxygen variation and hatching success of Devils Hole pupfish: An hypothesis

Variación del oxígeno diel y éxito de eclosión del pez perrito del Devils Hole: Una hipótesis

KEYWORDS: Devils Hole; Devils Hole pupfish; egg mortality; hatching success; oxygen saturation

ABSTRACT

Efforts to reproduce Devils Hole Pupfish, *Cyprinodon diabolis* under laboratory conditions have been mostly unsuccessful over the past thirty years. Observations suggest that egg and larval survival in refugium populations and in Devils Hole is also extremely low. A review of the literature regarding egg and larval mortality in other species of pupfish, as well as an extensive literature on temperature tolerance of pupfish, suggests mechanisms that may explain this high larval and egg mortality. In general, oogenesis, followed by egg development, are the most temperature sensitive parts of the pupfish life cycle. Other pupfishes show arrested development of eggs at temperatures near 32°C, with oxygen saturation of 70% or less. Data from Devils Hole reveal that most larvae are hatched in the inner third of the shallow shelf, with decreasing larval production occurring as a function of proximity to deeper water. Oxygen saturation in the main body of water in Devils Hole is about 40%. Over the inner portion of the shelf, oxygen saturation varies from night time levels of about 40% to mid-day levels in excess of 100%. It is possible that eggs laid anywhere in Devils Hole undergo arrested development daily, and that the arrested development is interrupted as a function of increasing oxygen saturation. This would increase the probability of hatching in the inner portion of the shelf, and decrease probability of hatching in deeper water. Such a pattern would explain the observed variation in larval density over the shallow shelf in Devils Hole.

CLAVES: Devils Hole; pez perrito de Devils Hole; mortalidad del huevo; éxito de eclosión; saturación de oxígeno

RESUMEN

Los esfuerzos para reproducir al pez perrito del Devils Hole, *Cyprinodon diabolis* bajo condiciones de laboratorio, en su mayor parte han sido sin éxito durante los últimos treinta años. Las observaciones sugieren que la sobrevivencia del huevo y de la larva en las poblaciones en refugio y en Devils Hole son también, extremadamente bajas. Una revisión de la literatura con respecto a la sobrevivencia del huevo y de la larva en otras especies de peces perrito, sugieren mecanismos que pueden explicar la alta mortalidad del huevo y de la larva. En general, la oogenesis, seguido por el desarrollo del huevo, son las partes mas sensitivas a la temperatura del ciclo de vida del pez perrito. Otros peces perrito muestran desarrollos retrasados de huevos a temperaturas cercanas a los 32°C, con saturación de oxígeno de 70% o menos. Datos del Devils Hole revelan que la mayor parte de las larvas eclosionan en el tercio interno del arroyo somero, con una decreciente producción larval ocurriendo como una función de la proximidad de aguas mas profundas. La saturación de oxígeno en el cuerpo principal del agua en el Devils Hole es cercana al 40%. sobre la porción interna del arrecife, la saturación del oxígeno varia de niveles nocturnos cercanos a 40% a niveles de medio día con excesos del 100%. Es muy posible que los huevos depositados en cualquier parte del Devils Hole, experimenten un desarrollo atrasado diario, y que el desarrollo atrasado es interrumpido como una función del incremento de la saturación de oxígeno. Esto incrementa la probabilidad de eclosión en la porción interna del arrecife, y decrece la probabilidad de eclosionar en aguas mas profundas. Tal patrón explicaría las variaciones observadas en la densidad larval sobre la parte somera del Devils Hole.

HUBBS,C.*;VALDES-GONZALES,A. (CH - Department of Zoology, The University of Texas at Austin, Austin, TX 78712, U.S.A.; AV-G - Facultad de Ciencias Biológicas, Laboratorio de Acuicultura, Universidad Autónoma de Nuevo León, Monterrey, NL, México)

Interbrood intervals of *Gambusia* species

Intervalos entre partos en especies de *Gambusia*

KEYWORDS: reproduction; fecundity; mosquitofish; Poeciliidae; reproducción; fecundidad; pez mosquito

ABSTRACT

The potential number of offspring is controlled by females as males are always in excess supply. The number of offspring from females is influenced by: A) the number of offspring at one time (positively correlated with female size); B) the age of first (and last) reproduction; C) the length of the annual reproductive season (longer in low latitudes and when water temperatures are consistent); D) the mass of the individual young; and E) the time between broods (= interbrood interval). The available data on offspring is greatest for A and sequentially less until E. We present data for interbrood intervals for species of *Gambusia*. *Gambusia gaigei*, *Gambusia heterochir*, *Gambusia nobilis*, and *Gambusia longispinis* have interbrood intervals of about 45 days and *Gambusia affinis* and *Gambusia speciosa* have interbrood intervals of about 30 days.

CLAVES: reproducción; fecundidad; pez mosquito; Poeciliidae; reproducción

RESUMEN

El número potencial de crías es controlado por las hembras como machos siempre se presentan en exceso. El número de crías por hembra está influenciado por: A) el número de crías por parto (positivamente correlacionado con la talla de la hembra); B) la edad para el primer (y el último) evento reproductivo; C) la duración de la estación reproductiva (mayor en bajas altitudes y temperatura consistente; D) la masa o volumen de cada cría; y E) el tiempo entre puestas (= intervalo entre cada evento reproductivo). Los datos disponibles sobre crías es mayor para A y secuencialmente menor hasta E. Se presentan datos para intervalos de puestas para especies de *Gambusia*. *Gambusia gaigei*, *Gambusia heterochir*, *Gambusia nobilis*, y *Gambusia longispinis* tienen intervalos de puesta de aproximadamente 45 días, y *Gambusia affinis* y *Gambusia speciosa* tienen intervalos de aproximadamente 30 días.

SHEFFER,R.J.*; SHIRLEY,C.; MINCKLEY,W.L.; HEDRICK,P.W. (Arizona State University)

Fecundity, growth rate and fluctuating asymmetry in the Gila topminnow *Poeciliopsis occidentalis occidentalis*

Fecundidad, tasa de crecimiento y fluctuaciones asimétricas en la sardinita del Gila (*Poeciliopsis occidentalis occidentalis*)

KEYWORDS: Gila topminnow; Arizona; endangered species; fecundity; growth rate; asymmetry

ABSTRACT

Fecundity, growth rate and bilateral asymmetry are being investigated in samples of topminnows from Monkey Spring, Sharp Spring, Cienega Creek, and a population derived from Bylas Spring. The Monkey Spring population appears to have lower fecundity than the other three. Other results will be discussed. Future plans include laboratory breeding of all four populations with continued measurement of the above mentioned characteristics.

CLAVES: sardinita del Gila; Arizona; especies en peligro; fecundidad; tasa de crecimiento; asimetría

RESUMEN

Fecundidad, tasa de crecimiento y simetría bilateral están siendo investigadas en muestras de sardinitas del Gila de Monkey Spring, Sharp Spring, Cienega Creek y una población derivada de Bylas Spring. La población de Monkey Spring parece tener más baja fecundidad que las otras tres. Otros resultados serán discutidos. Los planes a futuro incluyen reproducción en laboratorio de las cuatro poblaciones con medidas continuas de las características antes mencionadas.

HORN,MICHAEL J. (Arizona State University; U. S. Bureau of Reclamation)

Use of storage lipids as an indicator of nutritional status of individual larvae of the razorback sucker (*Xyrauchen texanus*)

El uso de los lípidos almacenados como un indicador del estatus nutricional de larvas individuales del matalote jorobado (Xyrauchen texanus)

KEYWORDS: critical period; Lake Mohave; larval fish; nutrition; razorback sucker

ABSTRACT

Razorback sucker (*Xyrauchen texanus*) populations have all but disappeared throughout most of their historic range. Lake Mohave, Arizona-Nevada, contains the largest remnant population of this fish in existence. This population is composed of aged fish and is declining rapidly. Recruitment of new fish to the adult population appears to be the limiting factor in Lake Mohave. Substantial numbers of larvae are present in the lake each spring following spawning, but survivorship is too low to detect. Several hypothesis exist to explain lack of recruitment in the razorback sucker population of Lake Mohave, Arizona-Nevada. One such hypothesis explaining an apparent complete failure of each year class may be the presence of a critical period during the larval phase related to nutrition. Previous studies have indicated all larvae consistently disappear at the same size, about 10-12mm, the size at which their yolk reserves are used up. In this study fat stores of larval razorback suckers were measured using a gravimetric, di-ethyl ether extraction. To determine a base-line for comparison, a series of larvae were raised in the laboratory at known concentrations of food ranging from starvation to ad-libitum. By comparing lipid levels of wild caught larvae with laboratory it should be possible to assess the condition of wild larvae to determine if nutrition is influencing early survivorship.

CLAVES: período crítico; Lago Mohave; larva de pez; nutrición; matalote jorobado

RESUMEN

Las poblaciones del matalote jorobado (Xyrauchen texanus), están todas por desaparecer en la mayor parte de su rango histórico. El Lago Mohave, Arizona-Nevada, contiene la población remanente más grande existente de estos peces. Esta población está compuesta de peces viejos y está declinando rápidamente. El reclutamiento de nuevos peces a la población de adultos, parece ser el factor limitante en el Lago Mohave. Un número substancial de larvas están presentes en el lago cada primavera, siguientes a la temporada de desove, sin embargo los sobrevivientes están en números muy pequeños para ser detectados. Existen varias hipótesis para explicar la pérdida de reclutamiento en el Lago Mohave, Arizona-Nevada. Una de tales hipótesis que explica una aparente y completa falta de cada clase del año, puede ser la presencia de un período crítico durante la fase larval relacionada a la nutrición. Estudios previos han indicado que todas las larvas consistentemente desaparecen a una misma talla (10-12 mm), tamaño al cual las reservas del saco vitelino son agotadas. En este estudio se midieron las reservas de grasas almacenadas de las larvas del matalote jorobado usando un método gravimétrico y extracción con éter dietil. Para establecer una línea base de comparación, una serie de larvas fueron llevadas en el laboratorio a concentraciones conocidas de comida que variaron desde la inanición hasta *ad-libitum*. Mediante la comparación de los niveles de lípidos de larvas silvestres cautivas en el laboratorio, podría ser posible evaluar la condición de las larvas silvestres para determinar si la nutrición esta influenciando sobre los estudios tempranos de los sobrevivientes.

BURKE,T. (Bureau of Reclamation, PO Box 61470, Boulder City, NV 89005)

Rearing wild razorback sucker larvae in lake-side backwaters, Lake Mohave, Arizona/Nevada

Crianza de larvas silvestres de matalote jorobado, en bahias aisladas del Lago Mohave, Arizona/Nevada

KEYWORDS: razorback sucker; Lake Mohave; rearing; reservoirs

ABSTRACT

The Native Fish Work Group captured over 10,000 wild razorback sucker larvae, reared them in lakeside ponds and released them to the reservoir during the past year. Spawning aggregations of adult suckers were located using monthly helicopter surveys. Field teams were dispatched to these sites each week. Biologists worked at night capturing larvae attracted to white lights submerged one meter below the surface. Larvae were brought into laboratory, fed brine shrimp and held for three weeks to allow full development of paired fins and to verify species. Young were then transferred to predator-free ponds around Lake Mohave and monitored with trapnets throughout the summer. Fish were harvested during September and October. Survival varied among ponds, ranging from 0 to 60%. Maximum growth exceeded 30 centimeters in nine months. Growth and survival statistics will be presented.

CLAVES: matalote jorobado; Lago Mohave; crianza; reservorios

RESUMEN

El Grupo de Trabajo de Peces Nativos capturó alrededor de 10,000 larvas de matalote jorobado, los crió en pozas aledañas al lago y los liberó en el reservorio durante el año pasado. Las agregaciones de adultos desovantes fueron localizados mediante evaluaciones mensuales en helicópteros. Los equipos de campo fueron enviados a estos sitios cada semana. Los biólogos trabajaron durante la noche capturando las larvas que fueron atraídas por luz blanca sumergida un metro bajo la superficie. Las larvas fueron traídas al laboratorio, alimentadas con camarón fresco y mantenidos por tres semanas para seguir el desarrollo completo de las aletas pareadas y verificación de la especie. Los jóvenes fueron transferidos a pozas libres de depredadores en los alrededores del Lago Mohave y monitoreados con trampas de red durante el verano. Los peces fueron cosechados durante Septiembre y Octubre. La sobrevivencia varió en todas las pozas, variando del 0 al 60%. El crecimiento máximo excedió 30 cm en nueve meses. Se presentará la estadística de crecimiento y sobrevivencia.

HINES,R.T. (RTH - Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR)

Influence of suspended sediments on larval razorback sucker *Xyrauchen texanus* vulnerability to predation

Influencia de los sedimentos en suspensión sobre la vulnerabilidad de depredación de las larvas del matalote jorobado *Xyrauchen texanus*

KEYWORDS: Lake Mohave; razorback sucker; larvae; non-native fishes; turbidity; predation; endangered species

ABSTRACT

The razorback sucker *Xyrauchen texanus* is an endangered catostomid endemic to the Colorado River basin. The largest remaining population of razorback sucker resides in Lake Mohave, Arizona-Nevada. Impoundment modified the physical and chemical characteristics of the Colorado River, controlling extremes in flow, moderating temperatures,

and reducing turbidity. In addition, the creation of clear-water reservoirs provided lacustrine habitat for numerous non-native fishes. Razorback sucker spawn annually along the shores of Lake Mohave, but natural recruitment has been undetected since dam closure 40+ years ago. Identifying the causes of recruitment failure has been problematic, but predation on early life- stages by non-native fishes is suspected. A contributing factor to predation by non-native fishes may be changes in the physical properties of the habitat. Historically, turbid habitats were likely utilized by adult and larval razorback sucker. In contrast, many of the non-native fishes evolved in clear water habitats. Non-native predators forage visually, and may be adversely affected by turbidity, which has been found to reduce reactive distances and growth rates in many fish species. Therefore, an experiment was designed to determine if larval razorback sucker vulnerability to foraging green sunfish *Lepomis cyanellus* and juvenile Colorado squawfish *Ptychocheilus lucius* decreases with elevated suspended sediment concentrations. Predation trials were performed in aquaria at suspended sediment concentrations (bentonite clay) of 0, 0.25, and 2.0 ppt. Results indicate that larval razorback sucker are less vulnerable to foraging native and non-native predators with increased suspended sediment concentration.

CLAVES: Lago Mohave; matalote jorobado; larva; peces no nativos; turbidéz; depredación; especies en peligro

RESUMEN

El matalote jorobado (*Xyrauchen texanus*) es un catostómido amenazado endémico a la cuenca del Río Colorado. La mayor población remanente de matalote jorobado reside en el Lago Mohave, Arizona-Nevada. El represamiento del agua, modificó las características físicas y químicas del Río Colorado, controlando extremos en flujo, moderando temperaturas, y reduciendo la turbidéz. En adición, la creación de reservorios de agua-clara proporcionó habitat lacustre para numerosos peces no nativos. El matalote jorobado desova anualmente a lo largo de la orilla del Lago Mohave, pero el reclutamiento natural no ha sido detectado desde el cierre de la presa 40 años atrás. Identificar las causas de esta falta de reclutamiento ha sido problemático, pero se sospecha la predación en estudios tempranos de vida por peces no nativos. Un factor que contribuye a la predación pueden ser los cambios en las propiedades físicas del habitat. Históricamente, los hábitats turbios fueron supuestamente utilizados por matalote jorobado adulto y larval. En contraste, muchos de los peces no nativos están relacionados a hábitats de agua clara. Los predadores no nativos forrajean visualmente, y pueden ser adversamente afectados por la turbidez reduciendo las distancias de reacción y tasas de crecimiento en muchas especies de peces. Por esta razón, fue diseñado un experimento para determinar si la vulnerabilidad de las larvas de matalote jorobado al forrajeo del "green sunfish" (*Lepomis cyanellus*) y al juvenil del charal del Colorado (*Ptychocheilus lucius*) decrece con elevadas concentraciones de sedimentos suspendidos. Ensayos de predación fueron realizadas en acuarios a concentraciones de sedimentos suspendidos (arcilla bentonita) de 0, 0.25, y 2.0 ppt. Los resultados indicaron que las larvas de matalote jorobado son menos vulnerables al forrajeo de depredadores nativos y no nativos con concentraciones incrementadas de sedimentos suspendidos.

[HUBBS STUDENT PAPER COMPETITOR]

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Efficiency of light traps for capture and retention of larval and young-of-the-year juvenile razorback sucker

Eficiencia de trampas de luz para la captura y retención de larvas y juveniles del año del matalote jorobado

KEYWORDS: razorback sucker; larvae; juveniles; light traps; capture efficiency; retention efficiency

ABSTRACT

In 1993, the National Park Service, U.S. Fish and Wildlife Service, and other Upper Colorado River Basin researchers decided to follow the lead of lower basin associates and implement a light-trap sampling program to help assess razorback sucker *Xyrauchen texanus* production and downstream distribution of the progeny. For this experimental program, they selected a commercially available, floating, 30-cm tall, quatrefoil-style light trap featuring a D-cell powered, 2-volt, constant-intensity light circuit and light-distribution rod that provide 0.1 lux of warm, white light (in air) at 0.5 m from the trap's center. Under National Park Service sponsorship, we conducted a series of laboratory experiments to assess potential for razorback sucker capture and retention, provide guidelines for use of the traps, and better interpret field results.

Most experiments were conducted in triplicate in 43-cm deep, still, clear water in 1.2-m diameter tanks under light-excluding tents with 2-mm (for larvae) or 6- mm slit-width (for juveniles) versions of the above described traps. For capture experiments, 50 larvae or 25 juveniles were released into each tank and allowed to acclimate to the tank and darkness during a sequence of 0.5 h intervals of simulated daylight, dusk, and full darkness before traps were set for 1, 4, or 8 hours. For corresponding retention experiments, fish were placed in trap catch basins and allowed to calm before traps were placed in tanks.

Based on 1-h trials, capture efficiencies (percentage of 50 or 25 fish caught) were greatest for razorback sucker juveniles (44-64%; 25-35 mm TL) and flexion mesolarvae (24-32%; 12-13 mm TL) and least for non-feeding,

yolk-bearing protolarvae (14-22%; 10-11 mm TL) and postflexion mesolarvae (6-20%; 15-20 mm TL, some metalarvae). Capture efficiencies increased between 1- and 4-h trials for protolarvae (14-22% and 22-30%, respectively) and postflexion mesolarvae (6- 20%, 32-42%) but not juveniles (44-64%, 40-52%) (no 4-h trials for flexion mesolarvae). Capture efficiencies increased again with 8-h trials for protolarvae (36-58%) but not for postflexion mesolarvae (26-44%) (no 8-h trials for flexion mesolarvae or juveniles). Few or no fish were captured when traps were unlit. Capture efficiencies for 1-h sets with protolarvae and postflexion mesolarvae during simulated dusk (0.5 h daylight and 0.5 h gradual reduction to darkness) were lower than for 1-h night-time trials reported above (10-16% and 0-10%, respectively). Because field water conditions are usually turbid, we also conducted a set of 1-hr turbid-water trials (50-75 FTUs). Capture efficiencies for flexion and postflexion mesolarvae (68-76%, 24-60%) were 2.6 to 2.7 times higher than in clear water, whereas those for juveniles (8-20%) were over two-thirds lower than in clear-water trials.

Retention efficiencies (percentage of fish retained) were high for protolarvae (68-98%, mostly >80%), and postflexion mesolarvae (96-100%) but somewhat lower for juveniles (56-84%); efficiencies were similar regardless of trial duration (flexion mesolarvae not tested). With unlit traps, 4-h retention efficiencies for protolarvae were very much reduced (8-28%); for postflexion mesolarvae and juveniles (single trial), reductions in efficiency were less drastic (72-100%, 40%). Retention efficiencies during simulated dawn (lighting sequence reverse of dusk) were lower than in full darkness for protolarvae (68-70%) but nearly the same for postflexion mesolarvae (96-100%) (no trials with flexion mesolarvae or juveniles).

CLAVES: matalote jorobado; larva; juveniles; trampas de luz; eficiencia de captura; eficiencia de retención

RESUMEN

En 1993, el Servicio de Parques Nacionales, el Servicio de Pesca y Vida Silvestre de los Estados Unidos y otras instituciones de la cuenca alta del Río Colorado decidieron dar seguimiento a las investigaciones de la cuenca baja, con el fin de implementar un programa de muestreo con trampas de Luz para ayudar a evaluar el matalote jorobado *Xyrauchen texanus* en su producción y distribución de su progenie a corriente abajo.

Para este programa experimental, ellos seleccionaron un flotador disponible comercialmente, de 30 cm de alto, con un estilo de trébol de cuatro hojas, funcionando con una batería "D", de 2 voltios, un circuito de luz de intensidad constante y un distribuidor de luz tipo rod que provee 0.1 lux de intensidad luminosa, una luz blanca (en el aire) a 0.5 m del centro de la trampa. Bajo el patrocinio del Servicio Nacional de Parques, nosotros conducimos una serie de experimentos de laboratorio para evaluar el potencial de captura del matalote jorobado y la retención, proporcionando lineamiento para el uso de las trampas y una mejor interpretación de resultados de campo.

La mayoría de los experimentos fueron conducidos por triplicado en 43 cm de profundidad, en agua mansa, en agua clara en tanques de 1.2 m de diámetro bajo tiendas de exclusión de luz, y con versiones de las trampas descritas anteriormente de 2 mm (para larva) o 6 mm de apertura de malla (para juveniles). Para experimentos de captura, se liberaron 50 larvas o 25 juveniles dentro de cada tanque y puestos para aclimatación a los tanques y a la oscuridad, durante una secuencia de simulación diurna con intervalos de 0.5 horas, crepúsculo y oscuridad completa antes que las trampas fueron colocadas por períodos de 1, 4 y 8 horas. Para los experimentos correspondiente de retención, los peces fueron colocados en los recipientes de las trampas de captura y tranquilizados antes de que las trampas fueron colocadas en los tanques.

Basados en pruebas de 1 hora la eficiencia de captura fue más alta (porcentajes de captura de peces de 50-25) para los juveniles de matalote jorobado (44-64%; 25-35 mm LT) y mesolarvas en flexión (24-32%; 12-13 mm Lt) y menor para protolarvas de alimentación por vitelo (14-22%; 10-11 mm Lt) y mesolarvas de postflexión (6-20%; 15-20 mm de Lt, algunas metalarvas). La eficiencia de captura se incremento entre pruebas de 1 y 4 horas para protolarvas (14-22% y 22-30% respectivamente) y postflexión de mesolarvas (6-20%, 32-42%) pero no para juveniles (44-64%, 40-52%) (no hubo pruebas de 4 horas para larvas de postflexion). La eficiencia de captura se incremento de nuevo con las pruebas de 8 horas para protolarvas (36-58%) pero no para larvas de postflexión (26-44%) (no hubo pruebas de 8 horas para mesolarvas de flexión o juveniles). Pocos o ninguno de los peces fueron capturados cuando las trampas estuvieron sin iluminación. La eficiencia de captura para series de una hora con protolarvas y mesolarvas de postflexión durante simulaciones de oscuridad (0.5 horas de luz diurna y una reducción gradual de 0.5 horas hasta la oscuridad) fueron menores que para las pruebas nocturnas de 1 hora reportadas con anterioridad (10-16% y 0-10% respectivamente). Dado que las condiciones de campo del agua presenta turbidez, nosotros también conducimos un grupo de experimentos de una hora en agua turbia (50-75 FTUs). La eficiencia de captura para mesolarvas de flexión y postflexión (68-76%, 24-60%) fueron de 2.6 a 2.7 veces mas alta que en agua clara, sin embargo, esto para juveniles (8-20%) fue de dos terceras partes más bajo que en aguas claras.

Las eficiencias de retención (porcentajes de peces retenidos) fue alta para protolarvas (68-98%, mayor de 80%), y mesolarvas de postflexión (96-100%) pero algo más bajas para juveniles (56-84%); las eficiencias fueron similares a pesar de la duración de las pruebas (las mesolarvas de flexión no fueron probadas). Con trampas sin luz, la eficiencia de retención en cuatro horas para protolarvas fue mucho más reducida (8-28%); para mesolarvas de postflexión y

juveniles (una sola prueba), la reducción en la eficiencia fue menos drástica (72-100%, 40%). La eficiencia de retención durante la simulación (secuencia reversible de luz-oscuridad) fue mas bajo que en la total oscuridad para protolarvas (68-70%) pero cercana para las mesolarvas de postflexión (96-100%) (no existieron pruebas con mesolarvas o juveniles)

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Effects of electrofishing fields on embryos and larvae of razorback sucker

Efectos de los campos de electropesca sobre los embriones y larvas del matalote jorobado

KEYWORDS: razorback sucker; electrofishing; embryos; larvae

ABSTRACT

Electrofishing over spawning grounds is used to capture adult razorback sucker (*Xyrauchen texanus*). Concerns have been raised about potential adverse impacts on spawning adults, developing embryos, and early larvae. In the laboratory, I evaluated effects of selected direct-current pulse frequencies and peak-voltage gradients in homogeneous fields on survival of embryos through hatching and survival and growth of larvae through 4 weeks after treatment. Treatment frequencies at 1.2 V/cm were 80 Hz with 5-ms pulses (40% duty cycle), 60 Hz with 4-ms pulses (24% duty cycle), 30 Hz with 4-ms pulses (12% duty cycle), and 15 Hz with three 1.6-ms pulses at a secondary frequency of 240 Hz (a pulse train patented as CPS; 7% duty cycle). Treatment frequency at 5.0 V/cm and 10.0 V/cm was 60 Hz with 4-ms pulses. Waveforms were square. Selected pulse frequencies and duty cycles were those used in field investigations or recommended to reduce injury to adult fish. Treatment fields were generated between full cross-sectional electrodes in a fiberglass trough by Coffelt Manufacturing's VVP-15 or CPS Mark XX electrofishing control units and an electrical generator. Tests were conducted in well water at 18.5oC and 650 microsiemens/cm conductivity. Samples of embryos at blastula (33 h after fertilization), early tailbud (78 h), or finfold (122 h) developmental stages, or pre-swimup larvae (36 h after hatching) were placed in nylon-mesh baskets and exposed for 10 s to one of the six treatment fields. Control groups for each life-stage were handled the same as treatment groups but without exposure to electricity.

Results suggest that electrofishing over razorback sucker spawning grounds is harmful to developing embryos and early larvae. In all treatment or control groups, survival of embryos tended to improve with advancing developmental state; the blastula stage was particularly sensitive to electrical fields. Highest survival of shocked embryos for developmental stages beyond blastula was in the 1.2-V/cm CPS and 30-Hz treatments (90-92% and 75-90%, respectively). Lowest survival at each embryonic developmental stage occurred in the 10-V/cm 60-Hz treatment and ranged from 3% (blastula) to 70% (finfold). Survival in all treatments at blastula (3-50%) and 5.0-V/cm and 10-V/cm 60-Hz treatments at early tailbud or finfold (43-72%) was significantly ($P <= 0.05$) lower than in corresponding control groups (88-95%). Embryo survival in other treatment groups was not significantly ($P > 0.05$) different from controls. Survival of larvae over the 4-week period after treatment was not affected by shocking. Growth of larvae in all treatments, as measured by change in standard length, was significantly lower than that of controls; growth was lowest in the 10-V/cm 60-Hz treatment. Among treatments, growth did not differ significantly.

CLAVES: matalote jorobado; electropesca; embrión; larva

RESUMEN

La electropesca es usada en los campos de desove para capturar adultos de matalote jorobado (*Xyrauchen texanus*). Una preocupación se ha desarrollado acerca de los impactos potenciales adversos sobre adultos desovantes, embriones en desarrollo, y los primeros estudios larvarios. En el laboratorio, evalué los efectos de la frecuencia de choques eléctricos (pulsos) de corriente directa y gradientes de voltaje en campos homogéneos, sobre la sobrevivencia y crecimiento de larvas en cuatro meses después del tratamiento. La frecuencia del tratamiento a 1.2 V/cm, fueron de 80 Hz en pulsos de 5-ms (40%), 60Hz en pulsos de 4-ms. La forma de la onda fue cuadrada. La frecuencia del pulso seleccionado y los ciclos empleados fueron aquellos usados en las investigaciones de campo o recomendados para reducir el daño a los peces adultos. Los campos de tratamiento fueron generados entre electrodos seccionales-cruzados completos en un canal de fibra de vidrio y por un generador y la unidad VVP-15 de Coffelt Manufacturing o una unidad de control de electropesca CPS Mark XX y un generador eléctrico. Las pruebas fueron realizadas en una columna de agua a 18.5 C y 650 microsiemens/cm de conductividad. Las muestras del embrión a la blástula (33 h después de la fertilización), inicios del brote de la cola (78 h), estudios de desarrollo del pliegue de la aleta, o larvas prenadadoras (36 h después), fueron colocados en canastas de redes de nylon y expuestas por 10 s a uno de los seis tratamientos de campo. Los grupos de control para cada estadio de vida fueron manejados de igual forma que los grupos de tratamiento, pero sin exposición a la electricidad.

Los resultados sugieren que la electropesca en los campos de desove del matalote jorobado es dañino para el desarrollo del embrión y estudios larvarios tempranos. En los grupos de tratamiento y de control, la sobrevivencia de

los embriones aumenta con el avance en el estado de desarrollo; la blástula fue particularmente sensitiva a los campos eléctricos. La más alta sobrevivencia de los embriones tratados para los estudios de desarrollo más allá de la blástula fue en los tratamientos de 1.2-V/cm CPS y 30-Hz (90-92% y 75-90%, respectivamente). La más baja sobrevivencia a cada desarrollo embrional ocurrió para el tratamiento de 10-V/cm 60 Hz y varió del 3% (blástula) al 70% (pliegue de la aleta). La sobrevivencia en todos los tratamientos durante el estadio de la blástula (3-50%) y tratamientos 5.0-V/cm y 10V/cm 60 Hz a el brote de la cola o pliegue de la aleta (43-72%) fue significativamente ($p <= 0.05$) diferente del control. La sobrevivencia de las larvas en el período de 4 semanas después del tratamiento, no fue afectado por el efecto eléctrico. El crecimiento de las larvas en todos los tratamientos, medido por el cambio en la longitud standard, fue significativamente más bajo que en el grupo de control; el crecimiento fue más bajo en el tratamiento 10-V/cm 60-Hz. Entre los tratamientos el crecimiento no difirió significativamente.

[HUBBS STUDENT PAPER COMPETITOR]

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Environmental education: One missing link between science and society

La educación ambiental: Un eslabón perdido entre la ciencia y la sociedad

KEYWORDS: environmental education; conservation

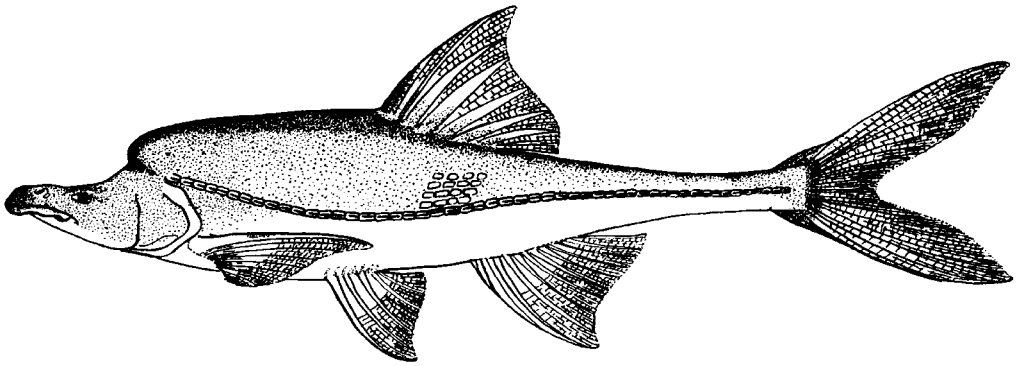
ABSTRACT

The purpose of this study is to briefly point out some basic concepts that might better contribute to the overall success efforts that decision makers, resource managers and field researchers invest in our planet's biodiversity conservation. Environmental education is highlighted as one articulated mechanism between scientific knowledge and our societies' common knowledge and is possibly one missing link that has limited our understanding and comprehension of the many different concepts or significances of our two different "languages and ways of communication". A working model is proposed that incorporates the three basic elements of communication between scientists and general public. These elements are: (1) The scientific information needed by decision makers and researchers, (2) Transform such information so it may be understood and incorporated into our common knowledge, (3) With this new knowledge or information, initiate a cultural process that will change our attitudes towards the ways we utilized and preserved our resources. A schematic presentation of a hypothetical case is reviewed.

CLAVES: educación ambiental; conservación

RESUMEN

Dentro del presente trabajo, se señalan brevemente, algunos conceptos básicos, para contribuir exitosamente a los labores que persiguen los tomadores de decisiones, los administradores de recursos naturales o los investigadores de campo en la conservación de los recursos naturales. Se resalta como mecanismo de articulación entre el conocimiento científico y el conocimiento común de la sociedad, a la educación ambiental, considerado por el autor como un posible eslabón perdido que no ha permitido el claro entendimiento entre investigadores y publico general. Se propone un "modelo" en donde se incorporan y combinan los 3 aspectos más relevantes de la comunicación, que deben existir entre científicos y público en general y que se resume en: (1) Generar información científica que sea utilizada primeramente por los tomadores de decisiones y conservacionistas, (2) Trasformar e interpretar dicha información, para que sea incorporada al conocimiento común, (3) Gestar mediante la Educación Ambiental, un cambio de actitud hacia el uso y valoración que le damos a los recursos naturales. Se resalta en forma esquemática, un caso problema hipotético del como el modelo puede ser aplicado.



\Humpback chub drawing courtesy of University of Nevada Press, Reno, Nevada from “Fishes and Fisheries of Nevada” by Ira La Rivers

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Species of special concern at public aquaria

Especies de interés especial en acuarios públicos

KEYWORDS: species of special concern; threatened species; endangered species; public aquaria

ABSTRACT

Aquaria open to the public have kept protected species for educational display and captive breeding purposes. A survey of such institutions was conducted to list the types of protected aquatic species kept, and if they were propagated. Many invertebrates, amphibians, reptiles and fishes are currently being bred, most taxa being foreign to North America. Aquaria personnel offer husbandry and pathology expertise, as well as limited space for future potential breeding programs. A unique asset is an audience of millions of people who visit zoos and aquaria each year, some of whom can be engaged on environmental issues through properly interpreted exhibits of protected species. Stronger ties between governmental, educational and aquaria facilities could be forged for mutual benefits regarding the protection of North American species and habitats.

CLAVES: especies de interés especial; especies amenazadas; especies en peligro; acuarios públicos

RESUMEN

Los acuarios abiertos al público deben proteger especies para programas de educación y propuestas de reproducción en cautiverio. Un estudio de instituciones afines se condujo para enlistar los tipos de especies acuáticas protegidas mantenidas, y si éstas fueron propagadas. Algunos invertebrados, anfibios, reptiles y peces que actualmente procrean, la mayoría de estos taxa existentes son exóticos de Norte América. Personal del acuario ofrece cuidado y experiencia en patología, así como espacios destinados a futuros programas de reproducción potencial. Una ventaja única es una audiencia de millones de gente quien visita los zoológicos acuarios cada año, algunos de los cuales pueden ser reservados para temas ambientales mediante exhibiciones interpretadas adecuadamente sobre especies protegidas. Esfuerzos conjuntos entre el gobierno, acuarios e instituciones de educación podrían ser realizados para alcanzar beneficios mutuos en la protección de las especies y los hábitats de Norte América.

CONTRIBUTED PAPER

Thirty-eight U.S. Aquariums were surveyed to gauge their participation in conservation breeding and related programs for aquatic, Threatened or Endangered Species, (T.E.S.), including Species Of Special Concern, (S.O.S.C.). Taxa included those protected by state, federal, or international laws. Twenty-nine aquariums responded that they housed such taxa. Their combined number of visitors for 1993 totalled more than 24 million people. The aquariums ranged in size from collections of 520 to 15,000 specimens, and had annual visitations of from 90,000 to 3 million guests. Marine and freshwater specimens surveyed could include representatives of invertebrates, fishes, amphibians, and reptiles. Aquariums were run by municipal, state, or federal governments, or were organized and administered as private, non-profit institutions. Two were for-profit institutions.

METHODS - U.S. Aquariums were surveyed because of their unique facilities for housing and breeding aquatic and semi-aquatic species. Zoos were not surveyed unless they had an aquarium component, and housed a significant lower vertebrate or invertebrate collection. Taxa were asked to be listed to the sub species level if possible, along with their common name. The taxa's status was listed as Extinct, (EX.); Endangered, (E.); Threatened, (T.); or, as a Species Of Special Concern, (S.O.S.C.). These designations were taken from individual state T.E.S. lists; the U.S. Endangered and Threatened Species list, (1994); the Convention on International Trade on Endangered Species (C.I.T.E.S., 1991); and, the International Union for the Conservation of Nature (I.U.C.N.), Red Data Book (Goombridge, 1993) list. S.O.S.C. species were identified from state or federal lists and by field researchers who determined that a taxa required S.O.S.C. status though it might not have that official designation at this time.

RESULTS - A total of 152 taxa are involved in propagation projects, representing 14 invertebrate; 11 fish; 7 amphibian; and, 8 reptile families. Of the 56 invertebrates, - 27 taxa are S.O.S.C., 26 are T., and 1 is E, and 2 are extinct. Fifty-nine fishes taxa contain 11 regarded as S.O.S.C., 3 T., 43 E., and 2 which are extinct. Amphibians are represented by 23 taxa, 8 of which are S.O.S.C., 11 T., and 4 are listed as E. Of the 14 reptiles taxa, 4 are S.O.S.C., 4 are T., and 6 are endangered. (Tables 1 and 2).

Propagation success is noted for 38 of the 56 taxa of invertebrates; 56 of the 59 fish taxa; 16 of the 23 amphibian taxa; and, 12 of the 14 reptile taxa.

U.S. species comprise the following percentages of the total taxa; invertebrates 46%; fishes 18%; amphibians 39%; and reptiles 43% (Table2).

DISCUSSION - Aquariums are the primary repository for imperiled aquatic invertebrate and fish projects among zoological institutions. While some successful amphibian and reptile propagation projects reside in aquariums, zoos which were not included as part of this survey, remain the main propagators of these aquatic and semi-aquatic taxa.

The rationale for propagation projects is multifaceted. The conservation of vanishing taxa through propagation has the goals of: potential reintroduction into historic or existing ranges; the preservation of as much genetic variability as possible; the elucidation of the life histories of some taxa; and, the education of the visiting public in conservation issues. Sometimes the choice of taxa to be brought in for propagation projects is based upon the premises that no other types of local, or international organizations can do so in a timely fashion, or have the infrastructure and qualified staff needed to carry out an immediate propagation project. Examples of these types of programs include the Tahitian snail and Madagascar fishes projects.

Public education in conservation has taken on a more primary role in zoological institutions in the last several years. Selected vanishing species can be used to illustrate the story of habitat and bio-diversity loss to visitors, while the real work of propagation goes on in behind-the-scenes areas. Despite the fact that these taxa are not charismatic, mega-vertebrates, the story of their decline and recovery can make an intriguing story to visitors, and potentially stimulate a greater understanding of habitat and biodiversity loss problems.

Conservation propagation is run under a variety of headings in zoological institutions. International programs are structured, multi-institution, long-term commitment projects that fall under the I.U.C.N./Conservation Breeding Specialist Groups, (C.B.S.G.). American programs of similar caliber are organized as A.Z.A./Species Survival Plans, (S.S.P.). Often the efforts are combined as C.B.S.G./S.S.P. programs, such as in the case of the Lake Victoria, Africa fishes and the Jamaican Island Iguana Programs. S.S.P.'s can not be established without an international component, and advisory biologists from outside of the aquarium community, such as found in the proposed S.S.P.'s for the Desert Fishes and Madagascar Fishes programs. S.S.P.'s generally take 2 to 3 years to organize and document for recognized status by the Wildlife Conservation Management Office of the AZA. Individual taxa can also be worked with through multi-institutional projects sponsored under the A.Z.A./Taxon Advisory Groups, (T.A.G.'s). Presently, there are Invertebrate; Marine Fishes; Freshwater Fishes; Amphibian; and, Reptile T.A.G.'s established, along with many other non-aquatic T.A.G.'s. Often, T.A.G. work leads to the formation of a larger, more formalized S.S.P. program. Individual taxa are sometimes worked with at a single institution depending upon facilities; staff expertise; commitment; and, legal access to the taxa.

Reintroduction of taxa is a long-term goal and a good measure of the success of a program. The Western banded killiefish; crested toad; Plymouth red-bellied turtle; and, Moorean snails, have already been reintroduced into parts of their native ranges. The successful sea turtle program has a very small propagation component, but a highly successful head starting and rehabilitation component. A few taxa of Lake Victoria cichlids are scheduled for reintroduction in 1995 and others such as the Texas spring salamanders could be repatriated in the next several years.

Conservation propagation projects demand a large time and facilities commitment on the part of participating institutions, and some facilities are at their capacity for the projects they can manager under present circumstances. However, the need to educate visitors about vanishing species and their disappearing habitats, especially in the U.S. remains a prime concern. There is a perception among zoological institution workers that visitors think of biodiversity and habitat loss as occurring almost exclusively in developing nations. A better perspective is needed toward the same problem in the United States. State and federal offices have formed partnerships for successful propagation projects, as evidenced by the 12% co-participation rate (Table 2). This rate could be higher in the future with stronger partnerships being formed between zoological institutions and governmental organizations.

ACKNOWLEDGEMENTS- I wish to thank all of the institutions and individuals who participated in the surveys and offered advice on the content of the survey.

LITERATURE CITED

ANONYMOUS. 1991. **Appendices I, II, and III to the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Department of the Interior**. U.S.F.W.S. Gov. Printing Office. Title 50, Part 23, Subpart C, Paragraph 23.23. September 30.

ANONYMOUS. 1994. **Endangered and Threatened Wildlife and Plants**. Department of the Interior. U.S. Gov. Printing Office. Title 5OCFR, 17.11 and 17.12.

FROST, DARREL R. EDITOR. 1985. **Amphibian Species of the World**. Allen Press and Assoc. System. Col. Lawrence, KS.

GOOMBRIDGE, BRIAN. EDITOR. 1994. 1994 I.U.C.N. **Red List of Threatened Animals**. I.U.C.N., Gland, Switzerland and Cambridge, England.

ROBINS, RICHARD C., BAILEY M. REEVE, CARL E. BOND, JAMES R. BROOKER, ERNEST A. LACHNER, ROBERT N. LEA AND W. B. SCOTT. 1991. **Common and Scientific Names**

of Fishes from the United States and Canada. American Fisheries Soc. Bethesda, MD. Sp. Pub. 20, Fifth edition.

TABLE 1. AQUARIUM AQUATIC PROPAGATION PROGRAMS

Abbreviation Key: AZA, American Zoo and Aquarium Association; NCWRC, North Carolina Wildlife Resource Committee; SSP, Species Survival Plan (AZA); CBSG, Conservation Breeding Specialist Group (IUCN); IUCN, International Union for the Conservation of Nature; FFTAG, Freshwater Fishes Taxon Advisory Group (AZA); ITAG, Invertebrate Taxon Advisory Group (AZA); USFWS, U.S. Fish and Wildlife Service; Florida DNR, Florida Department of Natural Resources; RTAG, Reptile Taxon Advisory Group (AZA); Group A, AZA/SSP/FFTAG/IUCN/CBSG/Lake Victoria Research Team; NOAA, National Oceanic and Atmospheric Association; NMFS, National Marine Fisheries Service.

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Scleractinia	Stony coral					
Acroporidae	Antler corals					
Acropora aspera	ditto	Tropical Pacific	Threatened	None	1	1
Acropora cervicornis	ditto	ditto	ditto	ditto	1	1
Acropora cytheria	ditto	ditto	ditto	ditto	1	1
Acropora digitifera	ditto	ditto	ditto	ditto	1	1
Acropora echinata	ditto	ditto	ditto	ditto	1	1
Acropora elseyi	ditto	ditto	ditto	ditto	1	1
Acropora florida	ditto	ditto	ditto	ditto	1	1
Acropora formosa	ditto	ditto	ditto	ditto	1	1
Acropora glauca	ditto	ditto	ditto	ditto	1	1
Acropora monticulosa	ditto	ditto	ditto	ditto	1	1
Acropora micropthalma	ditto	ditto	ditto	ditto	1	1
Anacropora sp.	ditto	ditto	ditto	ditto	1	1
Montipora digitata	Coral	Tropical Pacific	SOSC	ditto	2	1
Montipora verrucosa	ditto	ditto	ditto	ditto	1	1
Agariciidae						
Pavona spp.	ditto	ditto	Threatened	ditto	2	1
Caryophylliidae						
Catalaphylia jardinia	Elegans coral	Indonesia	SOSC	ditto	5	1
Eusmilia fastigata	Smooth flower coral	ditto	ditto		1	0
Euphyllia spp.	ditto	ditto	Threatened	ditto	9	1
Plerogypa spp.	Smooth flower coral	Indonesia	Threatened	None	8	2
Dendrophylliidae						
Turbinaria sp.	ditto	ditto	SOSC	ditto	1	1
Faviidae						
Caulastrea furcata	ditto	ditto	ditto	ditto	1	1
Montastrea annularis	Boulder star coral	Belize	ditto	ditto	1	0
Montastrea cavernosa	Great star coral	Florida	ditto	ditto	1	0
Fungiidae						
Diaseris fragilis	ditto	ditto	ditto	ditto	1	1
Herpolitha limax	ditto	ditto	ditto	ditto	1	1
Polyphyllia talpina	ditto	ditto	Threatened	ditto	1	1
Zoopilus echinatus	ditto	ditto	SOSC	ditto	1	1
Merulinidae						
Hydnophora rigida	ditto	ditto	ditto	ditto	1	1
Pocilloporidae						

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Pocillopora damicornis	Coral	Tropical Pacific	Threatened	ditto	2	1
Seriatopora hystrix	ditto	ditto	ditto	ditto	1	1
Stylophora sp.	ditto	ditto	ditto	ditto	1	1
Poritidae						
Porites asteroides	Mustard coral	Belize	ditto	ditto	1	0
Porites porites	Finger coral	Belize	ditto	ditto	1	0
Porites sp.	ditto	ditto	ditto	ditto	6	1
Goniopora sp.	ditto	Tropical Pacific	ditto	ditto	9	2
Goniopora stokesi	Finger coral	Belize	Threatened	None	1	1
Mussidae						
Cynarina lacrymalis	Coral	Tropical Pacific	ditto	ditto	1	1
Lobophyllia spp.	ditto	ditto	ditto	ditto	1	1
Mollusca						
Nautilidae						
Nautilus belauensis	Palauan nautilus	Palau	SOSC	None	2	1
Nautilus pompilius	Chambered nautilus	Fiji; Philippines	ditto	ditto	6	1
Partulidae						
Partula hyalina	ditto	ditto	Extinct	AZA / SSP / CBSG	1	1
Partula nodosa	Tahitian snail	Tahiti; French	ditto	ditto	2	2
Planorbidae						
Planorbella magnifica	Magnificent ram's horn snail	North Carolina	State Endangered	N.C. Wildlife Res. Comm.	1	1
Unionidae	Freshwater mussels					
Actinonaias ligamentina	Mucket	Mississippi River / Rock River, IL	SOSC	AZA/FFTAG; ITAG	1	0
Cyclonaias tuberculata	Purple wartyback	ditto	ditto	ditto	1	0
Ellipsaria lineolata	Butterfly	ditto	ditto	ditto	1	0
Fusconaia flava	Wabash pigtoe	ditto	ditto	ditto	1	0
Lasmigona complanata	White heelsplitter	ditto and Ohio	ditto	ditto	2	0
Lampsilis sp.	Mucket	Ohio	SOSC	AZA/FFTAG; ITAG; Ohio Div. Nat. Res,; Ohio State Univ.	1	0
Lampsilis siliquoidea	Fat mucket	Rock River, IL	ditto	None	1	0
Ligumia recta	Black sandshell	ditto	ditto	ditto	1	0
Megalonaias nervosa	Washboard	Rock River, IL	ditto	ditto	1	0
Obliquaria reflexa	Three horn wartyback	ditto	ditto	ditto	1	0
Obovaria olivaria	Hickory nut	ditto	ditto	ditto	1	0
Quadrula metaneura	Monkey face	ditto	ditto	ditto	1	0
Quadrula quadrula	Maple leaf	ditto	ditto	ditto	1	0

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Amphibia						
Ambystomatidae						
Ambystoma mexicanum	Axolotl	Mexico	Threatened	ditto	1	1
Ambystoma opacum	Marbled salamander	Massachusetts	ditto	ditto	1	1
Ambystoma tigrinum	Tiger salamander	ditto	State Endangered	ditto	1	0
Bufonidae						
Bufo aluarius	Colorado river toad	Colorado	SOSC	ditto	1	0
Bufo guttatus	Smooth sided toad	Northern South	ditto	ditto	1	1
Bufo hemiophrys baxteri	Wyoming toad	Wyoming	Endangered	USFWS; Wyoming Game and Parks Commission	1	0
Peltophryne lemur	Puerto Rico crested toad	Puerto Rico	ditto	AZA/SSP	2	0
Cryptobranchidae						
Cryptobranchus allegeniensis	New York	SOSC	NY Fish Wildl.	1	0	
Dendrobatidae						
Dendrobates auratus	Green and Black arrow	Costa Rica	Threatened	None	4	4
Dendrobates azureus	Blue arrow poison frog	Brazil, Guyana,	ditto	ditto	7	6
Dendrobates granuliferus	Granulated dart frog	ditto	ditto	ditto	2	2
Dendrobates histrionicus	Kokoe-Pa dart frog Central So. America	ditto	ditto	2	2	
Dendrobates leucomelas	Yellow banded arrow poison	Venezuela, Guiana,	ditto	ditto	4	4
Dendrobates pumilio	Strawberry dart frog	Central America	ditto	ditto	2	2
Dendrobates reticulatus	Reticulated dart frog	South America	ditto	ditto	2	2
Dendrobates tinctorius	Dying arrow poison frog	French, Guiana,	Threatened	None	6	6
Epipedobates tricolor	Tricolor dart frog	South America	ditto	ditto	3	3
Plethodontidae						
Eurycea sp.	Comal springs salamander	Texas	SOSC	USFWS; Texas Parks & Wildlife; New Braunfel Park & Rec. Dept.; Edwards Aquifer Res.& Data Center	1	1

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Typhlomolge rathbuni	Texas blind salamander	ditto	Endangered	SW Texas State Univ.; Edwards Aquifer Res. & Data Center; USFWS; Texas Parks & Wildlife	1	1
Ranidae						
Rana yavapaiensis	Lowland leopard frog	Arizona	SOSC	None	1	1
Rhacophoridae						
Mantella aurantiana	Golden mantella frog	Madagascar	ditto	ditto	3	1
Mantella laevigata	Mantella frog	ditto	ditto	ditto	1	0
Mantella viridis	Green mantella frog	Madagascar	SOSC	None	1	0
Alligatoridae						
Caiman crocodilus yacare	Yacare caiman	ditto	Endangered	ditto	1	1
Iguanidae						
Paleosuchus palpebrosus	Dwarf caiman	South America	SOSC	ditto	1	0
Boidae						
Eunectes murinus	Green anaconda	South America	ditto	ditto	1	1
Cheloniidae						
Caretta caretta	Loggerhead sea turtle	Circum-tropical	Threatened	USFWS; Florida DNR; North Carolina WRC; Univ. of Virginia	8	2
Chelonia mydas	Green sea turtle	Circum-tropical	ditto	ditto	12	1
Lepidochelys kempii	Ridley sea turtle	Texas; North Carolina; Florida	Endangered	North Carolina WRC; USFWS; Texas A & M Univ.	3	1
Emydidae						
Clemmys guttata	Spotted turtle	New Hampshire	SOSC	None	1	1
Clemmys muhlenbergi	Bog turtle	New York	Endangered	ditto	2	1
Graptemys oculifera	Ringed sawback turtle	U.S.	Threatened	ditto	2	1
Pseudemys rubriventris bangsii	Plymouth red bellied turtle	Massachusetts	State Threatened	Massachusetts Fish & Wildlife	1	1
Iguanidae						
Cyclura nubila lewisi	Blue headed iguana	Cayman Islands	Endangered	AZA/RTAG;	1	0
Pelomedusidae						
Podocnemis expansa	Giant South American turtle	Northern South	ditto	ditto	4	4
Podocnemis unifilis	Yellow spotted turtle	Northern South	SOSC	AZA/CBSG/IUCN/CBSG	4	2
Testudinidae						
Geochelone carbonaria	Red footed tortoise	ditto	Endangered	ditto	1	1

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Osteichthys						
Ceratodidae						
Neoceratodus forsteri	Australian lungfish	Australia	Threatened	AZA/FFTAG; Lungfish Group	5	1
Cichlidae						
Astatotilapia piceatus	Thief cichlid	Lake Victoria,	Endangered	Group A	3	3
Haplochromis degeni	Degani cichlid	ditto	ditto	Aqua Science Res Gp.; Group	3	3
Haplochromis macula	Purplehead cichlid	ditto	ditto	ditto	4	4
Haplochromis maxillaris	Large jaw cichlid	ditto	ditto	Group A	1	1
Haplochromis orthostoma	Straight mouth cichlid	Lake Victoria,	Endangered	Michigan State Univ; Group A	6	6
Haplochromis perrieri	Pierrier's cichlid	ditto	ditto	ditto	6	6
Haplochromis sp. 1	Spot-bar cichlid	ditto	ditto	Group A; SW Ohio Univ.	4	4
Haplochromis sp. 2	Hippo point salmon	ditto	ditto	Michigan State Univ.	1	1
Haplochromis sp. 3	Mbita gold-chest	ditto	ditto	ditto	1	1
Haplochromis sp. 4	Chilotes	ditto	ditto	Group A	1	1
Haplochromis sp. 5	Red-eye guiarti	ditto	ditto	ditto	4	4
Haplochromis sp. 6	Oral-sheller	ditto	ditto	Mich. State Univ.; Aqua Sci. Res. Group;	1	1
Haplochromis sp. 7	Rock-Kribensis	ditto, Uganda	ditto	Group A	2	2
Haplochromis sp. 8	Madonna	ditto	ditto	Aqua Sci. Res. Group; Group A	1	1
Haplochromis sp. 9	Pink flush	ditto	ditto	SW Ohio Univ.	1	1
Haplochromis sp. 10	Red anal	ditto	ditto	Mich. State Univ.; Group A	1	1
Haplochromis sp. 11	Salmon	Lake Victoria,	ditto	Group A	1	1
Haplochromis sp. 12	Serranus-like	Lake Victoria	Endangered	Group A	2	2
Haplochromis sp. 13	Two strip-white lip	ditto	Extinct	ditto	3	3
Haplochromis sp. 14	Utajo	ditto	Endangered	ditto	1	1
Harpagochromis pectoralis	Cichlid	ditto	ditto	ditto	1	1
Nandopis beani	Sinaloa cichlid	Sonora, Mexico	SOSC	None	1	1
Oreochromis esculentus	Ngege tilapia	Lake Victoria,	Endangered	Group A	3	3
Paralabidochromis plagiodon	Slant-tooth cichlid	ditto	ditto	Group A; SW Ohio Univ.	6	6
Paratilapia pollen	Blue spotted	Madgascar	SOSC	AZA/FFTAG	3	3
Pytochromis ishmaeli	Thick-skin cichlid	Lake Victoria,	Endangered	Group A	2	2

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Ptyochromis xenognathus	Old-jaw cichlid	ditto	ditto	Group A; SW Ohio Univ.	3	3
Cyprinidae						
Gila ditaenia	Sonora chub	ditto	SOSC	USFWS	1	1
Gila intermedia	Gila chub	Arizona	ditto	None	1	1
Notropis bifrenatus	Bridle shiner	Massachusetts	State Threatened	ditto	1	1
Puntius cumingi	Cuming's barb	Sri Lanka	SOSC	ditto	1	1
Puntius nigrofasciatus	Black ruby barb	ditto	ditto	ditto	2	2
Puntius titteya	Cherry barb	ditto	ditto	ditto	1	1
Cyprinodontidae						
Cyprinodon alvarezi	Perrito de Potosi	Nuevo Leon	Extinct	Univ. de Neuvo Leon	1	1
Cyprinodon eximius	Conchos river pupfish	Texas and Mexico	Threatened	Univ. de Nuevo Leon; Texas	1	1
Cyprinodon longidorsalis	Charco la Palma pupfish	Mexico	Endangered	None	2	2
Cyprinodon macularius eremus	Quitobaquito pupfish	Arizona	ditto	USFWS	1	1
Cyprinodon macularius ssp.	Desert pupfish	California; Arizona	ditto	USFWS; Cal. Dept. Fish & Game.	4	4
Cyprinodon veronicae	Charco azule pupfish	Mexico	SOSC	Univ. de Nuevo Leon	2	2
Fundulus diaphanus menona	Western banded killiefish	Ohio	State Endangered	Ohio Div. of Wildlife	1	1
Megupsilon aporus	Dwarf pupfish	Mexico	ditto	Univ. de Nuevo Leon	2	2
Gobiidae						
Chlamydogobius eremius	Desert goby	Australia	SOSC	None	1	1
Goodeidae						
Allotoca maculata	Opal goodeid	Mexico	Endangered	ditto	2	2
Ameca splendens	Butterfly goodeid	ditto	ditto	ditto	3	3
Ataeniobius toweri	Blue-tailed goodeid	ditto	ditto	ditto	1	1
Characodon lateralis	Rainbow goodeid	ditto	ditto	ditto	1	0
Girardinichthys viviparus	Mexiclapique	ditto	ditto	ditto	1	1
Skiffia francesae	Golden skiffia	Mexico	Endangered	None	1	1
Xenoophorus captivus	Green goodeid	ditto	ditto	ditto	1	1
Osteoglossidae						
Arapaima gigas	Arapaima	South America	ditto	ditto	2	0
Scleropages formosus	Asian Bonytongue	S.E. Asia	ditto	ditto	2	0
Percidae						
Etheostoma fonticola	Fountain darter	Texas	ditto	USFWS; Texas Pks.	1	1
Salmonidae						

TAXA	COMMON NAME	AREA OF ORIGIN	STATUS IN NATURE	OTHER SPONSORING AGENCIES	NO. OF AQUARIUMS PARTICIPAT-ING	NO. WITH SUCCESSFUL PROPAGATION
Oncorhynchus spp.	Winter run salmon	U.S.	SOSC	USFWS; Cal. Fish & Game; Tyee Fishing Club; NOAA; Pac. Coast Fishing Assoc.	1	1
Scombridae						
Thunnus thynnus	Bluefin tuna	Virginia, California	ditto	NMFS	2	0
Poeciliidae						
Poeciliopsis occidentalis	Gila topminnow	Arizona/New Mexico	Endangered	USFWS	1	1
Xiphophorus couchianus	Monterey platyfish	Mexico	ditto	Univ. de Neuvo Leon	2	2
Xiphophorus gordoni	Quatro Cienegas	Coahuila, Mexico	ditto	USFWS; Univ. de Neuvo Leon	2	2
Xiphophorus meyeri	Muzquiz platyfish	Mexico	ditto	ditto	3	3
Xiphophorus milleri	Lake Catemaco platyfish	Vera Cruz Mexico	ditto	ditto	2	2

TABLE 2. TOTALS FOR TAXA UNDER CONSERVATION PROPAGATION (SUMMARIZED FROM TABLE 1).

TAXA	TOTAL NO. FAMILIES	TOTAL NO. TAXA	NO. TAXA PROPAGATED	PERCENT SUCCESSFULLY PROPAGATED	NO. U.S. TAXA PROPAGATED	U.S. TAXA % OF TOTAL	NUMBER OF GOVERNMENT COOPERATIVE PROGRAMS	PERCENT OF GOVERNMENT COOPERATIVE PROGRAMS
Invertebrates	14	56	38	68	26	46	2	4
Fishes	11	59	56	93	11	18	9	15
Amphibians	7	23	16	70	9	39	4	18
Reptiles	8	14	12	86	6	43	4	29
TOTALS	**40**	**152**	**122**	**80**	**52**	**34**	**19**	**12**

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Preserving allelic diversity: Are translocations successful?

Preservación de la diversidad de alelos: ¿Son exitosas las translocaciones?

KEYWORDS: translocation; refugia; allozymes; allelic diversity; heterozygosity; mosquitofish

ABSTRACT

Translocation of threatened and endangered fish species is a commonly used conservation tool. Despite the extensive use of refugia, the biological implications of translocations remain poorly understood. Of particular interest is the effect of translocation on genetic variability. Maintenance of genetic variability in refugia populations is assumed to be important for short-term and long-term success. We examined allozyme variability at 17 loci for mosquitofish *Gambusia affinis* populations with known introduction histories. Translocation history had little effect on genetic variability as measured by heterozygosity. However, refugia populations had considerably lower levels of allelic diversity than parental populations. All losses were of relatively rare alleles (less than 0.1 frequency in the parental populations). The results of a Monte Carlo simulation suggest that the observed loss of allelic variability was produced by an undocumented bottleneck early in the translocation history. These results are surprising because mosquitofish have numerous reproductive traits that should maximize effective population size, which in turn should increase the probability of retaining genetic variability in refugia populations.

CLAVES: translocación; refugio; alozimas; diversidad alélica; heterocigocidad; pez mosquito

RESUMEN

Translocaciones de especies de peces amenazadas y en peligro es una herramienta usada comúnmente en conservación. A pesar del uso de refugios, las implicaciones biológicas de las translocaciones permanecen pobremente entendidas. De particular interés es el efecto de la translocación en la variabilidad genética. El mantenimiento de la variabilidad genética en poblaciones de refugio se asume es importante para sucesos a corto y largo plazo. Examinamos la variabilidad de alozimas en 17 loci para poblaciones de pez mosquito *Gambusia affinis* con un historial de introducción conocido. La historia de translocación tiene poco efecto sobre la variabilidad genética como medida de heterocigocidad. Sin embargo, poblaciones de refugio tiene niveles considerablemente mas bajos de diversidad alélica que las poblaciones parentales. Todas las pérdidas fueron de alelos relativamente raros (menos del 0.1 de frecuencia en las poblaciones parentales). Los resultados de una simulación Monte Carlo sugiere que las pérdidas observadas de variabilidad alélica fue producida por un cuello de botella no documentado tempranamente en la historia de la translocación. Estos resultados son sorprendentes debido a que el pez mosquito tiene numerosos rasgos reproductivos que pueden maximizar el tamaño efectivo de la población, lo cual podría incrementar la probabilidad de retener la variabilidad genética en poblaciones de refugio.

[HUBBS STUDENT PAPER COMPETITOR]

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The importance of recognizing illusory populations of fishes

La importancia del reconocimiento de las poblaciones ilusorias de peces

KEYWORDS: illusory populations; pseudo-extirpation; loach minnow; Eagle Creek; *Rhinichthys cobitis*; Arizona

ABSTRACT

We define as illusory those extant populations of a species that are difficult to detect by sampling, either due to the behavior of the animal, the complexities of its habitat, or both. These species may seem absent from a locality when in fact they are not, even if there is a concentrated effort to detect their presence. An example: in 1950, Robert R. Miller collected fishes from Eagle Creek, AZ, which included loach minnow (*Tiaroga cobitis*). Since then, the stream has been monitored by numerous investigators, with some recent sampling efforts being quite extensive and actually targeting loach minnow habitat, yet this species had not been recollected. In July 1994, we captured ten loach minnow from a single Eagle Creek riffle. Absence of loach minnow from collections of the past four decades had suggested that it was extirpated from this part of its native range. This "pseudo-extirpation," the erroneous belief that a species is extirpated from a locality, is not uncommon in the recent history of Arizona's native fish fauna. Unfortunately, species that are assumed extirpated may not be given management consideration. This presents a problem, since the species is still there. Managers need to recognize the difficulty in accurately assessing the status of illusory fish populations, and understand that the error of "pseudo-extirpation" could ultimately result in extinction.

CLAVES: poblaciones ilusorias; pseudo-extirpación; loach minnow; Eagle Creek; *Rhinichthys cobitis*; Arizona

RESUMEN

Definimos como ilusorio aquellas poblaciones intactas (no dañadas) de especies que son difíciles de detectar por muestreo, ya sea debido a la conducta del animal o a las complejidades de su habitat, o ambas. Estas especies pueden parecer ausentes de una localidad cuando en realidad no están ausentes, aún si hay esfuerzos concentrados para detectar su presencia. Un ejemplo: en 1950, Robert R. Miller, colectó peces de Eagle Creek, en Arizona, el cual incluyó loach minnow (*Tiaroga cobitis*). Desde entonces el arroyo ha sido monitoreado por numerosos investigadores, siendo algunos de los muestreos más recientes más extensivos y de hecho orientándose al habitat de loach minnow, todavía esta especie no ha sido recolectada. En julio de 1994, capturamos 10 loach minnow de un simple recodo en Eagle Creek. La ausencia de loach minnow de las colecciones de las pasadas cuatro décadas sugieren que fueron extirpadas de esta parte de su extensión nativa. Esta "pseudo-extirpacion", la creencia errónea de que una especie es extirpada de una localidad, es poco común en la historia reciente de la ictiofauna nativa de Arizona. Desafortunadamente, las especies que se suponen extirpadas pueden no estar en las consideraciones de manejo dadas. Esto presenta un problema después para las especies que se encuentran ahí. Los manejadores necesitan reconocer las dificultades de valorar con precisión el estatus de las poblaciones ilusorias de peces, y entender que el error de "pseudo-extirpación" podría resultar a final de cuentas en extinción.

[HUBBS STUDENT PAPER COMPETITOR]

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The role of native and introduced fish species on high mountain, desert stream communities

El papel de las especies nativas e introducidas en las comunidades de arroyos desérticos de altas montañas

KEYWORDS: trout; predation; competition; non-native species; community dynamics; streams

ABSTRACT

Fish have been known to have profound effects on aquatic food webs. Introduced fish species in particular can dramatically alter food web dynamics. The overall effects of fish, as well as, differences in introduced and native fish species effects, are not well understood in lotic systems, however. We conducted a large scale in situ experiment to determine how native and introduced fish species affected a stream food web. We fenced off sections of a stream in the Uinta mountains and manipulated the top fish predator in each section. The experiment consisted of 3 replicates of brook trout only (introduced), cutthroat trout only (native), brook and cutthroat trout, sculpin (native), and no fish treatments. Invertebrate density and behavior and algal production was monitored throughout the experiment. Our results suggest that both biotic and physical attributes were important in governing food web dynamics in this system. In particular, the different feeding behaviors exhibited by the fish affected the abundance and behavior of the invertebrate prey assemblage.

CLAVES: trucha; depredación; competencia; especies no nativas; dinámica de comunidades; arroyos

RESUMEN

Es conocido que los peces causan profundos efectos sobre las cadenas alimenticias acuáticas. Las especies de peces introducidas en particular, pueden alterar dramáticamente la dinámica de las cadenas alimenticias. Sin embargo, en general los efectos del pez, así como las diferencias de los efectos entre las especies nativas e introducidas, no son bien conocidas en los sistemas lóticos. Nosotros conducimos un experimento in situ a gran escala, para determinar como las especies de peces nativas e introducidas afectan las cadenas alimenticias en las corrientes de agua. Nosotros cercamos secciones de un arroyo en las montañas Uinta y manipulamos al pez depredador tope en cada sección. El experimento consistió de tres réplicas de solo trucha de arroyo (brook trout) especie introducida, solo trucha (cutthroat trout), truchas de arroyo y cutthroat, sculpin (nativo), y tratamiento sin peces. La densidad de invertebrados, comportamiento y producción de algas fue monitoreado durante el experimento. Nuestros resultados sugieren que ambos, atributos físicos y bióticos fueron importantes en el equilibrio de la cadena alimenticia de este sistema. En particular, los diferentes comportamientos de alimentación exhibidos por los peces, afectaron la abundancia y comportamiento de la comunidad de invertebrados presa.

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Variance in fish populations of Aravaipa Creek, Arizona

Varianza en poblaciones de peces de Aravaipa Creek, Arizona

KEYWORDS: southwestern fishes; endangered species; population ecology; management; Aravaipa Creek; Arizona

ABSTRACT

Trends of decline and extirpation in southwestern fish populations have over time catalyzed field studies resulting in management decisions. Yet, populations continue to decline, indicating either misinterpretation of field data or a pattern of ineffectual agency decisions. Field data often represent short-term studies, which may be of questionable value in interpretation of long-term trends. Analyses of variance for fish populations in Aravaipa Creek were conducted using short-term and long-term datasets. Variance is described in respect to location, time, and species composition. Population variance provides information on ecological processes critical to effective management applications.

CLAVES: peces del suroeste; especies en peligro; ecología de poblaciones; manejo; Aravaipa Creek; Arizona

RESUMEN

Las tendencias de declinación y extirpación de las poblaciones de peces del Suroeste a través del tiempo han motivado estudios de campo, que han resultado en decisiones de manejo. Las poblaciones aún continúan declinando, lo cual indica interpretaciones erróneas de los datos de campo o decisiones ineficientes por parte de las agencias. Los datos de campo a menudo representan estudios a corto plazo, los cuales pueden ser de valor cuestionable en la interpretación de las tendencias a largo plazo. Los análisis de varianza para las poblaciones de peces en Aravaipa Creek fueron realizadas usando datos de corto y largo plazo. La varianza se describe respecto a la localidad, tiempo y composición de especies. La varianza de la población proporciona información sobre los procesos ecológicos críticos para aplicarse en el manejo efectivo.

GORMAN,OWEN T.*; SEALS,JOHN M. (U.S. Fish and Wildlife Service, P.O. Box 338, Flagstaff, AZ 86002-0338)

Habitat use by the endangered humpback chub (*Gila cypha*) in the Little Colorado River, Arizona near Grand Canyon

Uso del hábitat por el charal jorobado (*Gila cypha*), especie en peligro de extinción, en el Little Colorado River (Pequeño Río Colorado), Arizona, cerca del Gran Cañón

KEYWORDS: Cyprinidae; *Gila cypha*; ecology; streams; habitat; endangered species; Grand Canyon; Arizona

ABSTRACT

The objective of our study was to determine habitat use by the endangered humpback chub (*Gila cypha*) in the Little Colorado River. During the day, subadult (>150 mm TL) and adult humpback chub (>210 mm TL) used habitats 80 to >300 cm depth, very slow to slow currents (0.02-0.30 m/s), associated with areas containing a mix of sand, cobble, and small and large boulder substrates, used near-benthic vertical positions (>=80% depth), and associated with areas with a mix of low and high vertical structure and cover. At night, subadult and adult humpback chub showed a shift in habitat use to include more shallow (<100 cm), open areas with less vertical structure and cover, fewer large substrates, slow currents (0.10-0.30 m/s), and mid-water vertical positions. When available, adult chubs showed some association with travertine dams and reefs.

In contrast, juvenile humpback chub (100-150 mm TL) were restricted to more shallow areas (80-200 cm deep) and used midwater to near- benthic vertical positions and did not show a strong a nocturnal shift in habitat use. Young-of-year (YOY) humpback chub were largely restricted to shallow (<150 cm deep), near shore (< 600 cm lateral distance) areas with slow currents, a mixture of fine, cobble and small boulder substrates, moderate cover and vertical structure, and used midwater and lower pelagic vertical positions. At night YOY tended to shift to areas closer to shore/edges, zero to slow currents, increased vertical structure and cover, and primarily used near-benthic vertical positions. Adult and subadult vs YOY humpback chub showed a complementary pattern of habitat use. However, juvenile chub showed an intermediate habitat use pattern between YOY and adults; this may be a reflection of an ontogenetic shift in habitat use in humpback chub in the 100-150 mm size class.

CLAVES: Cyprinidae; *Gila cypha*; ecología; corrientes; hábitat; especies en peligro; Gran Cañón; Arizona

RESUMEN

El objetivo de nuestro estudio fue determinar el uso del hábitat por el charal jorobado (*Gila cypha*) en peligro de extinción en el Pequeño Río Colorado. Durante el día, el charal jorobado subadulto (>150 mm LT) y el adulto (>210mm LT) usaron hábitats de 80 a >300 cm de profundidad, en corrientes de muy lentas a lentas (0.20-0.30 m/s), asociados con áreas que contienen una mezcla de arena, canto rodado, y pequeños y grandes substratos redondeados, usaron posiciones verticales casi bénticas (>=80% de profundidad), y asociadas con áreas con una mezcla baja y alta

de estructura vertical y cobertura. Por la noche, el subadulto y el adulto mostraron intercambio en el uso del hábitat para incluir áreas más someras (<100 cm) y abiertas con menos estructura vertical y cobertura, menos substratos grandes, corrientes lentas (0.10-0.30 m/s), y posiciones verticales a la mitad del agua. Cuando estuvieron disponibles, los charales adultos mostraron cierta asociación con vertedores y arrecifes.

En contraste, los charales juveniles (100-150 mm LT) estuvieron restringidos a áreas más someras (80-200 cm de profundidad) y usaron posiciones desde la mitad del agua hasta casi bénticas y no mostraron un intercambio nocturno fuerte en el uso del hábitat.

Los charales jorobados de un año (YOY - 100-150 mm TL) estuvieron muy restringidos a áreas someras (<150 cm de profundidad), cercanas a la orilla (<600 cm de distancia lateral) con corrientes lentas, una mezcla de canto rodado fino y pequeños substratos de piedras redondeadas, de moderada cobertura y estructura vertical, y usaron posiciones verticales a la mitad del agua y más abajo que pelágico. Durante la noche los YOY tendieron a intercambiar a áreas más cercanas a las orillas/límites, corrientes nulas o bajas, estructura vertical y cobertura incrementadas y usaron primariamente posiciones verticales casi bénticas. Adultos y subadultos y los YOY mostraron un patrón complementario de uso del hábitat. Sin embargo, los juveniles mostraron un patrón de uso de hábitat intermedio entre los YOY y los adultos; esto podría ser un reflejo de un intercambio ontogenético en el uso del hábitat del charal jorobado en la clase de tamaño de 100-150 mm.

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Habitat use by speckled dace (*Rhinichthys osculus*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*Catostomus latipinnis*) in the Little Colorado River, Arizona near Grand Canyon

Uso del hábitat por speckled dace (*Rhinichthys osculus*), bluehead sucker (*Catostomus discobolus*), y flannelmouth sucker (*Catostomus latipinnis*) en el Pequeño Río Colorado (Little Colorado River), Arizona cerca del Gran Cañón

KEYWORDS: Cyprinidae; speckled dace; Catostomidae; bluehead sucker; flannelmouth sucker; ecology; streams; habitat; Grand Canyon; Arizona

ABSTRACT

The objective of our study was determine habitat use by native fishes in the Little Colorado River. In this paper I will present habitat use patterns for speckled dace (*Rhinichthys osculus*), bluehead sucker (*Catostomus discobolus*), and flannelmouth sucker (*Catostomus latipinnis*). During the day, speckled dace showed a relatively generalized pattern of habitat use; they were associated with near shore/edge areas (<600 cm lateral distance) of shallow to moderate depth (20-150 cm), a mix of sand, cobble and small boulder substrates, moderate cover and vertical structure, and upper to lower pelagic vertical positions. At night speckled dace used a similar array of habitats but shifted their use of vertical position down to the lower half of the water column. During the day, bluehead suckers used moderate to deep habitats (50-200 cm), slow to fast currents (0.1-1.20 m/s), a mixture of sand, cobbles and small to very large boulders, near-benthic vertical positions, and moderate vertical structure and cover. At night, blueheads shifted into shallower, more open areas with moderate currents (0.30-0.70 m/s), more sand and fewer large boulders C:\OFFICE30\NB.HLPtructure and cover. Flannelmouth suckers showed a similar pattern as the blueheads except that they used areas with slower currents (0.0-0.70 m/s) and were less strongly associated with large substrates.

CLAVES: Cyprinidae; speckled dace; Catostomidae; bluehead sucker; flannelmouth sucker; ecología; corrientes; hábitat; Gran Cañón; Arizona

RESUMEN

El objetivo de nuestro estudio fue determinar el uso del hábitat por peces nativos en el Pequeño Río Colorado. En este documento presentaré patrones de uso del hábitat para speckled dace, bluehead sucker y flannelmouth sucker. Durante el día speckled dace mostró un patrón relativamente generalizado de uso del hábitat; estuvieron asociados con áreas límite/cercanas a la orilla (<600 cm de distancia lateral) de profundidades de someras a moderadas (20-150 cm), una mezcla de arena, substratos de canto rodado y pequeños guijarros, moderadas cobertura y estructura vertical, y posiciones verticales pelágicas de superiores a inferiores. En la noche, speckled dace usó un orden similar de hábitats pero cambió su uso de la posición vertical inferior a la mitad inferior de la columna de agua. Durante el día, bluehead sucker usó hábitats de moderados a profundos (50-200 cm), corrientes de lentas a rápidas (0.1-1.2 m/s), una mezcla de arenas, guijarros y cantos rodados de pequeños a muy grandes, posiciones verticales casi bénticas, y moderadas estructura vertical y cobertura. En la noche, blueheads se cambiaron hacia áreas someras y más abiertas con corrientes moderadas (0.30-0.70 m/s), más arena y pocos cantos rodados grandes y menos estructura vertical y cobertura. Flannelmouth suckers mostraron un patrón similar al de los blueheads excepto que usaron áreas con corrientes más lentas (0.0-0.70 m/s) y estuvieron menos fuertemente asociados con substratos grandes.

ALLAN,N.L.*; OTIS,E.O.; WEISS,S.J.; MAUGHAN,O.E. (Arizona Cooperative Fish and Wildlife Research Unit, University of Arizona, Tucson, Arizona)

Biotic and abiotic factors affecting distribution of native fishes in streams tributary to the Colorado River in Grand Canyon

Factores bióticos y abióticos que afectan la distribución de peces nativos en arroyos afluentes del Río Colorado en Gran Cañón

KEYWORDS: *Catostomus discobolus*; *Catostomus latipinnis*; *Rhinichthys osculus*; Colorado River; Grand Canyon; Arizona

ABSTRACT

Fish populations from six small streams in or near the Grand Canyon, Arizona, were surveyed seasonally between January 1992 and August 1993. Fish were sampled on each stream throughout the first 5 km upstream from the confluence with the Colorado River; and up to 14 km of some streams. Native fish species commonly encountered were bluehead sucker, *Catostomus (Pantosteus) discobolus*, flannelmouth sucker, *Catostomus latipinnis*, and speckled dace, *Rhinichthys osculus*. Shinumo and Kanab Creeks contained perennial populations of *C. discobolus* and *R. osculus*. The Paria River always contained *R. osculus*, but *C. latipinnis* only occurred in the spring. The fish community in Bright Angel Creek was dominated by introduced trout (*Salmo trutta* and *Oncorhynchus mykiss*), with *C. latipinnis*, *C. discobolus* and *R. osculus* occurring seasonally. Tapeats Creek was occupied only by *O. mykiss*. No fish were observed in Deer Creek upstream from it's mouth. The most significant factors determining native fish distribution were the physical stream habitat conditions (especially water temperatures), presence of introduced trout, waterfalls that limit upstream movement of fish, and spawning migrations.

CLAVES: *Catostomus discobolus*; *Catostomus latipinnis*; *Rhinichthys osculus*; Río Colorado; Gran Cañón; Arizona

RESUMEN

Las poblaciones de seis pequeños arroyos dentro o cercanos al Gran Cañón, en Arizona, fueron evaluadas estacionalmente entre Enero de 1992 y Agosto de 1993. Los peces fueron muestreados en cada arroyo a través de los primeros 5 Km río-arriba, desde la confluencia con el Río Colorado; y hacia arriba hasta 14 Km de algunos arroyos. Los peces nativos comúnmente encontrados fueron el matalote de cabeza azul (bluehead sucker) *Catostomus (Pantosteus) discobolus*, flannelmouth sucker, *Catostomus latipinnis* y speckled dace, *Rhinichthys osculus*, los ríos Shinumo y Kanab contenían poblaciones perennes de C. discobolus y R. osculus. El río Paria siempre contuvo *R. osculus* pero *C. latipinnis* solamente ocurría en primavera. La comunidad de peces en el Bright Angel Creek fue dominada por las truchas introducidas *Salmo trutta* y *Oncorhynchus mykiss*, ocurriendo estacionalmente. El arroyo Tapeats fue ocupado solamente por *O. mykiss*, ningún pez fue observado río-arriba de la desembocadura del Deer Creek. los factores mas significativos que determinan la distribución de los peces nativos fueron las condiciones físicas del habitat del arroyo (especialmente temperatura del agua), presencia de la trucha introducida, cascadas que limitan los movimientos hacia arriba de los peces y migración de desove.

MARSH,P.C.*; DOUGLAS,M.E. (PCM - Arizona State University, Center for Environmental Studies, Tempe, AZ; MED - Arizona State University, Department of Zoology and Museum, Tempe, AZ.)

Humpback chub as food of non-native fishes in the Little Colorado River

El charal jorobado como alimento de peces no nativos en el Pequeño Río Colorado

KEYWORDS: humpback chub; *Gila cypha*; channel catfish; salmonids; non-native fishes; Little Colorado River; Grand Canyon; predation; endangered species

ABSTRACT

We examined foods of non-native rainbow and brown trout, channel catfish, and yellow and black bullhead in monthly samples from the Little Colorado River, Arizona, from June 1991 to July 1994. Food items varied among species, were low in diversity, and dominated by detritus, algae, and aquatic insects. Endangered humpback chub and other native fishes appeared minor components (5% frequency of occurrence in 315 guts). However, non-native fish are abundant, and even modest predation rates could result in consumption of substantial numbers of native fish. For example, if 5% of predators each eat 2 fish a week (the average number per stomach), then as few as 1,000 predators would consume 5,200 fish a year. Consumed chubs that we were able to measure (n = 11) averaged 121 mm TL and were mostly yearlings. We have not quantified age/size specific mortality, but recaptures of PIT-tagged individuals >150 mm TL suggest rates are low. Thus, annual loss to non-native predators of several thousand young chub could significantly impact the native population, even to the point of limiting or reducing population size by curtailing recruitment.

CLAVES: charal jorobado; *Gila cypha*; bagre de canal; salmónidos; peces no nativos; Pequeño Río Colorado; Gran Cañón; depredación;especies en peligro

RESUMEN

Examinamos alimentos de peces no nativos, truchas arcoiris y café, bagre de canal, y de bullhead amarillo y negro, en muestras mensuales del Pequeño Río Colorado, en Arizona, de Junio a Julio de 1994. Los productos alimenticios variaron entre las especies, fueron bajos en diversidad, dominando detritis, algas e insectos acuáticos. El charal jorobado, especie en peligro y otros peces nativos aparecen como componentes menores (5% de frecuencia de ocurrencia en 315 intestinos). No obstante, los peces no nativos son abundantes, e incluso las tasas de depredación modestas podría resultar en un consumo de números substanciales de peces nativos. Por ejemplo, si un 5% de depredadores come cada uno dos peces en una semana (el número promedio por estómago), entonces tan pocos como 1,000 depredadores, hubieran consumido 5,200 peces en un año. Los charales consumidos que fuimos capases de medir (n=11) promediaron 121 mm LT y fueron en su mayoría organismos del año. No cuantificamos época y tamaño de mortalidad específica, pero recapturas individuales PIT-etiquetados >150 mm LT, sugieren que las tasas son bajas. De este modo, la pérdida anual por depredadores no nativos de varios miles de charales jóvenes, pudiera significativamente impactar las poblaciones nativas, hasta el punto de limitar o reducir el tamaño de las poblaciones por baja en el reclutamiento.

CONVERSE,Y.K.* (YKC - Fish and Wildlife Department, Utah State University, Logan, UT)

Use of geomorphology to predict subadult humpback chub distribution in the Colorado River of Grand Canyon

Uso de la geomorfología para predecir la distribución de subadultos del charal jorobado en el Río Colorado en el Gran Cañón

KEYWORDS: humpback chub; geomorphology; shoreline; geology; hydraulics; Colorado River; Grand Canyon

ABSTRACT

Subadult (less than 200 mm TL) humpback chub (*Gila cypha*) densities were examined for 16 miles of the Colorado River below the confluence of the Little Colorado River. Geology and surficial hydraulic criteria were used to describe geomorphic reaches. Geomorphic processes were used to describe shoreline types within geomorphic reaches. Narrow reaches with greater total eddy area had higher densities than wider reaches with greater total riffle area. Vegetation, talus and debris fan shorelines with greater fish densities, had lower velocities, were deeper and offered more cover than bedrock, cobble and sand shorelines. Stability of these conditions for the range of Interim Flow Operations of Glen Canyon Dam was also examined.

CLAVES: charal jorobado; geomorfología; orilla; geología; hidráulicos; Río Colorado; Gran Cañón

RESUMEN

Densidades de subadultos (menos de 200 mm de LT) del charal jorobado (*Gila cypha*) fueron examinadas en 16 millas en el Río Colorado confluencia abajo con el Pequeño Río Colorado, el 99% de los subadultos de los charales capturados, a través de electropesca, fueron en esta área. Procesos geomórficos fueron usados para describir los tipos de orillas. La vegetación y orillas con despojos e inclinaciones tienen densidades de peces más grandes que las orillas con guijarros, arena y adoquines en el área de estudio totalmente, pero las densidades de orillas varían por extensión. Criterios geológicos e hidráulicas superficiales fueron usados para describir extensiones geomorfológicas. Extensiones estrechas con mayor área total EDDY demostraron un patrón de densidades más altas que las extensiones más amplias con un total de recodos más grande. Atributos de velocidad, profundidad, substrato y cobertura fueron medidos para los diferentes tipos de orillas para determinar las condiciones de preferencia de habitat de orilla. La estabilidad de estas condiciones para la serie de Operaciones de Flujo Provisional de la presa Glen Canyon también fue examinada.

[HUBBS STUDENT PAPER COMPETITOR]

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Historic and present distribution and abundance of humpback chub in Grand Canyon, Arizona

Distribución y abundancia actual e histórica del charal jorobado en el Gran Cañón, Arizona

KEYWORDS: humpback chub; Colorado River; Grand Canyon; distribution

ABSTRACT

Archaeological and historic records indicate that the endangered humpback chub (Gila cypha) was once distributed throughout the Colorado River and its major tributaries in Grand Canyon. Following completion of Glen Canyon Dam in 1963 and until 1970, mainstem distribution of the species was reported as 412 km, from the tailwaters

of the dam to Separation Canyon. Present distribution is 359 km, from river mile (RM) 30 (South Canyon) to RM 253 (Maxson Canyon), with 88 percent of adults in an 11-km area, =66rom RM 58.3 to RM 65.4. This population center for humpback chub in Grand Canyon is associated with the Little Colorado River (LCR), where the majority of mainstem adults and the LCR population component spawn. Limited mainstem spawning success is suspected, as indicated by ripe and gravid fish away from the LCR and few larval chubs. Distribution of humpback chub in the mainstem Colorado River in Grand Canyon is limited by cold, hypolimnetic releases from Glen Canyon Dam (8-10=F8 C, which also limit reproduction), low food availability, large numbers of predators, and possibly habitat instability from dam operations. The species was reported in low numbers from lower areas of Bright Angel Creek, Shinumo Creek, Kanab Creek, Tapeats Creek, and Havasu Creek, where it is still found in very small numbers. The population component inhabiting the LCR, and spawners ascending from the mainstem, occur only in the lower 13 km of stream. Although the distribution of humpback chub in Grand Canyon has contracted since Glen Canyon Dam was built, changes in species abundance are difficult to assess. Historic records indicate higher abundances throughout the canyon, but it appears that densities may be higher within the LCR.

CLAVES: charal jorobado; Río Colorado; Gran Cañón; distribución

RESUMEN

Los registros arqueológicos e históricos indican que el charal jorobado *Gila cypha* estuvo una vez distribuido a través del río Colorado y sus principales tributarios en el Gran Cañón. Siguiente a la construcción de la presa de Glen Canyon en 1963 y hasta 1970, el tronco principal de distribución de la especie fue reportada como de 412 km, desde el vertedor de la presa al Separation Canyon. La distribución actual es de 359 km, de 30 millas de río (RM) (South Canyon) a 253 RM (Maxon Canyon), con 88 porciento de adultos en una área de 11 km (6.6 millas), RM 58.3 a RM 65.4. Este centro de población para el charal jorobado en el Gran Cañón esta asociado con el Pequeño Río Colorado (Little Colorado River (LCR)), donde la mayoría de los adultos en la corriente principal y el componente poblacional del LCR desova. El limitado éxito reproductivo en la corriente principal esta suspendido, como lo indican los peces maduros y grávidos del LCR y las pocas larvas de charales. La distribución del charal jorobado en la corriente principal del Río Colorado en el Gran Cañón esta limitada por las descargas de agua hipolimnéticas y frías de la presa Glen Canyon (8-10° C, lo cual también limita la reproducción), baja disponibilidad de alimento, gran número de depredadores, y posiblemente inestabilidad del hábitat debido a las operaciones de la presa. La especie fue reportadas en números bajos de las aguas más bajas del Bright Angel Creek, Shinumo Creek, Kanab Creek, Tapeats Creek, y Havasu Creek, donde hasta ahora se encuentra en números muy pequeños. El componente poblacional que habita en el LCR, y los desovantes que ascienden de la corriente principal, ocurren solamente en los 13 km más bajos de la corriente. Aunque la distribución del charal jorobado en el Gran Cañón se ha contraído desde que la presa Glen Canyon fue construida, los cambios en la abundancia de especies son difíciles de evaluar. Aunque los registros históricos indican las abundancias más altas en el Gran Cañón, parece ser que las densidades más altas pueden estar en el LCR.

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Status of estuarine fishes inhabiting the Pecos River

Estatus de los peces estuarinos que habitan el Río Pecos

KEYWORDS: Pecos River; native fishes; exotic fishes; *Fundulus grandis*; *Menidia beryllina*; *Cyprinodon*; *Gambusia affinis*; *Lucania parva*

ABSTRACT

Portions of the Pecos River are currently occupied by three species of introduced, estuarine fish. *Fundulus grandis*, *Cyprinodon variegatus*, and *Menidia beryllina* are among the most abundant species in the saline portions of the Pecos River in Texas. They are also important in the river below Carlsbad, New Mexico, where they coexist with a variety of species. The spread and proliferation of *M. beryllina*, *C. variegatus* and, more recently, *F. grandis*, is cause for evaluation. Competition and genetic introgression between these exotic fish and similar or related native fishes, such as *Fundulus zebrinus*, *Gambusia affinis*, *Lucania parva*, and *Cyprinodon pecosensis*, may be important. Recent changes in water quality and quantity may enhance the success of exotic fish species and are also likely responsible for declines in native populations of freshwater fish.

CLAVES: Río Pecos; peces nativos; peces exóticos; *Fundulus grandis*; *Menidia beryllina*; *Cyprinodon*; *Gambusia affinis*; *Lucania parva*

RESUMEN

Porciones del río Pecos están ocupadas por tres especies de peces estuarinos introducidos. *Fundulus grandis*, *Cyprinodon variegatus* y *Menidia beryllina*, las cuales están entre las especies mas abundantes en la porciones salinas del río Pecos en Texas. Ellos también son importantes en el río por debajo de Carlsbad, Nuevo México, donde coexisten con una gran variedad de especies, la amplitud y proliferación de *M. beryllina*, *C. variegatus*, y mas

recientemente *F. grandis* es causa de una evaluación. La competencia y la introgresión genética entre estos peces exóticos y peces nativos o similares, tales como *Fundulus zebrinus*, *Gambusia affinis*, *Lucania parva* y *Cyprinodon pecosensis* puede ser importante. Cambios recientes en la calidad y cantidad del agua puede estimular el éxito de especies de peces exóticos y son presumiblemente responsables del declive de las poblaciones nativas de los peces de agua dulce.

LANG,B.K.*; HOBBES,A.L.; PROPST,D.L. (New Mexico Department of Game and Fish, Santa Fe, NM)

Distribution, abundance and food habits of piscivorous fishes inhabiting the Pecos River between Sumner Dam and Brantley Reservoir, New Mexico

Distribución, abundancia y hábitos alimenticios de peces piscívoros que habitan el Río Pecos, entre la presa Sumner y el reservorio Brantley, New Mexico

KEYWORDS: Pecos River; piscivorous fishes; food habits; macrohabitat; predation pressure

ABSTRACT

The effects of reservoir releases on the Pecos River ichthyofauna remain undetermined, especially during low flow periods (i.e., post spring run-off and prior to summer rainfall events). Three permanent study sites were sampled during summer 1992 and 1993 to characterize the inter- relationships of reservoir controlled Pecos River flows and the distribution, abundance and food habits of piscivorous fishes between Sumner Dam and Brantley Reservoir, New Mexico. The abundance of piscivorous species ranged from 0.2-18.1% of the total catch at each site. Twelve piscivorous species were collected during the study; eight taxa of which were native to the Pecos River. Native piscivores most commonly collected were Mexican tetra, *Astyanax mexicanus*; channel catfish, *Ictalurus punctatus*; and flathead catfish *Pylodictus olivaris*. White bass *Morone chrysops* and spotted bass *Micropterus punctulatus* dominated the non-native piscivorous catch. Most piscivores were seined from deep water (13-55 cm) macrohabitats (i.e., backwaters, debris pools, embayments, undercut banks) characterized by relatively slow water velocities (2-29 cm/sec.) with instream cover. Aquatic and semiaquatic insects (Ephemeroptera, Odonata, Hemiptera, Trichoptera, Coleoptera, Diptera, Hymenoptera) comprised the greatest proportion of piscivore gastrointestinal (GI) tracts. Fish prey observed in piscivore GI tracts included red shiner *Cyprinella lutrensis*, inland silverside *Menidia beryllina* and western mosquitofish *Gambusia affinis*. Miscellaneous piscivore ingesta consisted of aquatic macroinvertebrates (Turbellaria, Copepoda, Isopoda, Amphipoda, Decapoda), unidentified macrophytes and organic debris. Although the diversity of non-native piscivorous fishes has increased, piscivore abundance throughout the Pecos River study reach remains low. Vagility of piscivorous species within the system was apparently low, as the abundance of piscivores was highest in waters immediately downstream (i.e., 0.25-0.5 km) of mainstem impoundments. Macrohabitat studies documented syntopic occurrences of piscivores and non-predaceous native fishes. However, piscivore dietary studies during the past two years indicate low predation pressure on native fish populations.

CLAVES: Río Pecos; peces piscívoros; hábitos alimenticios; macrohábitats; presión por depredación

RESUMEN

El efecto de la liberación en reservorios de la ictiofauna del río Pecos permanece indeterminada, especialmente durante los períodos de flujo lento (i.e. escurrimiento posprimaveral, anterior a los eventos de precipitación de verano). tres estudios de sitios permanentes fueron muestreados durante el verano de 1992 y 1993 para caracterizar las interrelaciones de flujos controlados en reservorios del Río Pecos y la distribución, abundancia y hábitos alimenticios de peces piscívoros entre la presa Sumner y el reservorio Brantley, Nuevo Mexico. La abundancia de las especies piscívoras varió de 0.2-18.1% de las capturas totales en cada sitio. Doce especies piscívoras fueron colectadas durante el estudio; ocho taxa de los cuales fueron nativos al Río Pecos. Los piscívoros nativos más comúnmente colectados fueron el tetra mexicano, *Astyanax mexicanus*; el bagre de canal, *Ictalurus punctatus*; el bagre cabeza plana *Pylodictus olivaris*. La lobina blanca *Morone chrysops* y la lobina moteada *Micropterus punctulatus* dominaron en las capturas de piscívoros no nativos. La mayoría de los piscívoros fueron pescados con agalleras en hábitats de aguas profundas (13-55 cm) (como aguas estancadas, pozas, áreas socavadas) caracterizados por velocidades bajas de corriente (2-29 cm/sec.), con abrigos dentro de las corrientes. Los insectos acuáticos y semiacuáticos (Ephemeroptera, Odonata, Hemiptera, Trichoptera, Coleoptera, Diptera, Hymenoptera) comprenden la más grande proporción de los tractos gastrointestinales (GI) de los piscívoros. Las presas de los peces observadas en los tractos GI de los piscívoros incluyeron al red shiner *Cyprinella lutrensis*, *Menidia beryllina* y el pez mosquito del Oeste *Gambusia affinis*. La miscelánea de la ingestión de los piscívoros consistió de macroinvertebrados acuáticos (Turbellaria, Copepoda, Isopoda, Amphipoda, Decapoda), macrofítas no identificada, y restos de materia orgánica. Aunque la diversidad de peces piscívoros no nativos se ha incrementado, la abundancia de piscívoros durante el estudio en el Río Pecos permanece baja. La movilidad de las especies piscívoras en el sistema aparentemente fue baja, así como la abundancia de piscívoros fue más alta inmediatamente aguas abajo (0.25-0.5 km) de los reservorios de la corriente principal. Los

estudios de macrohábitats documentaron ocurrencias sintópicas de peces nativos predadores y no depredadores. Sin embargo, los estudios de dietas de los piscívoros durante los últimos dos años indican una baja presión de depredación sobre las poblaciones de peces nativos.

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The use of fishes as indicators of environmental water quality in the lower Rio Grande (Río Bravo del Norte), Texas and México

Los peces como indicadores ambientales de la calidad del agua del bajo Río Grande (Río Bravo del Norte), de Texas y México

KEYWORDS: lower Rio Grande; fish communities; water quality assessments; Texas; México

ABSTRACT

A major study of water quality in the Rio Grande along the Texas- Mexico border has recently been released by the governments of the U.S., Mexico, and Texas. The study found a variety of potentially toxic chemicals in the river in a variety of localities, but, in most cases, not in excessively high quantities and not in all samples, even from a given site. Trends of decreasing water quality over time were not clearly detected. The conclusion from this study was that while the river cannot be considered healthy, it may not be as impaired as previously predicted. The interpretations drawn from the chemical assessment of water quality are not supported by fish community data taken from stations sampled repeatedly in the lower Rio Grande since 1981. Species richness has steadily declined at these standard sampling stations which encompass a broad variety of habitat types. Long-term pollution, water misuse and mismanagement throughout the basin appear responsible for this apparent decrease in aquatic community integrity, in at least this portion of the river. Reliance on chemical water quality data, alone, for aquatic assessments is not recommended for future studies of the status of aquatic resources.

CLAVES: evaluación de calidad de agua; comunidades de peces; bajo Río Bravo del Norte; Texas; México

RESUMEN

Un estudio intensivo de la calidad del agua del Río Grande en la frontera de Texas y México ha sido dado a conocer por los gobiernos de los Estados Unidos, México y Texas. Este estudio reveló una variedad de substancias químicas potencialmente tóxicas encontradas en varias localidades del río. Sin embargo, en la mayoría de los casos, la cantidad de esas substancias no fue excesivamente alta en todas las muestras, aún de aquellas tomadas del mismo sitio. La tendencia decreciente de la calidad del agua con el paso del tiempo no fue detectada con claridad. La conclusión derivada de éste estudio fue que mientras que el río no puede ser considerado saludable, podría ser que su condición no sea tan mala como se predijo antes. Las interpretaciones sacadas de los análisis químicos de la calidad del agua no corresponden con los datos obtenidos de las comunidades de peces examinadas repetidamente en el bajo Río Grande desde 1981. La abundancia de las especies ha declinado en una forma progresiva en las áreas de muestreo que abarcan una variedad de tipos ambientales. La contaminación prolongada, el uso indebido del agua y el manejo inadecuado del ambiente en todo el delta del río parecen ser responsables del aparente deterioro de la integridad de las comunidades acuáticas, al menos en ésta parte del río. La evaluación de las condiciones acuáticas basada únicamente en datos de análisis químicos de calidad del agua no es recomendable para estudios futuros del estado de los recursos acuáticos.

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Community dynamics of secondary channels of the San Juan River

Dinámica de la comunidad de los canales secundarios del Río San Juan

KEYWORDS: secondary channels; seasonal variation; native fishes; non-native fishes; Colorado River basin

ABSTRACT

Secondary channels of the San Juan River are hypothesized to add to river habitat complexity by providing habitats that are less abundant or lacking in the main channel. This study was conducted to determine changes in fish species abundance and habitat availability in secondary channels. Fish communities in four secondary channels between Hogback, NM and Bluff, UT were sampled at three week intervals from July 1993 to November 1994. Discharge in channels ranged from 30 m during spring run-off, to zero flow in the fall and winter. The two upper-most sites retained permanent flow throughout the study period, while the lower sites were reduced to shallow, subsurface-fed riffles and isolated pools. Species richness was greatest during autumn and lowest in winter. Native fish abundance was highest during the early summer, whereas non-natives proliferated from late summer into autumn. Secondary channels appear to differ from the main channel physically and chemically and this difference seems to be

reflected in their biological composition. This study indicates that secondary channels are used heavily by both native and non-native fishes. During low flows, interactions among these fishes may be detrimental to the native species.

CLAVES: canales secundarios; variación estacional; peces nativos; peces no nativos; cuenca del Río Colorado

RESUMEN

Se hipotetiza que los canales secundarios del Río San Juan agregan complejidad al hábitat del río, proporcionando hábitats menos abundantes o que faltan en el canal principal. Comunidades de peces en cuatro canales secundarios entre Hogback, NM y Bluff, UT fueron muestreados en intervalos de tres semanas desde Julio 1993 a Noviembre de 1994. Las descargas en canales variaron de 30 m durante las escorrentías de primavera, hasta un flujo de cero en el otoño e invierno. Los dos sitios más arriba mantuvieron el flujo a través del período de estudio, mientras que los sitios más bajos fueron reducidos a niveles de agua someros, grietas alimentadas con agua subsuperficial, y pozas aisladas. La riqueza de especies fue más grande durante el otoño y la más baja en invierno. La abundancia del pez nativo fue muy alta cercano el verano, sin embargo proliferaron las especies no nativas desde finales del verano y en el otoño. Los canales secundarios presentaron diferencias físicas y químicas respecto del canal principal y esta diferencia aparente se manifiesta en su composición biológica. Este estudio indica que los canales secundarios son usados intensivamente tanto por los peces nativos como por los no nativos. Durante los niveles bajos de flujos, las interacciones con estos peces pueden ser en detrimento para las especies nativas.

[HUBBS STUDENT PAPER COMPETITOR]

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Effects of instream woody debris and complexity on the aquatic community in a high mountain, desert stream community

Efectos y complejidad de los restos de plantas leñosas sobre las comunidades acuáticas en una comunidad de arroyo desértico de alta montaña

KEYWORDS: Colorado River cutthroat trout; habitat complexity; coarse woody debris; streams

ABSTRACT

In order to understand the effect of changes in habitat complexity generated by instream woody debris on trout and macroinvertebrate densities and their interactions, we manipulated woody debris densities in the fall of 1991, resulting in significant changes in trout densities and physical characteristics in the summer of 1992. Trout prey electivity (Chesson's) and capture efficiency were directly related to habitat complexity. Macroinvertebrate densities did not respond as significantly to changes in habitat complexity as trout densities. The macroinvertebrates appeared to be limited by primary productivity rather than habitat complexity at the scale of complexity examined here. Habitat complexity was decreased in all of the manipulated study sections by high spring runoff in 1993 which removed most of the smallest branches. Measured responses where not as significant due to the reduction in complexity caused by high spring runoff. If stream restoration efforts are to succeed, additional work on spatial and temporal changes in habitat complexity are needed.

CLAVES: Colorado River cutthroat trout; complejidad del hábitat; restos gruesos de plantas leñosas; arroyos

RESUMEN

Con el objeto de entender los efectos de los cambios en la complejidad del hábitat, generada por restos de plantas leñosas en los arroyos sobre las densidades de truchas y macroinvertebrados y sus interacciones, nosotros manipulamos las densidades de los restos leñosos en el otoño de 1991, con cambios significativos en las densidades de truchas y características físicas en el verano de 1992. La eficiencia de captura y electividad de la presa (Chesson's) por la trucha estuvo directamente relacionada a la complejidad del hábitat. Las densidades de macroinvertebrados no respondieron tan significativamente a cambios en la complejidad el hábitat, como las densidades de truchas. Los macroinvertebrados aparentemente están limitados por la productividad primaria más que por la complejidad del hábitat a la escala de la complejidad examinada en este estudio. La complejidad del hábitat decreció en todas las secciones de estudio manipuladas debido a las altas escorrentías de la primavera de 1993, las cuales removieron la mayoría de las ramas pequeñas. Las respuestas medidas no fueron significativas debido a la reducción en complejidad causada por las altas escorrentías de primavera. Si los esfuerzos de restauración de arroyos son exitosos, trabajos adicionales sobe cambios espaciales y temporales de la complejidad del hábitat serán requeridos.

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Application and regulation of potassium permanganate to detoxify rotenone in streams

Aplicación y regulación del permanganato de potasio para detoxificar rotenona en arroyos

KEYWORDS: permanganate; detoxification; rotenone; piscicide; colorimetry; California

ABSTRACT

Potassium permanganate is a common oxidizer used to detoxify fish toxicants applied to flowing waters. Mixing and delivery systems for permanganate application were refined during 5 chemical treatments to recover threatened populations of Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*. Permanganate concentration is monitored using a portable colorimeter, improving control over application rate. This method is rapid and suitable for field use. The application and limitations of this method are discussed, and field experiences are described.

CLAVES: permanganato; detoxificación; rotenona; piscicida; colorimétrico; California

RESUMEN

El permanganato de potasio es un oxidante común, usado para detoxificar tóxicos de peces aplicados en corrientes de agua. Sistemas de mezcla y liberación para la aplicación de permanganato, fueron refinadas durante 5 tratamientos para recuperar poblaciones amenazadas de *Oncorhynchus clarki henshawi*. Las concentraciones de permanganato son monitoreadas usando un colorímetro portátil, mejorando el control sobre la tasa de aplicación. Este método es rápido y adecuado para el uso en campo. La aplicación y limitaciones de este método es discutido.

CONTRIBUTED PAPER

Ill advised or inadvertent introductions of fishes place many freshwater fish stocks at peril of extinction in western North America (Moyle and Williams 1990; Behnke 1992, see also Miller 1989). Given the present technologies of fish control, use of toxicants represents the only alternative to condemning many jeopardized fish taxa to extinction. Toxicants themselves pose a risk to nontarget biota, so their use requires a considered analysis of alternatives. In the urbanizing West, pesticide use is viewed with increasing skepticism by both the public and public institutions. Fishery managers must therefore exercise prudence in the use of these tools. Control and containment of fish toxicants have become equal priorities with control of target species.

Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), endemic to the Walker Lake basin of California and Nevada, are listed as a Threatened species under the federal Endangered Species Act. In California the major threat to their continued existence is displacement and/or hybridization with introduced trouts. A multi-state and federal interagency management plan currently governs recovery efforts for the western stocks of this species (Gerstung 1986). The plan prescribes the chemical eradication of alien fishes as an indispensable part of the recovery and reintroduction process. During the period 1987-1992 three headwater streams in the Walker Lake basin were treated with 1 to 2 ppm of the piscicide rotenone to remove non-native trout from planned Lahontan cutthroat trout reintroduction sites. Each of these treatments was repeated in consecutive years to assure efficacy, resulting in six completed rotenone applications and three successful reintroductions to date. Rotenone was applied to Silver Creek (Mono County, CA) in August 1994 to prepare a final stream in the Walker Lake basin for a cutthroat trout recovery population.

In each rotenone application, potassium permanganate ($KMnO_4$) was applied at rates from 1 to 6 ppm to detoxify stream water as it flowed from project areas. $KMnO_4$ oxidizes rotenone, its breakdown products, and other organic constituents of the formulation. The ability of $KMnO_4$ to neutralize the effect of rotenone on fish was established by J. M. Lawrence (1956), and methods for its application to standing waters for that purpose have been reported (Jackson 1957; Engstrom-Heg undated). In running waters potassium permanganate must be continuously applied to a stream to prevent rotenone from affecting biota in areas downstream of the intended treatment area. Potassium permanganate itself is toxic, warranting use of the minimum quantity necessary to effectively contain rotenone to the treatment area. Comprehensive guidelines and requirements for effective detoxification are discussed in Engstrom-Heg (Undated, 1972 and 1976). Devices for introducing solid $KMnO_4$ powder or crystals at a constant rate exist (Schoenecker and Rhodes 1965, Engstrom-Heg undated), but handling of the solids presents drawbacks under certain field conditions, such as wind and rain. Several accounts of fish eradication specify the use of $KMnO_4$ solutions for stream detoxification, but do not provide a detailed description of the apparatus and methods (Rinne and Turner 1991, Gresswell 1991, and Rosenlund in press). Mahon and Balon (1980) introduced $KMnO_4$ solutions with a peristaltic pump, which worked well during short term experimental treatments but is less suited to prolonged applications at remote locations. Price and Haus (1963) and Engstrom-Heg (1971a) detail the construction of constant flow devices--with no moving

parts or power requirements--which are suitable for sustained delivery of $KMnO_4$. Stefferud et al. (1991) describe the construction of a similar constant flow device used with both antimycin and potassium permanganate solutions. While each worker will favor his/her own approach, our experience suggests that larger capacity, constant discharge devices are more convenient, adaptable, and reliable.

This paper documents the use of a 200 L capacity, constant- flow device suitable for prolonged and precise application of $KMnO_4$ under field conditions. Field methods are detailed for removing rotenone and its residues from cold streams of low ionic strength. A new technique for field determination of potassium permanganate concentration using light absorbance colorimetry is presented. The case history of the 1994 rotenone-potassium permanganate treatment of Silver Creek is offered as a practical example of the method.

INSTITUTIONAL ASPECTS - The California Department of Fish and Game (Department) serves as trustee for the public trust values of fish, wildlife, and plants. In this role, the Department is responsible for management of the state's diverse biota. Part of this responsibility is to recover species in peril, which may require elimination of competing introduced organisms. Recovery efforts by the Department are authorized through a Memorandum of Understanding with the U.S. Fish and Wildlife Service as provided for under the federal Endangered Species Act. Projects receive public review pursuant to the California Environmental Quality Act (CDFG 1989, 1994a). Pesticide application and detoxification are performed by Department biologists whose duties also include conservation of non-salmonid aquatic biota and herpetofauna. Internal monitoring for quality assurance and regulatory compliance is accomplished by the Department's Pesticide Investigations Unit.

The pesticide regulation environment is populated by federal, state and local agencies with overlapping authority for regulating pesticide use. Pesticide registration and application are controlled by both the federal Environmental Protection Agency and the California Department of Pesticide Regulation. Specific pesticide applications are monitored by the county Agriculture Commissioner, who also enforces label and safety requirements. Unique to the eastern portion of the state, some pesticide uses are also controlled by the California Regional Water Quality Control Board, Lahontan Region. This agency imposes discharge requirements, monitors compliance with rotenone application rates, and measures for residues and wastes on and off the project site. The USDA Forest Service administers lands on which portions of each cutthroat trout project have occurred, prepares National Environmental Policy Act documents, and complies with federal policies and directives. Regulatory acceptance of the cutthroat trout restoration program is varied: many agencies support or even participate in treatments, while one has forcefully opposed the use of rotenone. Representatives of all the above agencies except EPA were present to observe or participate in the August 1994 application at Silver Creek.

MATERIALS AND METHODS - Potassium permanganate is introduced downstream of a fish passage barrier selected to prevent target species from recolonizing the treated stream reach. The delivery is made from a Mariotte bottle, a container devised to deliver fluids at a constant rate without automation (Engstrom-Heg 1971a). Like Price and Haus (1963) we fabricated 200 liter Mariotte bottles, using steel or plastic barrels such as those used for bulk transport of soft drink concentrate. The barrel is oriented horizontally on a slight incline, with a < inch or larger gate valve screwed into the lower "bung hole" to regulate outflow. Air is introduced to the bottle through a 1 cm intake tube mounted through the top of the barrel's cylindrical surface, and extending almost to the bottom. Unscrewing the intake tube gives access for filling with the $KMnO_4$ solution. In operation, the Mariotte bottle must be totally sealed except for the inlet tube and outlet valve. As fluid is drawn from the intake tube a negative pressure develops, determined by the height of inlet tube terminus over the outlet valve. This distance remains constant at 25-100 mm, therefore head, pressure, and delivery rate also remain constant as the tank drains. Attainment of pressure equilibrium is readily apparent as the air bubbles pop through the inlet tube, making a resonant "blup, blup" sound.

LOADING AND OPERATING MARIOTTE BOTTLES - Potassium permanganate is a respiratory and eye irritant, and creates persistent stains on both skin and clothes. Safety goggles, dust masks, rubber gloves, and coveralls are recommended when mixing and handling this chemical.

Potassium permanganate is saturated at approximately seven percent in cold water (Anonymous 1976); but in the field it is burdensome to mix stronger than a 1.0 percent solution within the time required. To simplify both mixing and calculations, we pre- measured 2.0 Kg aliquots of pourable grade fine crystalline $KMnO_4$ into Ziploc plastic bags, adding one bag per barrel of water to make a 1% tank mix. More concentrated solutions may crystallize out of solution inside the tank when working in freezing temperatures, clogging fittings and altering concentration. All mixing is done in a 10 liter plastic bucket with a pour spout, to avoid introduction of undissolved $KMnO_4$ into the barrel. At our work sites we devise a running water system with a garden hose, employing either a siphon or a 12 volt bilge pump. The convenience of running water can be important to workers loading quantities of material around the clock. Window screen is secured over the hose intake to exclude stream detritus which

might later plug the outlet valve. Initial mixing forms a $KMnO_4$ slurry in the bucket, which is briefly stirred with the running garden hose. Upon standing, undissolved crystals quickly settle to the bottom of the bucket, allowing the supernatant to be decanted through a funnel into the Mariotte bottle. Repeating this sequence ten to fifteen times dissolves and transfers all of the potassium permanganate into the barrel. Final filling is done by inserting the hose to the bottom of the Mariotte bottle, which thoroughly mixes the contents.

The apparatus is activated by opening the outlet valve after the inlet tube is tightened in place. Delivery rate is sampled by timing the release of a quantity of tank mix into a plastic graduated cylinder. Once pressure equilibrium exists in the bottle, adjustment of the outlet valve causes a virtually instantaneous change in the delivery rate.

The operating Mariotte bottle can be regulated to empty in less than two hours, or to last as long as a week. Gate valves are preferable to ball valves, as they permit finer adjustment of delivery rate. Maximum delivery rate is affected by the size and type of valve used, as well as the incline of the barrel from horizontal. With ¼ inch fittings, this design will treat approximately 0.1 m^3/second, or 3.7 cfs, at 3 ppm $KMnO_4$. Faster rates are not necessarily desirable; operations become limited by the time required to re-load the barrels. A practical strategy on any size stream is to run two barrels simultaneously, keeping a third one filled and ready for when the need arises. This improves scheduling flexibility when refilling barrels or responding to unexpected situations, such as plugged valves. It also provides some insurance that detoxification will be at least partially effective should a malfunctioning Mariotte bottle go undetected by a distracted attendant. It goes without saying that an operating detoxification station should be vigilantly attended 24 hours/day.

When constructed from plastic or steel barrels, our Mariotte bottles weigh 11.8 Kg or 18.6 Kg, respectively. Carried vertically, either type is easily strapped to a backpack frame and transported over rough terrain without undue difficulty. Plastic is the material of choice if bottles must be transported great distances. However, filled plastic barrels may awkwardly slide out of position or sag into conformity with the underlying ground surface. Deployment requires secure positioning where barrels will neither roll nor slide when filled. An improperly positioned 200 L Mariotte bottle does not regulate constant outflow, and is too heavy to reposition. Draining a disabled barrel under such circumstances would be an unwelcome logistical challenge. Finding suitable sites to situate Mariotte barrels on rocky stream banks can be surprisingly difficult. A length of clear poly tubing helps to span the distance from the Mariotte bottle to the stream, and aids visual checks of discharge rate and continuity. It is possible, but unlikely, to establish a siphon in the tube. This should not allowed to occur, as it would accelerate the delivery rate unpredictably.

APPARATUS ADJUSTMENT AND QUALITY CONTROL - Mariotte bottles are frequently calibrated by calculating the tank mix delivery rate needed to achieve a desired final concentration in the stream, knowing the tank mix concentration and stream discharge. The relationship between these parameters may be expressed as follows (equation 1):

$$\frac{C}{T} = \frac{10 \times D}{Q}$$

where: $\boldsymbol{C}$ = Desired concentration of $KMnO_4$ applied to stream (ppm), $\boldsymbol{T}$ = Tank mix concentration of $KMnO_4$ (%), $\boldsymbol{D}$ = tank mix delivery rate (ml/min), $\boldsymbol{Q}$ = Stream discharge (liters/min).

Desired tank mix delivery rate may then be calculated by solving this equation for "D", as we did in our earlier treatments. This method was satisfactory from the standpoint that rotenone toxicity and residues were contained within the treatment area. However, the method assumes accuracy when mixing the tank solution and measuring both delivery rate and stream discharge. The potential for making errors of measurement remains a troubling source of uncertainty, absent the ability to independently verify $KMnO_4$ concentration in the stream. The problem is compounded if stream discharge changes, necessitating recalculation when work may be frustrated by darkness, rainfall, or lack of sleep. A method for rapid field measurement of potassium permanganate in the receiving water was desired to provide information feedback for improved control over application rates. Such a tool would obviate the need for time consuming and potentially inaccurate stream gaging, and improve reliability and confidence in the detoxification.

Several unsuccessful approaches to field monitoring were evaluated and abandoned. Specific conductance was found to increase slightly when potassium permanganate is added to distilled water at the concentrations typically used. Unfortunately, the percent change in conductivity when potassium permanganate is added to natural surface waters is too small to resolve in practice. Moreover, potassium permanganate in some cases reduces the specific conductance of stream water, presumably by decomposing conductive organic solutes. Ocular comparison of color standards was attempted using potassium permanganate solutions of known concentration. In the laboratory we were unable to distinguish smaller than 1 ppm differences between stock solutions, providing insufficient resolution to use in the field. Moreover, dilute solutions of potassium permanganate rapidly degraded, changing color and further diminishing the utility of that technique. At the time of our field work we were unaware of the test kit

method of Engstrom-Heg (1971b). Future work will compare the utility of this technique with the one described below.

LIGHT ABSORBANCE COLORIMETRY - Potassium permanganate solutions have a useful light absorbance pattern which peaks in the green spectrum at 525 nm. Fujimura found that light absorption at this wavelength is linear to concentration, using commercially available narrow slit spectrophotometers and broader band light absorbance colorimeters. Both types of instrument accurately determined the concentration of potassium permanganate in water between 0 and 8 ppm during these tests. No dilutions, reagents, or sample treatment is required.

Two battery powered portable colorimeters were obtained and field tested, the Hach DR/700 and Chlorine Pocket Colorimeter. Both are compact, lightweight, and equipped with digital displays. An older model analog colorimeter was less sensitive and failed to produce a useable calibration curve. The DR/700 has interchangeable filter modules (for other uses), stores user calibration data, displays absorbance, percent transmission, and can directly output potassium permanganate concentration 1 0.1 ppm. This model was found to be a durable instrument during a previous rotenone-potassium permanganate treatment conducted in 1993. The Chlorine Pocket Colorimeter is specifically designed to measure the colored end products produced by a test kit analysis for dissolved chlorine (Hach 1991). The specificity of this model diminishes its flexibility for other uses, but makes it considerably less expensive to purchase. The Chlorine Pocket Colorimeter only displays concentration units intended by the manufacturer to indicate chlorine concentration. A linear relationship was empirically determined where the $KMnO_4$ concentration in ppm equals twenty times the display output. Precision of the pocket colorimeter is thus limited to ± 0.2 ppm potassium permanganate, which we believe provides a major improvement in application control.

To set or recalibrate outflow of a Mariotte bottle using this tool requires a rough estimate of the desired delivery rate for the tank mix. Begin to release at about half of the estimated rate, and select a point within 30 seconds travel time downstream at which to take water samples. A critical assumption of the method is that potassium permanganate is completely mixed at the sample point. After 5 minutes of application the potassium permanganate concentration is assumed to be steady at the sample point. Water samples are collected mid-channel and near each bank to validate the assumption of complete mixing. Potassium permanganate concentration is immediately measured by light absorbance colorimetry. The actual tank mix delivery rate is then increased proportionally to bring the stream concentration up to the desired final application rate. Adjustment of the delivery rate from the tank may be calculated as follows (Equation 2):

$$D_f = D_i \times \frac{C_f}{C_i}$$

where: $\boldsymbol{D_f}$ = Desired tank mix delivery rate (ml/min), $\boldsymbol{D_i}$ = Actual (measured) tank mix delivery rate (ml/min), $\boldsymbol{C_f}$ = Desired final concentration of $KMnO_4$ applied to stream (ppm), $\boldsymbol{C_i}$ = Actual $KMnO_4$ concentration determined by colorimetry (ppm).

Adjustment or fine tuning based on this approach saves much time over adjustment by trial, error, and remeasurement.

LIMITATIONS OF COLORIMETRY - Some factors occur in the field which may interfere with the direct measurement of $KMnO_4$ solutions using light absorbance colorimetry. Rhodamine dye is commonly used during stream piscicidal treatments to mark treated areas or to estimate hydraulic travel rates. Since Rhodamine dye strongly absorbs in the 525 nm range, it will interfere with potassium permanganate determinations and its use should be avoided if colorimetry will be used. Use of NaCl to trace the travel rate of streams is compatible with light absorbance colorimetry. No other registered water dyes have been tested for compatibility with this method. Turbidity and light absorbing compounds such as humic acids will interfere with measurement accuracy. In clear streams, these factors can be handled by using a sample blank to zero the instrument or to correct the absorbance readings. Because the Pocket Colorimeter uses an exposed cuvette, direct sunlight appears to destabilize the instrument's readings. Fortunately, holding the instrument in the shade close to the user's torso conveniently overcomes this confounding factor. The DR/700 has an enclosed cuvette holder and does not experience this problem.

STUDY SITE - The foregoing methods were used in a rotenone-potassium permanganate treatment of Silver Creek and its minor tributaries (Mono County, California) on August 23, 1994. This was the first of two planned treatments prior to establishing a recovery population of Lahontan cutthroat trout.

Silver Creek is a tributary of the West Walker River, which in turn historically joined Walker River near its terminus in Walker Lake (Mineral County, Nevada). Most of the watershed geology is of plutonic origin. Waterways in the project area vary from 2,440 meters to 3,430 meters above sea level. Conductivity at the bottom of the treatment area was 68 μs, and water temperature varied from 5.5°C to 17°C. The pH was measured between 7.6 and 8.0. Alkalinity and hardness varied through the treatment area from 15 to 54 mg/L $CaCO_3$ and 18 to 54 mg/L $CaCO_3$, respectively. Stream

discharge at the detoxification site measured 2.5 cfs. The treatment area included ten minor tributaries, and required a maximum work force of 22 people. Rotenone was applied at the nominal rate of 1 ppm.

RESULTS AND DISCUSSION - Detoxification equipment was readied and tested prior to activation of the rotenone drip stations. Approximately 1 Kg solid NaCl was released into the stream at the lowermost drip station 30 minutes prior to its activation. Arrival of the salt plume in the afternoon was detected by a surge in conductivity to greater than 100 μs,signalling the approximate time to begin detoxification.

Locally obtained brook trout (*Salvelinus fontinalis*) were placed in a holding tank and used for rotenone bioassay. Wire cages with bioassay fish were placed at the fish barrier, above the detox station, and at 15 minute and 30 minute travel time marks downstream. Caged bioassay trout above the detox station expired approximately 15 minutes after showing signs of rotenone intoxication. During this period numerous trout were observed running downstream in an apparent avoidance response to the rotenone. Eighteen hours later several hundred dead brook trout and rainbow trout (*Oncorhynchus mykiss*) were collected from below the detox station. Most of these appeared to be young of the year rainbow trout. These fish were inferred to have died from rotenone rather than potassium permanganate toxicity, as many of the carcasses had drifted downstream well below the unharmed bioassay fish. Living trout were also observed less than 15 minutes travel time below the detox station on August 24. At no time did caged bioassay fish at the 15 and 30 minute stations exhibit disequilibrium or other signs of rotenone toxicity.

Chemical analysis of water samples found peak concentrations of 8.3 ppb rotenone and 23 ppb rotenolone at the detox station following the treatment. Efficacy of rotenone elimination was evaluated by analysis of 17 temporally spaced water samples from the 30 minute mark. No rotenone or rotenolone residues were detected (CDFG 1994b). Testing detected no other organic constituents of the rotenone formulation at the detox site, so the efficacy of their removal by $KMnO_4$ could not be evaluated.

Detoxification continued until noon on August 24, at which time bioassay fish placed above the detox station appeared unaffected for more than two hours. Approximately 18 Kg of potassium permanganate were required to complete the treatment.

One plastic Mariotte bottle inexplicably and repeatedly slowed and stopped delivering tank mix. The problem was identified when it became apparent that slight dorsoventral flattening of the barrel had pressed the intake tube tightly against the bottom side of the barrel. Bevelling the lower end of the intake tube at 45° with a hacksaw prevented further sealing and flow interruption.

Ancillary to the purpose of controlling $KMnO_4$ application rates, we were able to independently determine stream discharge using light absorbance colorimetry. With final concentration D known, equation (1) was rearranged to solve for Q. Discharge was initially determined to be 2.3 cfs using a Pygmy meter; the colorimetric method yielded 2.5 ± 0.17 cfs.

The methods described above reliably detoxified rotenone under the field conditions encountered. Forethought, planning, and redundant preparations are vital aspects of any application of fish toxicants, as exact conditions and equipment behavior are never 100% predictable.

LITERATURE CITED

ANONYMOUS. 1976. **The Merck Index**. Windholz, M. (Ed). Merck & Company, Rahway, N.J., U.S.A. 1313 pp.

BEHNKE, R.J. 1992. **Native Trout of Western North America**. American Fisheries Society Monograph 6. American Fisheries Society, Bethesda, MD. 275 pp.

CALIFORNIA DEPARTMENT OF FISH AND GAME (CDFG). 1989. **Proposed negative declaration for Mono County Lahontan cutthroat trout restoration project**. California Department of Fish and Game. 16 pp + 5 attachments.

-----. 1994a. **Rotenone use for fisheries management**. Programmatic Environmental Impact Report (SCH 92073015). Inland Fisheries Division and Environmental Services Division, Sacramento, California. 334 pp.

-----. 1994b. **Pesticide Investigations Unit, Results of surface water and sediment monitoring for residues of rotenone, rotenolone and other organic compounds in Silver Creek and the West Walker River, Mono County, California. Rancho Cordova, California**, October 6, 1994. 16 pp.

ENGSTROM-HEG, R. **Undated. Draft guidelines for protection of non-target fish in pond outlets during rotenone treatments**. New York State Department of Environmental Conservation, Bureau of Fisheries.

-----. 1971a. A lightweight Mariotte bottle for field, laboratory, and hatchery use. **Progressive Fish-Culturist** 33:227- 231.

-----. 1971b. Direct measurement of potassium permanganate demand and residual permanganate. **New York Fish and Game Journal** 18(2):117-122.

-----. 1972. Kinetics of rotenone-potassium permanganate reactions as applied to the protection of trout streams. **New York Fish and Game Journal** 19(1):48-58.

-----. 1976. Potassium permanganate demand of a stream bottom. **New York Fish and Game Journal** 23(2):155-158.

GERSTUNG, E.R. 1986. **Fishery management plan for Lahontan cutthroat trout (*Salmo clarki henshawi*) in California and western Nevada waters**. California Department of Fish and Game, Sacramento, California. 52 pp.

GRESSWELL, R.E. 1991. Use of antimycin for removal of brook trout from a tributary of Yellowstone Lake. **North American Journal of Fisheries Management** 11:83-90.

HACH COMPANY. 1991. **Manual for chlorine pocket colorimeter**. Hach Company. Ames, Iowa. 43 pp.

JACKSON, C. 1957. Detoxification of rotenone-treated water. **New Hampshire Fish and Game Department. Tech. Cir**. No. 14.

LAWRENCE, J.M. 1956. Use of potassium permanganate to counteract the effects of rotenone on fish. **Progressive Fish-Culturist** 18(1):15-21.

MAHON, R. and E.K. BALON. 1980. Quantitative collection of fishes from small fast flowing streams. **Arch. Hydrobiol**. 90(3):324-329.

MILLER, R.R., J.D. WILLIAMS, and J.E. WILLIAMS. 1989. Extinctions of North American fishes during the past century. **Fisheries** 14(6):22-38.

MOYLE, P.B. and J.E. WILLIAMS. 1990. Biodiversity loss in the temperate zone: decline of the native fish fauna of California. **Conservation Biology 4(3):275-284.**

PRICE, R.W. and J.B. HAUS. 1963. Aids for stream reclamation. **Progressive Fish-Culturist** 25(1):37-39.

RINNE J.N. and P.R. TURNER. 1991. Reclamation and alteration as management techniques, and a review of methodology in stream renovation. Pp. 219-244 In **Battle Against Extinction** (W.L. Minkley and J.E. Deacon, eds.). The University of Arizona Press, Tucson & London.

ROSENLUND, B.D. and D.R. STEVENS. In press. **Application of antimycin (Fintrol) to alpine lakes and streams in Rocky Mountain National Park and the headwaters of Leadville National Fish Hatchery to establish populations of greenback and Colorado River cutthroat trout**.

SCHOENECKER, W. and W. RHODES. 1965. Potassium permanganate dispenser. **Progressive Fish Culturist** 27(1):55-56.

STEFFERUD, J.A., D.L. PROBST, and G.L. BURTON, 1991. Use of antimycin to remove rainbow trout from White Creek, New Mexico. **Proceedings of the Desert Fishes Council** 23:55-66.

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Mapping water dependent resources in Death Valley National Monument with computer software and a Global Positioning System

Mapeo de recursos dependientes del agua en el Death Valley National Monument con un software de computadora y un Sistema de Posicionamiento Global

KEYWORDS: Global Positioning System (GPS); software; habitat mapping; animal mapping; long-term monitoring

ABSTRACT

Resource management staff in Death Valley National Monument, California, are using global positioning system (GPS) hardware and AutoCAD and Grass software to map wetland and riparian features. When the hardware and software systems are used in conjunction, significant strides can be made in understanding the extent and spatial relationships of various objects.

Computer software and a GPS are being used in Death Valley resource management work to 1) establish permanent, long-term study plots 2) develop detailed map themes which show the locations of animal distributions and habitat types 3) quantitatively analyze various polygons areas 4) georeference aerial photos, which can in turn be digitized 5) develop landscape drawings which can be used for resource management planning purposes.

Several products have been developed thus far, and include a map of the distribution of pupfish and snails at Cottonball Marsh; a vegetation map for the area around Saratoga Springs; a map of the seasonal extent of water at Salt Creek; and a map which shows the location of the pools and snails at Badwater Spring.

CLAVES: Sistema de Posicionamiento Global; software de computadora; mapeo de hábitats; mapeo de animales; monitoreo a largo plazo

RESUMEN

El personal de manejo de recursos en el Death Valley National Monument, California, esta usando un Sistema de Posicionamiento Global (GPS), hardware y los software AutoCAD y Grass para mapear características riparias y de humedales. Cuando el hardware y el software son usados juntos, se pueden realizar avances significativos el entendimiento de la extensión y las relaciones espaciales de varios objetos.

El software de computadora y el GPS están siendo usados en el manejo de los recursos del Death Valley National Monument para 1) el establecimiento permanente de parcelas de estudio de largo plazo 2) el desarrollo detallados de

mapas que muestran la distribución de animales y tipos de hábitats 3) el análisis cuantitativos de varios polígonos de áreas 4) georeferencias de fotos aéreas, las cuales pueden ser digitalizadas 5) desarrollo de dibujos del paisaje que pueden ser usados con propósito de planeación y manejo de recursos.
Varios productos han sido desarrollados, e incluyen un mapa de la distribución del pez perrito y caracoles en Cottonball Marsh; un mapa de vegetación para los alrededores de Saratoga Springs; un mapa de la extensión estacional de agua de Salt Creek; y un mapa que muestra la localización de las pozas y caracoles de Badwater Spring.

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The impact of the Bliss (Idaho) landslide of 1993 on sensitive mollusc habitat

El impacto del derrumbe de Bliss (Idaho) de 1993 en el hábitat de moluscos sensibles

KEYWORDS: molluscs; environmental impacts; landslides; Snake River

ABSTRACT

On July 24, 1993 a landslide occurred at Bliss, Idaho, in which 100 acres of an ancient Yahoo clay landslide moved, forming a shallow dam on the Snake River. Water level in the Snake was raised nearly 3 meters, forming a pool extending over 5 km upstream. This inundated rapids and numerous riffle or lotic habitat areas, many of which were know to sustain sensitive molluscs. The reason for the movement of the ancient landslide is not certain, but a sewage lagoon at its crest and seasonal irrigation runoff along its western margin may have played a role. Ironically, the landslide was a former proposed Idaho Power Company damsite. Despite the absence of the dam, planning for sustenance of endangered species habitats must also take into account other adjacent land uses. Middle Snake River habitat for the Bliss Rapids Snail (*Taylorconcha serpenticola*; Federally listed as Threatened), the Giant Columbia River Limpet (*Fisherola nuttalli*; C3 but endangered in the Middle Snake River), California floater (*Anodonta californiensis*; C1), Columbia River Spire Snail (*Fluminicola columbianus*; C1), Snake River Physa Snail (*Physa natricina*; Federally listed as Endangered) was reduced in the Lower Salmon Falls Dam tailwaters or Hagerman Reach. All of these taxa occurred at the site of the actual landslide, and thus are now buried beneath debris. Though unstable and still experiencing channel fluctuation, below the primary landslide plug there is a substantive lotic habitat extending for approximately 1 km. Although there is considerable erosion continuing along the point of river constriction, eventually this new lotic habitat may be colonized by taxa from upriver, however, this is not a certainty due to very small populations of these taxa upstream and the fact that many fastwater sites in the reach don't support the sensitive molluscs present at others nearby. It is unclear whether the landslide will continue to move into the river corridor and when areas of landslide debris could be colonized by sensitive taxa. This site was thelowermost in the reach and is situated just above the Bliss impoundment, whose upper end is now filled with landslide debris.

CLAVES: moluscos; impactos ambientales; derrumbes; Río Snake

RESUMEN

En Julio, 1993 ocurrió un derrumbe en Bliss, Idaho, en el cual 100 acres de un antiguo derrumbamiento de arcilla Yahoo se movieron, formando una presa somera en el Río Snake. El nivel del agua en el Río alcanzó casi 3 metros, formando un estanque que se extendió 5 Km corriente arriba. Esto inundó numerosos y veloces rápidos o áreas de hábitats lóticos, muchos de los cuales eran conocidos por sostener moluscos sensibles. La razón del movimiento del derrumbamiento antiguo no es claro, pero una laguna de aguas negras en su cresta y el desagüe de irrigación estacional a lo largo de su margen Oeste podría haber jugado un papel. Irónicamente, el derrumbamiento fue primariamente un sitio para un presa propuesta por la Idaho Power Company. A pesar de la ausencia de una presa, la planeación para el sostenimiento de hábitats de especies en peligro debe también tomar en cuenta otros usos de la tierra adyacente. El hábitat en la parte media del Río Snake para el caracol Bliss Rapids (*Taylorconcha serpenticola*; federalmente listada como amenazada), la lapa Columbia Gigante *Fisherola nuttalli*; C3 pero en peligro en la parte media del Río Snake), el flotador de California (*Anodonta californiensis*; C1), Caracol del Río Columbia spire (*Fluminicola columbianus*; C1), Physa caracol del Río Snake (*Physa natricina*; listada federalmente como en peligro) fue reducido en las orillas de la Presa Lower Salmon Falls o Hagerman Reach. Todos estos taxa ocurrían en el sitio del derrumbe actual, y por lo tanto están ahora enterradas bajo el mismo. Aunque inestable y aún experimentando fluctuación del canal, existe bajo el derrumbamiento primario un sustantivo hábitat lótico que se extiende por aproximadamente 1 Km. Aunque existe una considerable erosión llevándose a cabo a lo largo del punto de constricción del río, eventualmente este nuevo hábitat lótico podría ser colonizado por taxa de río arriba, sin embargo, esto no ocurre debido ciertamente a poblaciones muy pequeñas de estos taxa corriente arriba y al hecho de que muchos sitios de aguas rápidas en el brazo del río no sostienen a los moluscos sensibles presentes en otros sitios cercanos. No es claro si el derrumbamiento continuará moviéndose dentro del corredor del río y cuando las áreas del

remanente del derrumbe podrían ser colonizadas por taxa sensitivos. Este sitio fue el más bajo en el brazo del río y está situado justo arriba del reservorio Bliss, cuya orilla superior está ahora llena con restos del derrumbe.

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Development of the Owens Basin Multi-Species Recovery Plan

Desarrollo del Plan de Recuperación Multiespecífico de la Cuenca Owens

KEYWORDS: Owens basin; U.S. Fish and Wildlife Service; endangered and threatened species; recovery plans; Owens tui chub; Owens pupfish

ABSTRACT

The existing recovery plans for the two listed fish species in the Owens Basin, the Owens pupfish (*Cyprinodon radiosus*) and the Owens tui chub (*Gila bicolor snyderi*), are single species oriented recovery documents. They focus narrowly on bolstering the number of individuals in isolated populations of these endangered fish. There is consensus among regulatory and land management agencies in the Owens Basin that the existing recovery plans as written promote an "aquarium approach" to species conservation, and cannot achieve true recovery. A new strategy is needed.

Development of a multi-species recovery plan is underway. This new plan will include the two listed endangered fish and will supersede the existing plans. The new multi-species recovery plan will also include recommendations for recovery of several candidate species, including the Fish Slough milk-vetch (*Astragalus lentiginosus* var. *piscinensis*), which has recently been proposed for endangered status. The recovery plan will emphasize an ecosystem- based approach to restoration of Owens Basin wetland and aquatic habitats.

The multi-species recovery plan is being funded by the U.S. Fish and Wildlife Service, California Department of Fish and Game, and Bureau of Land Management. We have assembled a task force made up of agencies and interested parties to assist in the process, including the U.S. Forest Service, Los Angeles Department of Water and Power, Inyo County, Desert Fishes Council, and others. We have recently issued a contract to a team of consultants to develop the multi-species recovery plan. The consultant team will work closely with the task force to prepare a plan that will redirect endangered species recovery efforts in the Owens Basin. The draft plan is due in early 1995.

CLAVES: cuenca Owens; U.S. Fish and Wildlife Service; especies en peligro y amenazadas; planes de recuperación; charalito tui del Owens; pez perrito del Owens

RESUMEN

Los planes de recuperación existentes para las dos especies de peces enlistados en la cuenca Owens, el pez perrito del Owens (*Cyprinodon radiosus*) y el charalito tui del Owens (*Gila bicolor snyderi*, son documentos de recuperación orientados en solo estas especies. Estos planes se enfocan estrechamente a reforzar el número de individuos en poblaciones aisladas de estos peces en peligro. Hay consenso entre las agencias regulatorias y de manejo de tierras en la cuenca Owens de que la existencia de este tipo de planes promueve "algo parecido a un acuario", para la conservación de especies, y no puede representar una recuperación verdadera. Es necesaria una nueva estrategia.

El desarrollo de planes de recuperación multiespecíficos, es el camino. Este nuevo plan incluirá las dos especies enlistadas y suplantará los planes existentes. El nuevo plan de recuperación multiespecífico también incluirá recomendaciones para varias especies candidatos, incluyendo el Fish Slough milk-vetch (*Astragalus lentiginosus]) var. (piscinensis*), los cuales recientemente han sido propuestos como especies en peligro. El plan de recuperación enfatizará una aproximación basada en el ecosistema para la restauración de los humedales de la Cuenca Owens y hábitats acuáticos.

El plan de recuperación de multiespecíficos está siendo financiado por el U.S. Fish and Wildlife Service, California Department of Fish and Game, y las Agencias y partes interesadas en el proceso, incluyendo el U.S. Forest Service, Los Angeles Department of Water and Power, Inyo County, Desert Fishes Council, y otros. Recientemente hemos suscrito un contrato con un equipo de consultores para desarrollar el plan de recuperación multiespecífico. El equipo de consultores trabajará estrechamente con la fuerza operante para preparar un plan que reorientará los esfuerzos de recuperación de especies en la cuenca Owens. Un borrador del plan se tendrá a principios de 1995.

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Desert fishes down under

Los peces del desierto de Australia

KEYWORDS: Australia; fish distribution; habitat; threats; management; springs

ABSTRACT

Australia contains vast areas of desert relative to North America although much of it contains little permanent water and remains ichthyologically unexplored. Thirty three native and eight introduced species have been recorded. I begin with a history of ichthyological exploration in central Australia. Then I provide a brief summary of Central Australian fish habitats and an annotated list of native and introduced species. Finally, I review the threats to central Australian fishes

CLAVES: Australia; distribución de peces; hábitat; amenazas; manejo; manantiales

RESUMEN

Australia contiene extensas áreas de desierto en relación a América del Norte, muchas de las cuales contienen poca agua permanente y que permanecen ictiológicamente inexploradas. Están registradas 33 especies nativas y ocho introducidas. Empiezo con la historia de exploraciones ictiológicas el Australia Central. Entonces doy un sumario breve de los habitats de peces en al zona, con una lista anotoda de especies, y termino con un repaso sobre las amenazas a peces Australianos.

CONTRIBUTED PAPER

INTRODUCTION - Australia has been isolated from the rest of the world for 50 million years, providing the flora and fauna a chance to evolve in unique ways, and develop a high degree of endemism. Unlike North America, Australia has been tectonically very stable for a considerable period of time; no major mountain building has occurred for tens of millions of years. Parts of the Finke River are thought to have followed the same course for at least 65 million years (my) and possibly up to 350 my (Cook 1968 cited in Pickup et. al. 1988). Significant streamflow in parts of central Australia ceased around 15 my ago (Van De Graaff et. al. 1977), marking the time that aridity first began in central Australia.

Today, 70% of Australia is semi-arid to arid desert (Fig. 1). In central Australia, average daily summer temperatures are typically 37-39°C (100°F). Occasionally, they may climb into the low 50's. Average daily winter temperatures range from 16 to 24°C. Night time temperatures in winter rarely drop below -2 or 3°C. In central Australia, annual evaporation varies between 2400 and 4400 mm. Average annual rainfall ranges from 110 mm around Lake Eyre to 300-450 mm on the margins. Rainfall is very sporadic. Droughts are the normal situation in central Australia. However, localized falls can be extremely heavy, for instance, 300 mm in an overnight storm at Merty Merty homestead, (near Innamincka) (Bonython 1989).

Not surprisingly, the desert region of Australia supports a limited, highly localized fish fauna. Only 11 families are represented by 33 native species, and two subspecies. The fish show a high degree of endemism and extraordinary adaptations for desert existence. In this paper, I provide an historical perspective on the ichthyological exploration of central Australia. Then I provide a brief summary of central Australian fish habitats and an annotated list of the fish species, both native and exotic. It concludes with an overview of the threats to central Australian fish.

PAST AND PRESENT ICHTHYOLOGICAL WORK - Prior to 1894, only three species had been recorded from central Australia. The Horn Expedition (Spencer 1896) was the first to investigate central Australian fishes. It made a number of important observations including the lack of evidence for aestivation by desert fish and the importance of flooding for dispersal. Several new species were described and new records made of others. This expedition raised the number of species in central Australia to 10, representing 7 families.

In the years between 1894 and 1971, sporadic collecting raised the total number of native fish recorded to 26 species from 9 families and 3 exotics from two families (Glover & Sim 1978a; 1978b). Detailed work on central Australian fishes really only began when John Glover, the Curator of Ichthyology at the South Australian Museum (SAM), undertook studies from 1967 until his death in 1992. He conducted many expeditions throughout central Australia, publishing several new records and discoveries, including the fishes from Dalhousie Springs. In the last checklist of central Australian fishes, Glover (1982) recorded 26 native species from 10 families and 4 exotic taxa from 3 families. The total numbers still recognized today is 22 native and two exotic species respectively.

Several other workers have made, or are continuing to make contributions to central Australian ichthyology. Hamar Midgley has irregularly sampled the larger Queensland Rivers and the Barkley Drainage

since the late 1960's. Helen Larson, the Curator of Ichthyology at the Nothern Territory Museum (NTM), has sampled many of the drainages in the Northern Territory, adding several new records. Since 1986, Jim Puckridge from Adelaide University has been conducting a study of the fish community dynamics in relation to the hydrological regime at Coongie Lakes. Work has also been conducted since 1988 in the South Australian portion by Bryan Pierce from the South Australian Research and Development Institute. This includes further genetic analysis of fish populations (independent of, though incorporating and expanding upon some of Glover's electrophoretic work), as well as the dynamics of fish populations, habitat assessment, management research and other ecological work. My own investigations started in 1985, and I have since sampled most drainages and habitats in the Lake Eyre drainage. Presently I am involved with work on South Australian springs with B. Pierce. Mark Adams from the SAM Evolutionary Biology Unit, and Terry Sim from the SAM Ichthyology Department, are continuing electrophoretic studies on central Australian fishes initiated by John Glover. Rob Wager from the Queensland Department of Primary Industries-Fisheries, is presently involved in endangered species research at Edgbaston and Elizabeth Springs, as well as some broader survey work in Queensland. The only taxonomists to recently deal with fishes of the region were Lucy Crowley and Walter Ivantsoff from Macquarie University. Their atherinid studies have recognized several new species from central Australia.

HABITATS - Lakes - Lakes in central Australia provide a very minor and irregular habitat for fish. Despite the great size of some lakes, most rarely contain water. Two exceptions to this are Woods Lake in the Wiso system and the Coongie Lakes in the Cooper Creek system; both are a series of interconnected, shallow lakes that rarely dry out (Reid and Puckridge 1990). Little data exist for Woods Lake, but the Coongie Lakes are rarely over 2m deep (Reid and Puckridge 1990) (Plate 1). When full, lakes such as Lake Eyre and Frome contain massive, although short lived fish populations that die off as salinity levels rise following evaporation (Ruello 1976).

Lake Eyre is the eighteenth largest lake in the world (Kreig 1989). It has a total area of 9,000 km^2, but is thought to have been three times larger and permanent around 50,000 years ago (Dulhunty 1982). During the record 1974 floods, the lake peaked at an estimated 32.5 million megalitres or 26 million acre feet. After some minor inflows in the intervening years, it was virtually dry again by 1979-80 (Bye & Will 1989). While rarely completely dry, it probably doesn't contain resident fish populations.

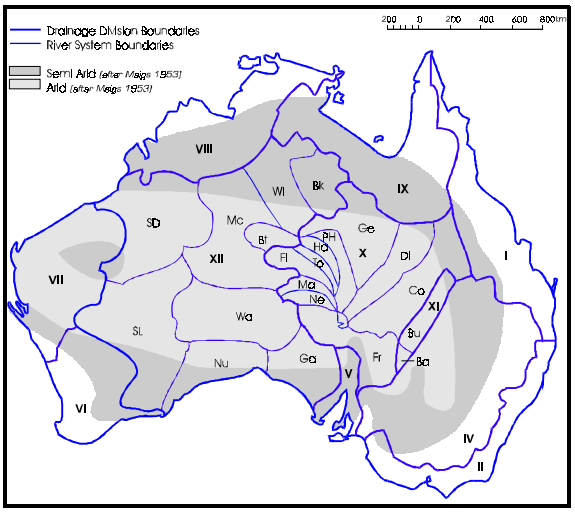

Figure 1. Australian Drainage Divisions (I=NE Coast; II=SE Coast; III=Tasmanian; IV=Murray-Darling; V=S Australian Gulf; VI=SW Coast; VII=Indian Ocean; VIII=Timor Sea; IX=Gulf of Carpentaria; X=Lake Eyre; XI=Bulloo-Bancannia; XII=Western Plateau) and Central Australian river systems: **Ba**-Bancannia; **Bk**-Barkley; **Bt**-Burt; **Bu**-Bulloo; **Co**-Cooper; **Di**-Diamantina; **Fi**-Finke; **Fr**-Frome; **Ga**-Gairdner; **Ge**-Georgina; **Ha**-Hale; **Ma**-Macumba; **Mc**-MacKay; **Ne**-Neales; **Nu**-Nullabour; **PH**-Plenty/Hale; **SD**-Sandy Desert; **SL**-Salt Lake; **To**-Todd; **Wa**-Warburton; **Wi**-Wiso.

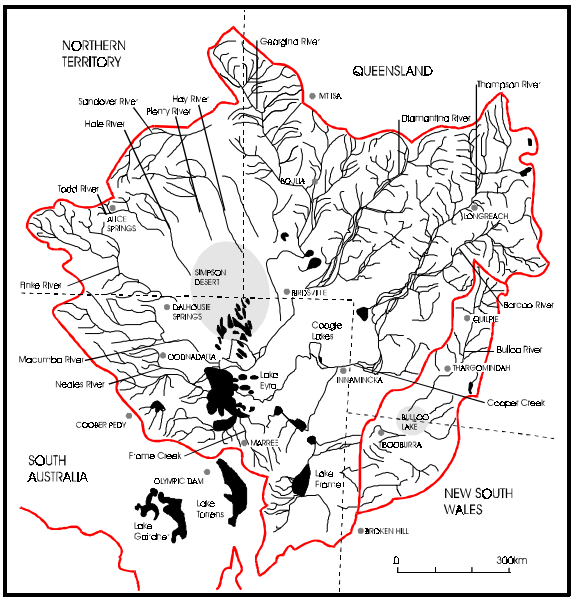

Figure 2. Lake Eyre and Bulloo-Bancannia drainage basins (modified from Allan 1989).

Rivers - Rivers in central Australia are unusual in that they all rise and end in the arid zone. In most of the world, desert rivers enter deserts from humid areas. There is no permanent flowing water in any waterways except springs and streams flow only after rainfall events. Central Australia does not have a wet and a dry season, however, large storms tend to be more common in summer when the occasional remnants of tropical cyclones drift over central Australia. Australian rivers are up to 1000 times more variable in mean annual discharge than most European and North American rivers (Gale & Bainbridge 1990). In small catchments streamflows are relatively short; perhaps a few hours to a few days. At any one site on a larger river, flow typically lasts for a few days to a few weeks, and flows lasting greater than one month are rare. Streamflow tends to travel slowly along the length of the river. Cooper Creek for example is reported to have gradients as low as 3cm/km. Thus, it may take one or two months for water to travel from upper to lower reaches. When in flood, rivers such as Cooper Creek may spread as wide as 50 km (Plate 2). Most rivers contain very little permanent water, other than a few permanent waterholes, most water disappears after a year or two with no flow (Plates 3, 4). What little available physiochemical data demonstrate that most waterbodies have very broad temperature and salinity ranges (Glover 1982). Doddridge (1992), working in lower Cooper Creek, recorded an annual temperature range of 13 to 34°C. Turbidity, caused by fine clay particles, is typically exceptionally high.

Australia is divided up into twelve major drainage divisions, with 3 in central Australia (Figure 1). The Bulloo-Bancannia Drainage Division covers approximately 100,570 km^2. It consists of the Bulloo River system which terminates in Bulloo Lake, a series of large ephemeral swamps on the Queensland-New South Wales border (Fig. 2). The Bancannia system consists of a series of small, isolated creeks and lakes, which along with the Bulloo River, remain poorly sampled, with most fish known only from a few specimens. Curiously, the Bulloo River's fish populations are far less abundant than expected compared to other central Australian rivers. This may be due to much higher turbidity levels relative to other central Australian rivers. Previous authors have incorrectly considered that the Bulloo River is, or was, part of the Murray-Darling Drainage Division (Lake 1971; Llewellyn & Pollard 1980). The present topography indicates that the most likely place for historical drainage was towards Lake Frome, and the fish fauna of the Bulloo River most closely resembles that of Cooper Creek, which had past connections to Lake Frome.

The Lake Eyre Drainage Division covers approximately 1,300,000 km^2, only 30% of which exceeds 250 m above sea level. Lake Eyre, at 15.2 m below sea level (Kotwicki 1989) is the terminus for all the drainage (Fig. 2).

Despite the relatively long and large size of the rivers, permanent water is quite limited in the Lake Eyre Division. The Neales River, for example, is reported to have two permanent waterholes. The Macumba (Plate 5), Finke (Plate 6), Todd, Hale Rivers and all of the Frome System have no permanent waterholes, while the

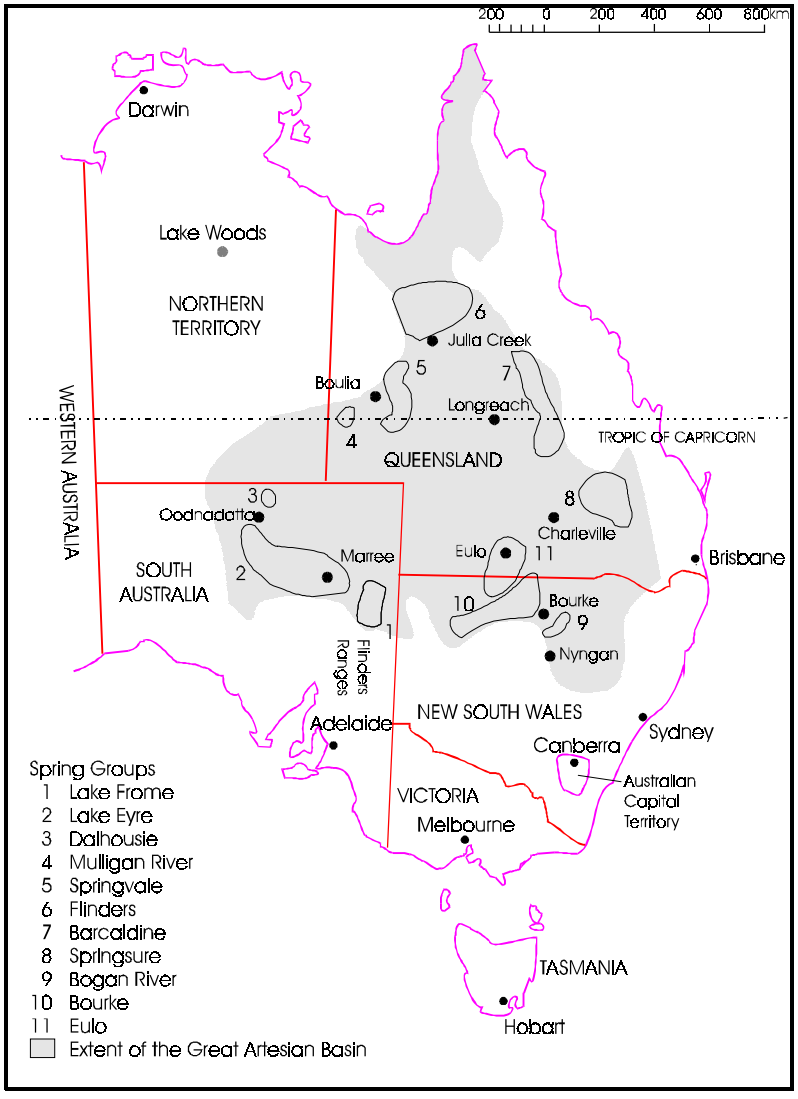

Figure 3. Spring Supergroups associated with the Great Artesia Basin (redrawn from Habermehl (1982) and Ponder (1986).

Plenty and Hay Rivers have only a couple of tiny springfed pools. The Georgina River has only one waterhole which has not dried since European settlement, although there are many which usually have water (Randal 1978). The Diamantina River has quite a few permanent waterholes, while Cooper Creek, in the least arid area, has the most waterholes, and not surprisingly the highest fish diversity.

Despite the appearance on a map that most of the larger rivers connect to Lake Eyre, the lake appears to act as a physical barrier to migration by some fish species. Most of the rivers that contribute water to the lake each have distinctive fish faunas (see Table 1). Several species are endemic to Cooper Creek, while the Diamantina River has no endemic species, though both rivers occasionally flow into Lake Eyre at the same time. There are no obvious reasons why the Cooper Creek endemics couldn't survive in the Diamantina River today. Although data are lacking on what lives in the lake, most species can access the lake during floods, and the lake habitat is not that different from their usual habitat. Nobody really knows why the endemics don't cross between the rivers.

The Western Plateau Drainage Division is around 2,455,000 km^2 and is mostly between 450 and 600 m above sea level. Primarily because most of it is inaccessible due to a lack of roads, its fish are very poorly known, especially in Western Australia. It consists of a series of fragmented drainages (Van De Graaff et. al. 1977); no major rivers exist and permanent water is apparently scarce. Despite lack of collecting, spangled perch (*Leiopotherapon unicolor*) have been recorded from all but three rive systems.

SPRINGS - All of the larger, and most permanent springs in central Australia are associated with the Great Artesian Basin (GAB) (Fig. 3). It is one of the largest artesian or groundwater basins in the world and covers 1.76 million km^2 or 22% of Australia (Ponder 1986). Eleven "supergroups" of springs are recognized (Habermehl 1982, Ponder 1986). Habermehl (1982) estimates there are approximately six hundred "springs"; however one "spring" may represent anywhere from two to 400 individual spring outlets (Ponder 1986). Most Australian springs are relatively small with a discharge of <1 l/s. Only 11 have discharges of 5 - 138 l/s, and all of these are located at Dalhousie Springs (Smith 1989). Many springs have a distinctive mound, and are thus often referred to as mound springs, although the size and composition of mounds vary greatly. Springs which do not form mounds are often referred to as artesian springs. Water from most of the springs is sufficiently low in dissolved solids to be suitable for stock and/or human consumption. Harris (1981) provides a short summary of the Aboriginal and European history of the springs. Relatively few springs harbor fishes, and only those known to contain endemic fishes are discussed here. A number are known to contain endemic invertebrates, although, with the exception of some groups, i.e. hydrobiid snails (Ponder & Clarke 1990), amphipods, ostracods, and isopods, most invertevrates are poorly studied. Many of the springs remain uncollected, however, most are relatively small and/or degraded. Despite this, chances of new discoveries are high.

Dalhousie Springs (Plate 7) are thought to have formed one to two million years ago (Kreig 1989). Within the Dalhousie springs complex there are 100 individual spring outlets, of which approximately 80 are still active and account for 41% of the natural spring discharge from the GAB (Habermehl 1982). These occur over an area of about 70 km^2 (Zeidler & Ponder 1989a). Dalhousie Springs are the only major group which produces warm water outflows; many springs have temperatures between 30 and 46 °C. These springs have by far the most significant spring fauna in Australia with 6 fish species, 4 of them endemic, at least six endemic hydrobiid snails, and several small crustaceans, including a blind amphipod (Zeidler 1991). In addition, a crayfish and a frog are also possibly endemic (Zeidler and Ponder 1989b). Due to its isolation there are currently no introduced aquatic animals in any of the springs and there has been very little modification to the springs except for the introduction of date palms (*Phoenix dactylifera*). In 1985, the property containing Dalhousie Springs was purchased by the South Australian Government to form Witjira National Park (Harris 1989), making Dalhousie Springs the first complete spring group in Australia to be protected.

The Lake Eyre supergroup (Plates 8-10) is the largest spring complex in terms of the number of individual springs. These occur in a band approximately 400 km long by 20 km wide around Lake Eyre (Ponder et. al. 1989). Although around 100 "spring groups" have been named (Casperton 1979), there are perhaps several thousand individual outlets, most of which are very small. The average age of water emerging from springs in the Southwest is one million years (Bentley et. al. 1986). Desert goby (*Chlamydogobius eremius*) has been recorded in thirty springs. Lake Eyre hardyheads (*Craterocephalus eyresii*) and spangled perch are occasionally recorded, and one exotic, "dambusia" (*Gambusia holbrooki*) is found in a few springs. Endemic invertebrates include ten species of hydrobiid snails from two genera (Ponder et. al. 1989), several ostracods (DeDeckker 1979), amphipods, an isopod (Nicholls 1943), and a Platyhelminth (Sluys 1986). Few other groups have been studied.

Edgbaston Springs (Plate 11) are a part of the Springsure supergroup. At least 44 springs have been identified at Edgbaston Springs (Wager 1994), some of which have naturally gone extinct. Most are very small, shallow, marshy, and none form mounds. Four native fishes have been recorded, redfinned blue eye (*Scaturiginichthys vermeilipinnis*), Edgbaston goby

(*Chlamydogobius sp. C*), Myross hardyhead (*Craterocephalus sp.*), (all endemic) and spangled perch (recorded once). Dambusia are also present in many springs. These springs contain the smallest natural habitat of any fish in Australia; the area inhabited by the redfinned blue eye is approximately 6-8,000 m^2 . Edgbaston Springs also contains some of the harshest freshwater environmental conditions; temperatures may vary diurnally by up to at least 21°C (Wager & Unmack in prep.). Despite their small size, Edgbaston Springs contains a very significant fauna which rivals that of Dalhousie Springs. It includes 7 congeneric snails, with up to 6 sympatric in some springs (Ponder & Clarke 1990). There are also undescribed ostracods, amphipods and other invertebrates (Ponder 1986).

Elizabeth Springs (Plate 12) are a part of the Springvale supergroup, which had several active springs prior to water extraction. Today, only Elizabeth Springs, which was once probably the second or third largest spring in the GAB, remains active, flowing at <5% of its original rate. It discharges through approximately 30 individual spring outlets spread over an area of 0.6 km^2. One fish, the Elizabeth Springs goby (*Chlamydogobius sp. A*), and one hydrobiid snail are known endemics (Unmack & Wager in prep. b).

FISH - General Remarks - There appear to be two reasons fishes have been able to persist in central Australia despite the lack of permanent water. First, it is generally rare for all waterholes in a particular system to be dry at the same time, and second, the permanency of some waterholes is affected by floods. Most species are very effective at migration. Within each river system, fish distribution is fairly uniform; most waterholes will typically contain 80-100% of the total fauna. During floods virtually every water body above the point where flow ceases are connected, albeit perhaps briefly, but the very low gradient allows flood water to persist for longer periods.

Most central Australian fishes have very broad environmental tolerances. All can tolerate temperatures between 15 and 35°C, and most would tolerate 7 to 37°C; a few, such as desert goby and spangled perch (*Leiopotherapon unicolor*) (Merrick & Schmida 1984), can tolerate lows of 4 and highs of 42°C for short periods. Virtually every Australian fish examined can tolerate direct transfer into 50% sea water. However, few can tolerate 100% sea water. Most can generally survive in relatively low oxygen concentrations, although specific data are lacking. The recruitment of most species is linked to flooding. Several species can spawn independently of flooding, but significant juvenile recruitment occurs only after floods. Most species generally spawn at temperatures above 20 to 26°C. Most of the smaller species, especially hardyheads, rainbows, smelts, and glassperches, tend to lay relatively few (20-60) eggs daily during the warmer months. Larger species, such as catfish, grunters, and perches tend to spawn large numbers of small eggs during floods. All of the gobies and gudgeons tend to attach eggs onto hard surfaces. The male guards the eggs until hatching, after which no further parental care occurs.

SPECIES ACCOUNTS - Central Australian fishes and data on their distribution are presented in Table 1. Brief accounts of each species biology, ecology and life history follow. Most ecological information given is based on populations outside of central Australia as most central Australian populations have not been studied.

Clupeidae - herrings - Bony bream or gizzard shad *Nematalosa erebi* (Gunther 1868) - Bony bream are very similar ecologically to the North American genus *Dorosoma* (J. Puckridge, pers. comm.). It is the second most widespread fish in Australia, and is abundant in central Australia. In the Murray River, individuals grow to 470 mm and spawn in early summer independent of flooding. They are highly fecund, with 199 - 403 mm TL females producing 33,000 - 880,000 eggs (Puckridge & Walker 1990). In Cooper Creek, bony bream have a much broader spawning period, and they don't grow as large (J. Puckridge pers. comm.). Annual kills of bony bream, common during winter, have been attributed to several causes, including achlya (Puckridge et. al. 1989) or parasitic infections (Langdon et. al. 1985), and low water temperatures.

Retropinnidae - smelts - Australian smelt *Retropinna semoni* (Weber 1895) - The Australian smelt is widespread in Southern Australia, but within central Australia it is restricted to Cooper Creek, where it is abundant. Maximum size is 100 mm TL. Spawning can begin in mid-winter and may extend into early summer in Cooper Creek (J. Puckridge pers. comm.). Fecundity is probably low (Merrick & Schmida 1984).

Plotosidae - eeltailed catfish - Hyrtl's catfish *Neosilurus hyrtlii* Steindachner 1867 - Hyrtl's catfish is the third most widespread fish in Australia and is usually abundant in central Australia, where it grows to 350 mm TL. Spawning has been observed during floods, and fecundity ranges from 1,600 to 15,300 eggs for females from 186 - 267 mm TL (Orr & Milward 1984).

Dalhousie catfish *Neosilurus sp.* - The Dalhousie catfish is restricted to fourteen springs at Dalhousie Springs (Kodric-Brown & Brown 1993) where it is generally abundant. It is listed as Threatened by the Australian Society for Fish Biology (ASFB) (Jackson 1992). Maximum size is 120mm (Glover 1989), although specimens will grow to 180mm in captivity.

TABLE 1. DISTRIBUTION RECORDS FOR CENTRAL AUSTRALIAN FISHES

	BBDB		------LAKE EYRE DRAINAGE BASIN -----											WESTERN PLATEAU DRAINAGE									HAB.		
NATIVE SPECIES	**Bu**	**Ba**	**Co**	**Di**	**Ge**	**LE**	**Fr**	**Ne**	**Ma**	**DS**	**Fi**	**To**	**PH**	**Bk**	**Wi**	**Bt**	**Mc**	**SD**	**SL**	**Wa**	**Nu**	**Ga**	**Ri**	**Sp**	**CS**
bony bream	X	-	X	X	X	X	X	X	X	-	X	-	-	X	X	-	-	-	-	-	-	-	X	-	-
Australian smelt	-	-	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Hyrtl's catfish	X	-	X	X	X	-	-	X	-	-	X	-	-	X	X	-	-	-	-	-	-	-	X	-	-
Dalhousie catfish	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	V
false-spined catfish	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	U
Cooper Creek catfish	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
silver tandan	X	-	X	X	X	-	-	-	X	-	-	-	-	X	X	-	-	-	-	-	-	-	X	-	-
Finke hardyhead	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	R
Dalhousie hardyhead	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	V
Lake Eyre hardyhead	-	-	X	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Glover's hardyhead	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	V
Myross hardyhead	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	E
desert rainbowfish	X	-	X	X	X	-	-	X	X	-	X	-	-	X	X	-	-	-	-	-	-	-	X	-	-
red-finned blue eye	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	E
western chanda perch	-	-	X	X	X	-	-	-	-	-	X	-	-	X	X	-	-	-	-	-	-	-	X	-	-
Lake Eyre golden perch	-	-	X	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Bulloo River golden perch	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
banded grunter	-	-	-	-	X	-	-	X	-	-	X	-	-	X	-	-	-	-	-	-	-	-	X	-	-
Welch's grunter	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
spangled perch	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-	-	-	X	X	-
Barcoo grunter	X	-	X	X	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-
Western carp gudgeon	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Midgley's carp gugeon	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Lake's carp gudgeon	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Finke mogurnda	-	-	-	-	-	-	-	-		X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-

(Continued)

TABLE 1. DISTRIBUTION RECORDS FOR CENTRAL AUSTRALIAN FISHES (CONTINUED)

	BBDB		------LAKE EYRE DRAINAGE BASIN -----											WESTERN PLATEAU DRAINAGE									HAB.		
NATIVE SPECIES	**Bu**	**Ba**	**Co**	**Di**	**Ge**	**LE**	**Fr**	**Ne**	**Ma**	**DS**	**Fi**	**To**	**PH**	**Bk**	**Wi**	**Bt**	**Mc**	**SD**	**SL**	**Wa**	**Nu**	**Ga**	**Ri**	**Sp**	**CS**
Flinders Ranges mogurnda	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	V
Bulloo mogurnda	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	Ex
Frew mogurnda	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-
desert goby	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-
Elizabeth Springs goby	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	E
Dalhousie goby	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	R
Edgbaston goby	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	E
Finke goby	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-
flathead goby	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Total	12	-	19	11	11	5	5	7	4	6	9	1	1	9	6	1	1	1	1	-	-	-	26	12	12
TRANSLOCATED NATIVES																									
silver perch	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Murray-Darling golden perch	-	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	X	-	-
Murray cod	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
INTRODUCED EXOTICS																									
dambusia	X	-	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	-
goldfish	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-
carp	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-

BBDB=Bulloo-Bancannia Drainage
Bu=Bulloo River system
Ba=Bancannia system

Lake Eyre Drainage
Co=Cooper Creek system
Di=Diamantina River system
Ge=Georgina River system
LE=Lake Eyre
Fr=Frome River system
Ne=Neales River system
Ma=Macumba River system
DS=Dalhousie Springs
Fi=Finke River system
To=Todd River system
Ha=Hale River system
PH=Plenty/Hale River system

Western Plateau Drainage
Bk=Barkley system
Wi=Wiso system
Bt=Burt system
Mc=MacKay system
SD=Sandy Desert system
SL=Salt Lake system
Wa=Warburton system
Nu=Nullabour system
Ga=Gairdner system

Habitat
Ri=Rivers, lakes, anything but a spring
Sp=Springs

CS=Conservation Status (Jackson 1992)
Ex=Extinct (not in Jackson 1992)
E=Endangered
V=Vulnerable
PT=Potentially Threatened
R=Restricted
U=Uncertain Status

Fecundity ranges from 136 to 1,197 eggs for 72 - 120mm TL females. It is not known if spawning is seasonal or occurs all year round (Glover 1989). This species occurs voluntarily in water up to 40°C (Unmack pers. obs. 1994). Glover & Sim (1978a) originally proposed that this species and Dalhousie hardyheads were both limited to thermal waters because they appeared to have low tolerance to temperatures below 20°C. However, this appears inaccurate, as once acclimated, Dalhousie catfish will feed, and show no sign of distress, at 16°C (Unmack unpub. data).

False-spined catfish *Neosilurus sp.* - This rare species is known only from two specimens from central Australia that were collected in 1974 from the Bulloo River. Virtually nothing known of this species except that it grows to at least 300 mm TL (Allen 1989).

Cooper Creek catfish undescribed genus and species (Plate 13) - The Cooper Creek catfish is an undescribed species and genus which is very poorly known. It is confined to Cooper Creek where it is widespread and usually common, though not abundant. It appears to be a distinct lineage of Plotosidae. Maximum size is at least 600 mm. It has the largest egg size and lowest fecundity per unit length of any fish in central Australia, or any other Australian freshwater plotosid. A 450 mm female contains approximately 1,000 eggs (Unmack in press).

Silver tandan *Porochilus argenteus* (Zeitz 1896b) - Silver tandans are found in most of the larger rivers where they can be very abundant at times. They probably spawn during flooding, undertake substantial migrations, and grow to 300 mm TL.

Atherinidae - hardyheads or silversides - Finke hardyhead *Craterocephalus centralis* Crowley & Ivantsoff 1990b - The Finke hardyhead is a recently described species. It is generally widespread and abundant, though restricted to the Finke River, where it grows to 64 mm TL. It is listed as Restricted by ASFB (Jackson 1992). Like most craterocephalids they probably spawn during the warmer months, laying a few eggs daily.

Dalhousie hardyhead *Craterocephalus dalhousiensis* Ivantsoff & Glover 1974 (Plate 14) - This species is restricted to approximately 7 springs at Dalhousie Springs (Kodric-Brown & Brown 1993). It is listed as Vulnerable by the ASFB (Jackson 1992). Growing to 78 mm TL, this is the only member of the genus known to be morphologically sexually dimorphic (Ivantsoff & Glover 1974). In aquaria, this species lays a few eggs a day when temperatures are maintained over 24°C. It is not known whether they reproduce throughout the year or seasonally under natural conditions. Dalhousie hardyheads have the highest recorded voluntary temperature tolerance of any Australian fish; they will live in 40°C and make very brief excursions into water of 41.8°C (Glover 1989).

Lake Eyre hardyhead *Craterocephalus eyresii* (Steindachner 1884) - Three isolated populations of Lake Eyre hardyheads exist, Lake Eyre, Northern Flinders Ranges and Lake Torrens/Willochra Creek (which is not a central Australian drainage). Their abundance and distribution fluctuates widely. They may occasionally be found in the lower reaches of most rivers draining into Lake Eyre, e.g. Cooper Creek and Diamantina River, however, these are probably ephemeral populations. In fact, throughout most of their range there is no permanent water, and they appear to persist by leap-frogging between semi-permanent waterholes. Despite having the highest and widest salinity tolerance of any Australian fish, 0-110 ppt (Glover & Sim 1878a), it was estimated (Ruello 1976) that at least twenty million of them died in Lake Eyre in 1975 when salinity levels rose with dropping water levels. They can grow to 100 mm TL. Most previously published information on this species was obtained from, and is now largely applicable, only to Murray hardyhead (*Craterocephalus fluviatilis*), which were considered synonymous with Lake Eyre hardyheads until Crowley and Ivantsoff (1990b) separated them.

Glover's hardyhead *Craterocephalus gloveri* Crowley & Ivantsoff 1990a - Glover's hardyhead is known from only three springs at Dalhousie Springs. It is listed as Vulnerable by the ASFB (Jackson 1992). Morphologically they are very similar to Dalhousie hardyhead, making them difficult to distinguish. This species tends to inhabit slightly cooler springs than Dalhousie hardyhead, but the two appear to be sympatric in one spring. This species attains 50 mm TL, and in aquaria, it lays a few eggs a day and appears to spawn at slightly lower temperatures than Dalhousie hardyhead (Unmack unpub. data). It is not known whether they reproduce year round or seasonally in the wild.

Myross hardyhead *Craterocephalus sp.* - This species was only discovered during mid-1994. It's restricted to one spring-fed pool in the Edgbaston Spring complex, and will probably be considered endangered. Ecological work, and a description are being prepared by Wager and Brooks.

Melanotaeniidae - rainbowfishes - Desert rainbowfish *Melanotaenia splendida tatei* (Zietz 1896a) - The desert rainbowfish is widespread and abundant in all the larger rivers, where they grow to 80 mm TL. In aquaria, *M. splendida* (all subspecies) generally lay 50-100 eggs daily whenever temperatures are adequate (generally > 20-24°C). Life history data are available only on other subspecies from outside central Australia.

Pseudomugilidae blue eyes - Redfinned blue eye *Scaturiginichthys vermeilipinnis* Ivantsoff, Unmack, Saeed & Crowley 1991 - The redfinned blue eye, discovered in 1989, is listed as Endangered by the ASFB (Jackson 1992). Though recorded from eight springs at Edgbaston Springs, it's abundance and

occurrence varies, such that presently it is known from only five springs. Principal threats include dambusia, sheep and cattle fouling the water, and/or dying in springs. They are known to reach 28mm TL (Wager & Unmack in prep), making them the smallest freshwater fish in Australia with the longest scientific name! In aquaria, redfinned blue eye lay a few eggs daily at temperatures over 20°C, although temperatures over 26°C are preferred (Unmack & Brumley 1990). Little is known of their breeding behavior in the wild.

Ambassidae - glassfishes - Western chanda perch *Ambassis mulleri* Klunzinger 1879 - Though widespread in the larger rivers, abundance of this species fluctuates greatly. Due to a revision of Ambassidae (Allen & Burgess 1989), all previous records of *A. castelnaui* for central Australia are now applicable to western chanda perch, and past records of pennyfish (Denariusa bandata) (Glover & Sim 1978a; Glover 1982 and others), were misidentifications of this species. Western chanda perch can grow to at least 60 mm TL.

Percichthyidae - cods and perches - Lake Eyre golden perch, yellowbelly or callop *Macquaria* sp. ssp. (Plate 15) - This is the largest species found in central Australia, growing to around 600 mm and 5.6 kg. It was recently recognized as distinct from the larger (760 mm and 23 kg) Murray-Darling golden perch (*M. ambigua ambigua*) by Musyl & Keenan (1993), but not not described. It is widespread and abundant in most of the larger rivers, and is a major angling species. A small commercial fishery exists in lower Cooper Creek in South Australia. All biological information provided here is for Murray-Darling golden perch since this little-known species is likely similar in most regards. Spawning occurs during a flood at temperatures over 23°C and fecundity is between 100,000 and 1,000,000 eggs. One of few freshwater fish in the world known to lay pelagic eggs (Merrick & Schmida 1984), this species' migrations of up to 2300 km (Reynolds 1983) are some of the longest migrations recorded by any fully freshwater fish.

Bulloo golden perch or yellowbelly *Macquaria sp. ssp.* - Considered common throughout the Bulloo River, this species was recently recognized, but not described, as a separate subspecies (Musyl & Keenan 1993). Biological information is the same as for previous species.

Terapontidae - grunters - Banded grunter *Amniataba percoides* (Gunther 1864) - The banded grunter is probably the fourth most widespread fish in Australia. In central Australia, it is found only in the Finke and Georgina Rivers, Barkley Drainage, and (from a single record) the Neales River (Glover 1984). Typically they are common and may grow up to 200 mm TL. Fish between 70 and 90g produce 40,000-77,000 eggs and spawning occurs at temperatures ranging from 26 to 33°C (Merrick & Schmida 1984). No research has been carried out upon central Australian populations.

Welch's grunter *Bidyanus welchi* (McCulloch & Waite 1917) - Welch's grunter, reaching at least 350 mm TL, is widespread and often abundant in most of the larger rivers. Spawning appears to be associated with flooding, with 280 mm females producing 100,000 pelagic eggs. Like golden perch, this species also produces fully pelagic eggs. Most information on their breeding biology is derived only from laboratory studies (Merrick & Schmida 1984).

Spangled perch *Leiopotherapon unicolor* (Gunther 1859) (Plate 16) - The spangled perch is the most widespread fish in Australia, and is known from all but three separate basins (which haven't had any native fish recorded from them) in central Australia. They can reach a length of 300 mm TL, but females mature at 78 mm TL. Spawning occurs at temperatures over 26°C and flooding is not necessary to induce it. A 24 g fish produces 24,000 eggs, and a 65g fish produces 113,200. Because of its ability to rapidly colonize new waterbodies, it has often been proposed that this species can aestivate, either as eggs or adults, however there is no evidence to support this claim (Llewelyn 1973). It is also commonly reported in so called "rains of fish", where usually spangled perch can be found scattered on the ground after heavy downpours. These fish have clearly not fallen from the sky, but have migrated there via overland flow (Glover 1990). This species has particularly good dispersal abilities; Shipway (1947) recorded hundreds of young spangled perch swimming 10miles in six hours along a wheel rut.

Barcoo grunter *Scortum barcoo* (McCulloch & Waite 1917) - The Barcoo grunter is generally widespread in the larger rivers where it may be locally abundant at times. Prior to about 1975 it was only known to science by the single holotype collected in 1916 (Vari. 1978; Merrick & Barker 1975).

Eleotridae - gudgeons - Western carp gudgeon *Hypseleotris kluzingeri* (Ogilby 1898) - The western carp gudgeon is widespread and usually abundant in Cooper Creek and the Bulloo River. Individuals reach 60 mm TL, and usually spawn in spring and early summer, during flooding, at temperatures over 20°C. Flooding may not be a prerequisite to spawning. Females mature at 30mm and deposit between 1,000-2,000 eggs on a hard object near the water surface. Males guard the eggs until fry hatch in fifty hours (Lake 1967). There is no further parental care.

Midgley's carp gudgeon *Hypseleotris sp.* - Midgley's carp gudgeon is widespread, though typically less abundant than western carp gudgeon, in Cooper Creek and the Bulloo River. They grow to 40 mm TL, and usually spawn in spring and early summer at temperatures over 20°C. Flooding is not considered necessary for spawning. Females mature at around 25

mm TL, and lay 200-400 eggs on a hard object (not near the surface like in western carp gudgeon). The male guards the eggs until hatching occurs in 7-8 days (Unmack unpub. data).

Lake's carp gudgeon, *Hypseleotris sp.* (?) - Lake's carp gudgeon has only been collected in upper portions of the Barcoo and Thompson Rivers in the Cooper Creek Drainage. It appears to be the rarest of the three *Hypseleotis* subspecies. It strongly resembles Lake's carp gudgeon from the Murray-Darling System, although its specific status remains unclear.

Flinders Ranges, Balcanoona or Barcoo mogurnda or purple spotted gudgeon *Mogurnda* sp. - The Flinders Ranges mogurnda is restricted to a couple of creeks in the Flinders Ranges, but was also recently recorded from a very short section of the upper Barcoo River. It is listed as Vulnerable by the ASFB (Jackson 1992). It was only recently recognized as different from the northern purple spotted gudgeon (*M. mogurnda*) (Glover 1989). It grows to around 150mm. Spawning for all Australian *Mogurnda spp.* is basically the same. In nature, they probably spawn throughout the warmer months of the year. In aquaria, they spawn at temperatures over 20°C and females lay between 200-800 eggs, usually on the underside of a hard object. The male guards the eggs until fry hatch in seven days. Spawnings are generally repeated, as long as temperature is maintained above 20°C (Young 1987; Hanson 1988). The genus is one of the few for which life history studies have included central Australian populations.

Finke or Dalhousie mogurnda or purple spotted gudgeon *Mogurnda* sp. (Plate 17) - The Finke mogurnda is restricted to Dalhousie Springs and the Finke River, where it is usually common, but never abundant. Its taxonomic status is still uncertain, however, I believe it will be recognized as distinct from northern purple spotted gudgeon, a species I no longer consider to be part of the central Australian fauna. It biology is the same as the previous species.

Bulloo mogurnda or purple spotted gudgeon? *Mogurnda* sp. - Taxonomic status of the single specimen collected from the Bulloo Drainage in 1955 is unclear. It may represent an extirpated population of the Flinders Ranges mogurnda.

Frew mogurnda or purple spotted gudgeon *Mogurnda* sp. - The Frew mogurnda is presently know only from a small portion of the Barkley Drainage. Its present taxonomic status is unknown, but, due to its long isolation, I feel it is likely to prove to be a new species once closely studied.

Gobiidae - gobies - Desert goby *Chlamydogobius eremius* (Zietz 1896a) - The desert goby is widespread and often abundant in the Neales River, and extends southwards around Lake Eyre to Clayton Bore. It is typically found in rivers, springs and bore drains. This is the only species in central Australia which has undergone extensive field study (Glover 1971; 1973). Known to reach 60 mm TL, in aquaria, spawning generally occurs at temperatures above 26°C with females typically laying 50-250 eggs on the ceiling of a cave. Males guard the eggs until hatching, which typically occurs in 10 days. They rarely seem to live longer than one year (Thompson 1983). Desert gobies are the Australian "equivalent" of the pupfishes (*Cyprindon*). They can tolerate temperatures from 5 to at least 40°C, salinities as high as 60 ppt, and have been collected at oxygen concentrations as low as 0.8 mg/l (Glover 1973; Glover 1982).

The genus *Chlamydogobius* is presently being revised by H. Larson who will describe the following species:

Elizabeth Springs goby *Chlamydogobius sp. A* - Restricted to Elizabeth Springs, population size of this species is estimated at 1,000-2,000 individuals. It is listed as Endangered by the ASFB (Jackson 1992). They will grow to a maximum size of 62 mm TL. Spawnings have been recorded at temperatures over 20°C. Around 40-100 eggs are laid on the ceiling of a cave, with males guarding the eggs until hatching occurs ten days later (Unmack & Wager in prep. a).

Dalhousie goby *Chlamydogobius sp. B* (Plate 18) - The Dalhousie goby is restricted to approximately 28 springs at Dalhousie Springs where it is usually common (Kodric-Brown & Brown 1993). It is listed as Restricted by the ASFB (Jackson 1992), and its biology is probably similar to the above species.

Edgbaston goby *Chlamydogobius sp. C* - The Edgbaston goby occurs in small numbers in approximately 11 of the Edgbaston Springs. It is listed as Vulnerable by the ASFB (Jackson 1992) as a result of various threats, including dambusia, cattle and sheep fouling the water, and dying in springs. Their breeding biology is almost identical to the desert goby (Unmack and Wager unpub. data).

Finke goby *Chlamydogobius sp. D* - The Finke goby is generally restricted to the upper Finke River, where it may be common, though typically not abundant. It should probably be considered Restricted. Its breeding biology is probably similar to the above congeners.

Flathead goby *Glossogobius giurus* (Hamilton 1822) - The flathead goby is widespread through out Northern Australia and the Indo-Pacific region. In central Australia, it is found only in the Georgina River where it appears to be common, growing to at least 200 mm TL. It apparently has a marine larval stage (Allen 1989), and it is quite possible that this population, which has not been studied, is one of the only populations that does not have access to the sea. Very little known of its biology in Australia in general.

EXOTIC SPECIES - Poeciliidae - livebearers - Dambusia *Gambusia holbrooki* (Girard 1859) - Dambusia is widespread and common in the Neales and Diamantina Rivers and Cooper Creek. A few other populations exist around Lake Eyre, isolated parts of the

Bulloo-Bancannia Drainage Division, and in the Nullabour and Gairdner Drainages (Glover 1982). All records of mosquito fish (*G. affinis*) for Australia are now considered to be dambusia (Lloyd & Tomasov 1985). Dambusia appear to have caused few problems to native fish populations, probably because of the lack of alteration to river flows. However, they are reported to have caused a decrease in fish populations inhabiting non-riverine habitats, for example, Clayton Bore (Glover 1989), and springs (Unmack & Brumley 1990; Unmack 1992; Wager & Unmack in prep.).

One spot livebearer *Phalloceros caudimaculatus* (Hensel 1868) - The one spot livebearer was recorded in 1973 from Trephina Creek in the Todd River Drainage (Victorian Museum records). None have been reported before or after this, and none were seen or caught during a recent survey (Unmack unpub. data).

Swordtail *Xiphophorus helleri* Heckel 1848 - Swordtails were reported by Thompson (1982) as being present in the Todd River, but none have been reported since, and a recent survey failed to find any (Unmack unpub. data).

Cyprinidae - carps - Goldfish *Carassius auratus* Linnaeus 1758 - There have been at least two independent introductions of goldfish in the Cooper Creek drainage. They have been in the upper reaches of the Barcoo River for many years (Merrick & Schmida 1984), are now widespread in the Thompson River (R. Wager, pers. comm.), and have recently been recorded from Coongie Lakes (Reid & Puckridge 1990; Glover 1990), although they were apparently first introduced there in the 1970's (Pierce 1993). Goldfish are also known from a reservoir associated with the sewage plant at Woomera in the Gairdner Drainage since 1956-7, where it was probably unintentionally introduced during local flooding (Glover 1979; Glover 1982).

Carp *Cyprinus carpio* Linnaeus 1758 - Carp are only known from the tailings dam at Leigh Creek coal mine, on a tributary to Frome Creek. Efforts will be made to poison this population in the near future (B. Pierce pers. comm.).

TRANSLOCATED NATIVE SPECIES - Percichthyidae - cods and perches - Murray cod *Macullochella peelii peelii* (Mitchell 1838) - Murray cod were first introduced into the Cooper Creek System by the Queensland Department of Primary Industries in 1989 and 1990. Specimens have been captured, although it is unknown if they will establish a self maintaining population. It has probably been introduced elsewhere, as it is a popular angling/eating fish, and fingerlings are readily available.

Murray-Darling golden perch, yellowbelly or callop *Macquaria ambigua ambigua* (Richardson 1845) - Two stockings of Murray-Darling golden perch have been recorded in the Hay/Plenty River Drainage (Unmack unpub. data). They have also been stocked in Clayton Bore which leads towards Lake Eyre (Unmack unpub. data). It has probably been introduced elsewhere as it is a popular angling/eating fish, and fingerlings are readily available. It is unknown whether this species will hybridize with related species.

Terapontidae - grunters - silver perch *Bidyanus bidyanus* (Mitchell 1838) - Silver perch have been stocked into Clayton Bore which leads into Lake Eyre (Unmack unpub. data). All comments for Murray-Darling golden perch (above) also apply here.

IMPACTS AND THREATS - Rivers and Lakes - Central Australia has largely avoided many of the typical impacts to aquatic ecosystems experienced elsewhere, probably as a result of central Australia's isolation and very low population density. No dams are present, although they are still occasionally proposed, but numerous impacts threaten the integrity of central Australia's unique aquatic ecosystems.

A total of eight exotic and translocated species have been recorded from central Australia. This includes the recent translocations of three native fish, Murray cod, Murray-Darling golden perch and silver perch, either by local landholders or government agencies for angling purposes. Five exotic species, dambusia, swordtails, one spot livebearers, goldfish, and carp, have been recorded, but only three remain, and this should reduce to two as the carp will be poisoned in the near future (B. Pierce pers. comm.). The impacts of exotic fishes have been low, primarily because natural flow regimes have been maintained and the area is naturally variable with few permanent habitats. This could easily change if a predatory species adapted to this environment is released. While no impacts have yet been shown for translocated native fish, the potential for disaster through hybridization with congeners is very serious. Two of the translocated species have closely related species in central Australia. Hybridization between local and translocated stocks could weaken the fitness of unique locally adapted stocks and lead to a decrease in native fish populations and irreplaceable genetic loss.

Unfortunately, the isolation of this area allows considerable illegal fishing to continue largely undetected. Many locals obtain fish for local consumption by use of gill nets, and dynamite is sometimes utilized. Others, however, take commercial quantities and transport them to interstate markets. Due to the low number of waterholes present during drought, such practices can result in severe reduction in year classes of fish susceptible to capture in gill nets.

Sediment loads have most likely increased since the introduction of rabbits and the overstocking of livestock since the late 1800's. Both are known to cause an overall loss in vegetation which increases soil erosion. While no direct impacts relating to this have been reported in Australia, it is likely to have caused

some siltation to waterholes and changes to nutrient dynamics, although these rivers naturally carried large quantities of sediment.

Australia contains the largest populations of feral animals in the world including, goats, camels, horses and donkeys, as well as domesticated sheep and cattle. Aside from causing soil erosion and loss of vegetation, they foul waterholes through their faeces or carcasses, sometimes making them uninhabitable to fish (Pierce 1993). Because of the paucity of water, introduced herbivores congregate in the riparian zone and on floodplains, heavily trampling and overgrazing these areas.

A commercial fishery was recently established at Lake Hope on the lower Cooper Creek for Lake Eyre golden perch. This was allowed on the basis that this was a temporary lake/waterhole which was isolated from the system and would inevitably dry out. If this practice were expanded to include other waterholes, fish populations could easily be decimated due to the limited number of refuges present. A key consideration is the role of ephemeral waterbodies in sustaining fish populations in an exceptionally variable system. To what extent do these populations rely on the rare recruitment opportunities provided by inundation of outlying sites? What are the evolutionary implications of harvesting the colonizing populations in these outliers? Unfortunately, no biological studies have been completed to ascertain the sustainablility and management implications of these practices.

There have been numerous past proposals to dam several rivers and divert water into the Murray-Darling system for irrigation. Dams are also frequently proposed for flood control on the Todd River above Alice Springs. Fortunately all such proposals have been defeated so far. There are presently no catchment management arrangements for any rivers, and there is considerable resistance by the upstream state governments to consider the needs of downstream water users.

Springs - The following is an abbreviated summary of the extent of impacts largely drawn from summaries by Harris (1992) and Ponder (1986).

Water exploitation in the GAB started in the late 1870's when the first bores or wells were sunk. This caused an initial period of drawdown, or loss of pressure in the aquifer, and a decline in discharge of most springs within the GAB. Virtually all springs in the Bogan and Bourke supergroups are extinct, or nearly so (Pickard 1992), many in the Eulo supergroup are extinct (Ponder 1986), and only one spring, Elizabeth Springs (which flows at <95% of its original rate), remains active in the Springvale supergroup (Habermehl 1982). Comparisons with descriptions of early explorers indicate that flows of many of the Lake Eyre supergroup springs have also been reduced. The GAB is now in equilibrium between recharge and discharge; that is, no further decrease in spring flow is expected providing no new developments occur. In an effort to reduce wastage of water, there is an active program underway to control or cap flowing bores. This will hopefully enhance spring flows. One development that threatens the Lake Eyre supergroup is the Olympic Dam mining venture, which presently draws 15 megalitres per day, and plans to expand withdrawals to 33 megalitres per day (Harris 1992). The impacts of increased extraction are difficult to accurately predict, but present levels of extraction have impacted several nearby springs. There is also a proposal to establish an iron smelting plant near Coober Pedy, presumably using artesian water in considerable amounts, if not for industrial processes then certainly for the proposed township. Another mining proposal at Cloncurry (near Julia Creek, Queensland) also hopes to use GAB water (R. Wager pers. comm.).

Virtually every spring has cattle or sheep grazing on it except those at Dalhousie Springs, where grazing ceased in 1985 (Harris 1989). A few of the Lake Eyre Springs were fenced in 1986-1988 (Harris 1992), and a few springs are protected within Carnarvon Gorge National Park (Ponder & Clark 1990). Due to the lack of water and fodder, stock tend to congregate around springs, producing trampling of the surrounding area as well as disturbance to the spring itself. Faeces tend to pollute springs by causing high ammonia concentrations. Occasionally, stock get trapped in soft mud and die, or they just happen to be in a spring when they die. In very small springs this results in the complete loss of fauna, and in larger springs the total biomass tends to be reduced.

Many of the generally small springs in Queensland, which has a relatively higher density of people and pastoral properties (ranches) than elsewhere, have been dug out by pastoralists to improve water supply for stock (Ponder & Clarke 1990; R. Wager pers. comm.). None of the springs have been channelized or diverted, primarily because of their small size, and no irrigation has occurred in central Australia, but springs are generally easily accessible to stock.

The only recorded introduced species is dambusia, which occurs in a few springs in the Neales River and Frome Creek portions of the Lake Eyre supergroup, and a few scattered Queensland springs. The species range is gradually expanding, primarily through flood dispersal. Dambusia is a major threat to redfinned blue eye and Edgbaston goby at Edgbaston Springs. No efforts have yet been made to eradicate dambusia from any spring. Fortunately, due to its isolation, Dalhousie Springs remains free of exotic fish, however, this could easily change with increased tourism. The large warm pools (32-38°C) there would make ideal environments for many tropical fish species.

There is considerable debate as to whether fencing springs to prevent animal grazing is threatening or protecting them. The few Lake Eyre supergroup springs which have been fenced have become overgrown with *Phragmites australis*. This may result in a change to the

plant and animal communities of unknown proportions If the springs are not fenced, then they risk being destroyed by cattle trampling and pollution. There is also disagreement as to how much grazing occurred on the springs prior to European settlement. Did the spring flora and fauna ever experience grazing? Have the springs had time to come into equilibrium with cattle grazing? Have the springs changed to the point of being dependent upon grazing to maintain aquatic habitats? *Phragmites australis* tends to decrease water depth by collecting sediment, but it was present before cattle grazing; what was the water depth then? (Although the flow rate was higher then too). We also don't know how the Aborigines managed the springs. It is thought that they may have used fire to maintain access to the springs or to catch game. Another historical question asks what the springs were like when the mega-fauna roamed them prior to extinction of that fauna about 10,000 years ago? These are challenging management questions, which no one has yet attempted to answer.

CONCLUSIONS - The fishes of the Australian desert are in remarkably good condition compared to other deserts of the world such as those of North America. Australia has been fortunate to avoid two of the greatest threats to aquatic desert ecosystems; changes to flow regimes, and introduced species (Rinne & Minckley 1991). Major gaps remain in our knowledge of central Australian fishes. Little is known of the biology and ecology of most species, many of which remain undescribed. Extrapolations are often made from data on populations from elsewhere, yet these may prove to be different species once closely examined. Genetic techniques for sorting out these and other problems are just starting to be applied. There are regular proposals to either dam rivers, or exploit water from the GAB. Presently essentially unregulated, tighter restrictions need to be applied to stocking of native and translocated angling species. Finally, there are no management strategies or interstate agreements (fisheries are managed at the State level, not Federal) in place to deal with any sudden problems that might occur such as an outbreak of an introduced species or any other problem. We need to be diligent in the future in our efforts to maintain the status quo.

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LITERATURE CITED

ALLAN, R. J. 1989. Climatic conditions during the 1973-76 Lake Eyre flooding period. In, **The Great Filling of Lake Eyre in 1974**. Eds. Bonython, C. W. & Fraser, A. S. Royal Geographical Society of Australasia, South Australian Branch, Adelaide. pp 10-31.

ALLEN, G. R. 1989. **Freshwater fishes of Australia**. T.F.H. Publications, New Jersey. 240pp.

ALLEN, G. R. & BURGESS, W. E. 1990. A review of the glassfishes (Chandidae) of Australia and New Guinea. **Records of the Western Australian Museum**. Supplement No. 34. pp 139-207.

BENTLEY, H. W., PHILLIPS, F. M., DAVIS, S. N., GOVE, H., HABERMEHL, M. A., AIREY, P. L., CALF, G. E., ELMORE, D., GOVE, H. E. & TORGERSON, T. 1986. Chlorine 36 dating of very old groundwater 1. The Great Artesian Basin, Australia. **Water Resources Research** 22: 1991-2001.

BONYTHON, C. W. 1989. Introduction and overview. In, **The Great Filling of Lake Eyre in 1974**. Eds. Bonython, C. W. & Fraser, A. S. Royal Geographical Society of Australasia, South Australian Branch, Adelaide. pp 1-9.

BYE, J. A. T. & WILL, G. D. 1989. The hydrology of the filling. In, **The Great Filling of Lake Eyre in 1974**. Eds. Bonython, C. W. & Fraser, A. S. Royal Geographical Society of Australasia, South Australian Branch, Adelaide. pp32-43.

CASPERSON, K. C. 1979. **Mound springs of South Australia. Part 1. Physical features, history, biota and conservation requirements**. South Australian Department of Environment & Planning, SADE 20.

COOK, P. G. 1968. **1:250 000 Geological Series-Explanatory Notes**. Henbury, N. T. Bureau of Mineral Resources, Geology and Geophysics. Canberra.

CROWLEY, L. E. L. M. & IVANTSOFF, W. 1990a. A second hardyhead, *Craterocephalus gloveri* (Pisces: Atherinidae), from Dalhousie Springs, central Australia. **Ichthyological Exploration of Freshwaters** 1(2): 113-122.

CROWLEY, L. E. L. M. & IVANTSOFF, W. 1990b. A review of species previously identified as *Craterocephalus eyresii* (Pisces: Atherinidiae). **Proceedings of the Linnean Society of New South Wales** 112(2): 87-103.

DE DECKER, P. 1979. Ostracods from the mound springs area between Strangways and Curdimurka, South Australia. **Transactions of the Royal Society of South Australia** 103: 155-168.

DODDRIDGE, L. K. 1992. **The autecology of the Cooper Creek tortoise, *Emydura sp.* (aff. *krefftii*.** Unpublished dissertation, graduate diploma in science, University of New England, Armidale, New South Wales, Australia.

DULHUNTY, J. A. 1982. Holocene sedimentary environments in Lake Eyre, South Australia.

Journal of the Geological Society of Australia 29: 437-442.

GALE, S. J. & BAINBRIDGE, S. 1990. The floods of Eastern Australia. **Nature** 345: 767.

GLOVER, C. J. M. 1971. **The taxonomy and biology of *Chlamydogobius eremius* (Zeitz, 1896)**. M. Sc. Thesis, University of Adelaide.

GLOVER, C. J. M. 1973. Adaptations of a central Australian gobiid fish. **Bulletin of the Australian Society for Limnolnology**. 5: 8-10.

GLOVER, C. J. M. 1979. Studies on central Australian fishes: further observations and records, part 1. **South Australian Naturalist** 53(4): 35-44.

GLOVER, C. J. M. 1982. Adaptations of fishes in arid Australia. In, **Evolution of the Flora and Fauna of Arid Australia**. Eds. Barker, W. R. & Greenslade, P. J. M., pp 241-246. Peacock Publications, Adelaide.

GLOVER, C. J. M. 1984. Additions to the fish fauna of South Australia. **Transactions of the Royal Society of South Australia** 109(1): 59-60.

GLOVER, C. J. M. 1989. Fishes. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 89-112.

GLOVER, C. J. M. 1990. Fishes. In, **Natural History of the North-East Deserts**. Eds. Tyler, M. J., Twidale, C. R., Davies, M., & Wells, C. B. Royal Society of South Australia, Adelaide. pp 189-198.

GLOVER, C. J. M., & SIM, T. C. 1978a. A survey of central Australian ichthyology. **Australian Zoologist** 19(3): 245-256.

GLOVER, C. J. M., & SIM, T. C. 1978b. Studies on central Australian fishes: a progress report. **South Australian Naturalist** 52(3): 35-44.

HABERMEHL, M. A. 1982. **Springs in the Great Artesian Basin, Australia - their origin and nature**. Bureau of Mineral Resources, Geology & Geophysics, Australia Report No. 235.

HARRIS, C. 1981. Oases in the desert: the mound springs of Northern South Australia. **Proceedings of the Royal Geographers Society of South Australia** 81: 26-39.

HARRIS, C. 1989. Dalhousie Springs - An introduction. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 1-4.

HARRIS, C. 1992. Mound Springs: South Australian conservation initiatives. **The Rangeland Journal** 14(2): 157-173.

HANSEN, B. 1988. The purple-spotted gudgeon, *Mogurnda adspersa*. **Fishes of Sahul** 5(1):200-202.

IVANTSOFF, W. I. & GLOVER, C. J. M. 1974. *Craterocephalus dalhousiensis* n.sp., a sexually dimorphic freshwater teleost (Atherinidae) from South Australia. **Australian Zoologist** 18: 88-98.

IVANTSOFF, W., UNMACK, P., SAEED, B., & CROWLEY, L E. L. M. 1991. A redfinned blue-eye, a new species and genus of the family Pseudomugilidae from central Western Queensland. **Fishes of Sahul** 6(4): 277-282.

JACKSON, P. D. 1992. Australian Threatened Fishes, 1992 Supplement. **Australian Society for Fish Biology Newsletter** 22(2): 17-22.

KODRIC-BROWN, A. & BROWN, J. H. 1993. Highly structured fish communities in Australian desert springs. **Ecology** 74(6): 1847-1855.

KOTWICKI. V. 1989. Floods in the Western Lake Eyre Basin and their impact on Dalhousie Springs. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 41-46.

KRIEG, G. W. 1989. Geology. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 19-26.

LAKE, J. S. 1967. Rearing experiments with five species of Australian freshwater fishes I. Inducement to spawning. **Australian Journal of Freshwater and Marine Research** 18: 137-153.

LAKE, J. S. 1971. **Freshwater Fishes and Rivers of Australia**. Thomas Nelson Australia Ltd, Melbourne. 61pp.

LANGDON, J. S., GUDKOVS, N., HUMPHREY, J. D. & SAXON, E. C. 1985. Deaths in Australian freshwater fishes associated with *Chilodonella hexasticha* infection. **Australian Veterinary Journal** 62(12): 409-413.

LLEWELLYN, L. C. 1973. Spawning, development, and temperature tolerance of the spangled perch, *Madigania unicolor* (Gunther), from inland waters in Australia. **Australian Journal of Freshwater and Marine Research** 24: 73-94.

LLEWELLYN, L. C. & POLLARD, D. A. 1980. Family Plotosidae. In, **Freshwater Fishes of South-eastern Australia**. Ed. McDowell, R. M. Reed, Sydney. Pp91-93.

LLOYD, L. N. & TOMASOV J. F. 1985. Taxonomic status of the mosquitofish, *Gambusia affinis* (Poeciliidae), in Australia. **Australian Journal of Marine and Freshwater Research** 36, 447-51.

MEIGS, P. 1953. World distribution of arid and semi-arid homoclimates. In, **Reviews of research on arid zone hydrology**. UNESCO, Paris. Arid Zone Program. 1: 203-209.

MERRICK, J. R. & BARKER, J. 1975. The Barcoo grunter rediscovered. **Australian Society for Limnology Newsletter** 12(4): 20-21.

MERRICK, J. R. & SCHMIDA, G. E. 1984. **Australian Freshwater Fishes: Biology and Management**. Griffith Press Ltd. 409pp.

MUSYL, M. K. & KEENAN, C. P. 1992. Population genetics and zoogeography of Australian

freshwater golden perch, *Macquaria ambigua* (Richardson 1845) (Teleostei: Percichthyidae), and electrophoretic identification of a new species from the Lake Eyre Basin. **Australian Journal of Marine and Freshwater Research** 43(6): 1585-1601.

NICHOLLS, G. E. 1943. The Phreatoicoidea. Part 1. The Amphisopidae. **Papers and Proceedings of the Royal Society of Tasmania** 1942: 1-145.

ORR, T. M. AND MILWARD, N. E. 1984. Reproduction and development of *Neosilurus ater* (Perugia) and *Neosilurus hyrtlii* Steindachner (Teleostei: Plotosidae) in a tropical Queensland stream. **Australian Journal of Freshwater and Marine Research** 35: 187-195.

PICKARD, J. 1992. Artesian springs in the Western Division of New South Wales. **The Graduate School of Environment Working Papers Series, Macquarie University** Paper No. 9202. pp 123.

PICKUP, G., ALLEN, G. & BAKER, V. R. 1988. History, paleaeochannels and palaeofloods of the Finke River, central Australia. In, **Fluvial Geomorphology of Australia**. Ed. Warner, R. F. Academic Press, Sydney. pp 177-200.

PIERCE, B. E. 1992. Why chase fish in the desert? South Australia's inland water stock assessment program. **SAFISH Magazine** 17(1): 4-9.

PIERCE, B. E. 1993. "Up the creek" South Australia's channel country and its major waterways. **SAFISH Magazine** 17(4): 4-8.

PONDER, W. F. 1986. Mound springs of the Great Artesian Basin. In, **Limnology of Australia**. Eds. DeDeckker, P. & Williams, W. D. CSIRO, Australia and W. Junk, The Hague. pp 403-420.

PONDER, W. F. & CLARK, G. A. 1990. A radiation of hydobiid snails in threatened artesian springs in western Queensland. **Records of the Australia Museum** 42(3): 301-363.

PONDER, W. F., HERSHLER, R. & JENKINS, B. J. 1989. An endemic radiation of hydrobiid snails from artesian springs in Northern South Australia: their taxonomy, physiology, distribution and anatomy. **Malacologia** 30(1): 1-140.

PUCKRIDGE, J. T., WALKER, K. F., LANGDON, J. S., DALEY, C & BEAKES, G. W. 1989. Mycotic dermatitis in a freshwater gizzard shad, the bony bream, *Nematalosa erebi* (Gunther), in the River Murray, South Australia. **Journal of Fish Diseases** 12(3): 205-221.

PUCKRIDGE, J. T. & WALKER, K. F. 1990. Reproductive biology and larval development of a gizzard shad, *Nematalosa erebi* (Gunther) (Dorosomatinae: Teleostei). in the River Murray, South Australia. **Australian Journal of Freshwater and Marine Research** 41: 695-712.

RANDAL, M. A. 1978. Hydrogeology of the South-Eastern Georgina Basin and environs, Queensland and Northern Territory. **Geological Survey of Queensland, Publication No.** 366.

REID, J. R. W. & PUCKRIDGE, J. T. 1990. Coongie Lakes. In, **Natural History of the North-East Deserts**. Eds. Tyler, M. J., Twidale, C. R., Davies, M., & Wells, C. B. Royal Society of South Australia, Adelaide. pp 119-131.

REYNOLDS, L. F. 1983. Migration patterns of five fish species in the Murray-Darling River system. **Australian Journal of Freshwater and Marine Research** 34(6): 857-871.

RINNE, J. N. & MINCKLEY, W. L. 1991. Native fishes in arid lands: A dwindling resource of the desert Southwest. **USDA Forest Service General Technical Report** RM-206. pp 45.

RUELLO, N. V. 1976. Observations on some fish kills in Lake Eyre. **Australian Journal of Freshwater and Marine Research** 27: 667-672.

SHIPWAY, B. 1947. Rains of fishes? **Western Australian Naturalist** 1(2):47-48.

SLUYS, R. 1986. First representative of the order Macrostomida in Australia (Platyhelminthes, Macrostomidae). **Records of the South Australian Museum** 19 (18): 399-404.

SMITH, P. C. 1989. Hydrology. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 27-40.

SPENCER, B. 1896. **The Horn Scientific Expedition to Central Australia**. Dulace & Co., London.

THOMPSON, G. 1982. Fish collecting on a part round Australia trip. **Fishtales** 13(7) :6-10.

THOMPSON, G. 1983. The desert goby, *Chlamydogobius eremius*. **Fishes of Sahul** 1(2): 17-20.

UNMACK, P. 1992. Further observations on the conservation status of the redfinned blue-eye. **Australian and New Guinea Fishes Association Bulletin** 12: 8-9.

UNMACK, P. J. (IN PRESS) The unique Cooper Creek catfish from central Australia. **Fishes of Sahul**.

UNMACK, P. & BRUMLEY, C. 1991. Initial observations on the spawning and conservation status of the redfinned blue-eye, (*Scaturiginichthys vermeilipinnis*). **Fishes of Sahul** 6(4): 282-284.

UNMACK, P. J. & WAGER, R. N. E. (In prep a) Threatened Fishes of the World, Elizabeth Springs goby, *Chlamydogobius sp*.

UNMACK, P. J. & WAGER, R. N. E. (In prep b) The Elizabeth Springs goby, its aquarium care, habitat and conservation status.

VAN DE GRAAFF, W. J. E., CROWE, R. W. A., BUNTING, J. A. & JACKSON, J. 1977 Relict early Cainzoic drainage's in arid Western Australia. **Zeitschrift fur Geomorphologie** 21(4): 379-400.

VARI, R. P. 1978. The *Terapon* perches (Percoidei, Teraponidae). A cladistic analysis and taxonomic revision. **Bulletin of the American Museum of Natural History** 159(5): 175-340.

WAGER, R. 1994. **The distribution and status of the red-finned blue eye. Final Report Part B: The distribution of two endangered fish in Queensland**. Endangered species unit project number 276.

WAGER, R. N. E. & UNMACK, P. J. (In prep) Threatened fishes of the world, *Scaturiginichthys vermeilipinnis*.

YOUNG, M. 1987. A tank breeding of *Mogurnda mogurnda*. **Fishes of Sahul** 4(3): 174-177.

ZEIDLER, W. 1991. A new genus and species of phreatic amphipod (Crustacea: Amphipoda) belonging in the "chiltonia" generic group, from Dalhousie Springs, South Australia. **Transactions of the Royal Society of South Australia** 115(4): 177-187.

ZEIDLER, W. & PONDER, W. F. 1989a. Summary.. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 123.

ZEIDLER, W. & PONDER, W. F. 1989b. Conclusions and recommendations. In, **Natural History of Dalhousie Springs**. Eds. Zeidler, W. & Ponder, W. F. South Australian Museum, Adelaide. pp 125.

ZIETZ, A. H. C. 1896a. Pisces. In, Spencer, B. Ed. **Report on the work of the Horn Scientific Expedition to central Australia. Part 2. Zoology**. London. pp 176-180, pl 16.

ZIETZ, A. H. C. 1896b. Description of an additional new species of fish from the Finke and Barcoo Rivers. In, Spencer, B. Ed. **Report on the work of the Horn Scientific Expedition to central Australia. Part 2. Zoology**. London. pp 410-411, pl 16.

(See plates on following pages)

Plate 1. Coongie Lake. It dries on average every 7 years. Approximately 8 native and 2 introduced fishes have been recorded.

Plate 2. Cooper Creek near Innamincka overflowing its banks during 1990 floods. Photo by B. Pierce.

Plate 3. A pool in the Thompson River at Longreach. After flooding, small pools of water remain for short periods of time. This one, with a maximum depth of 60 cm, contained several thousand fish and was dry two months after this photo was taken.

Plate 4. Avington waterhole in the upper Barcoo River near Blackall. Fourteen native and one introduced species were collected when this photo was taken.

Plate 5. Macumba River just North of Oodnadatta; a typical central Australian river, most of which are dry except for short periods after rain.

Plate 6. The Finke River is thought to have followed the same course for up to 350 million years. Nine native species were recorded on this visit.

Plate 7. Dalhousie Spring number A2, one of the larger springfed pools at Dalhousie springs. Six fish species inhabit this 33°C spring.

Plate 8. Blanch Cup, southwest of Lake Eyre, is one of the Lake Eyre supergroup springs, and one of the largest mound springs. Desert goby have been introduced. Hamilton Hill (background) is an extinct spring thought to be one million years old.

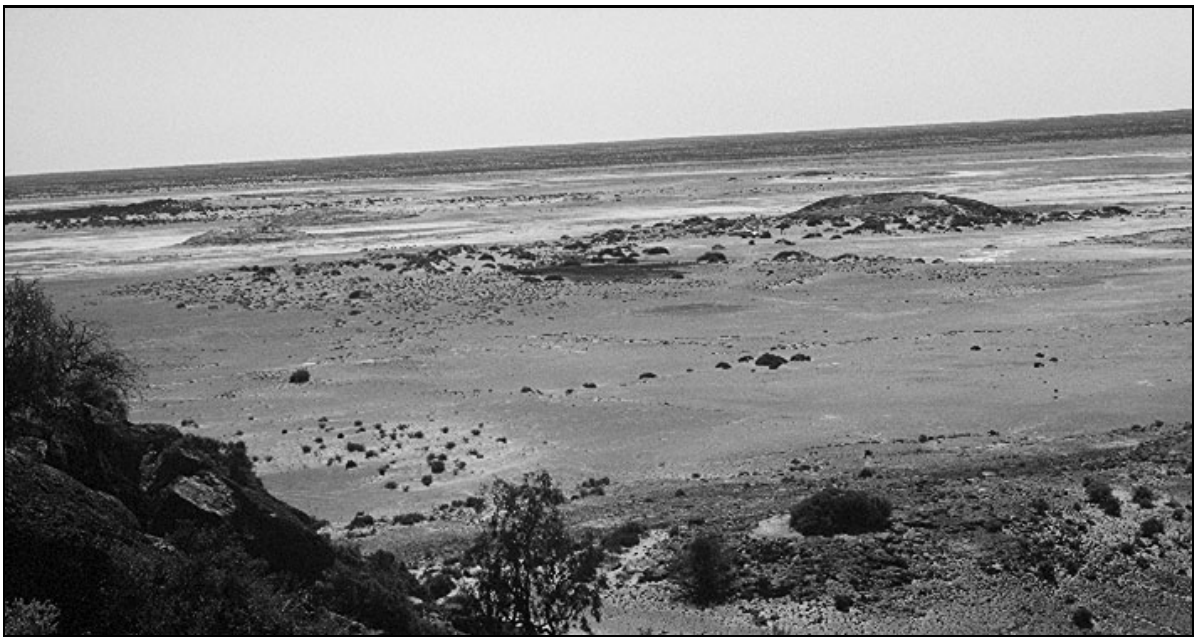

Plate 9. View from Hamilton Hill over Blanch Cup. A vehicle, barely visible on the front, left hand side of the large mound gives an indication of scale. Two smaller mond springs are also present 6 and 7 cm to the left of Blanch Cup.

Plate 10. View downstream from the head of Coward Springs of the Lake Eyre supergroup. Up to three fish species have been recorded here, although only the desert goby is permanently resident. Discharge is 2-3 l/s.

Plate 11. The source of one the Edgbaston Springs in the Springsure supergroup and type locality of the redfinned blue eye. Edgbaston goby are also present. Approximately three eighths of the springs is visible. Maximum depth is 4 cm and water temperature fluctuates more diurnally than annually.

Plate 12. Outflow channel of one of the Elizabeth Springs in the Springvale supergroup. Elizabeth Springs goby are common here. These springs were recently fenced to prevent further cattle damage.

Plate 13. Cooper Creek catfish, 45 cm TL.

Plate 14. Dalhousie hardyhead, 6 cm TL. Photo by R. Felix.

Plate 15. Lake Eyre Golden Perch, 30 cm TL.

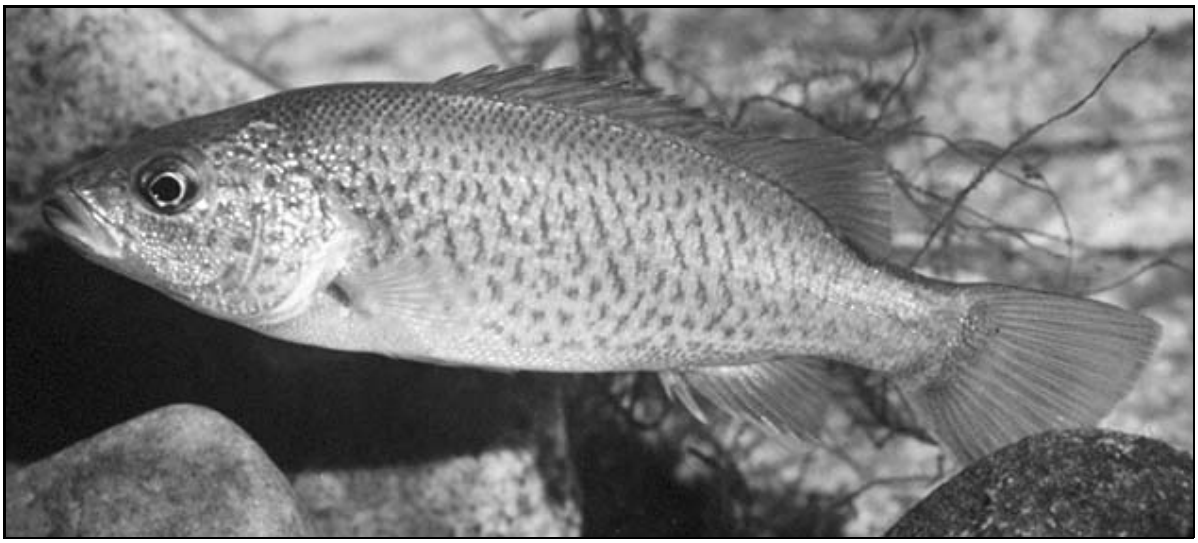

Plate 16. Spangled perch, 15 cm TL. Photo by R. Felix.

Plate 17. Dalhousie mogurnda, 8 cm TL. Photo by R. Felix.

Plate 18. Female Dalhousie goby, 4 cm TL.

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Background and overview of the Recovery Implementation Program for endangered fishes in the upper Colorado River basin

Antecedentes y resumen del Programa de Implementación de la Recuperación para peces en peligro en la parte alta de la cuenca del Río Colorado

KEYWORDS: Colorado squawfish; humpback chub; bonytail; razorback sucker; upper Colorado River basin; Colorado River; Colorado River Recovery Implementation Program

ABSTRACT

Four native fishes of the Colorado River system are listed as endangered under the Endangered Species Act: the Colorado squawfish *Ptychocheilus lucius*, the humpback chub *Gila cypha*, the bonytail chub *Gila elegans*, and the razorback sucker *Xyrauchen texanus*. The Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin (Recovery Program) is a partnership among Federal and State agencies, environmental organizations, and private water development interests whose mission is to recover the endangered fishes in the upper Colorado River basin while allowing for water development to continue. In its first 6 years of existence, major Recovery Program accomplishments include: (1) the operation of several Federal reservoirs has been modified to help meet the instream flow requirements of the fish, (2) water and water rights have been acquired provide instream flows in several critical river reaches; (3) genetic refugia have been established for several of the most endangered fish stocks; (4) interim guidlines have been developed for stocking of non-native fishes in the upper basin, and (5) a broad based information and education effort has been implemented. Over 150 favorable biological opinions have been issued on water depeletion projects since the inception of the Program in 1988. Recovery Program activities are currently focused on acquisition and legal protection of instream flows, expanding refugia for the endangered fish, restoration of flooded bottomland habitats, providing fish passage at several historic diversion structures, control of non-native fish population in selected river reaches, and implementation of an experimental stocking program for the razorback sucker.

CLAVES: charal del Colorado; charal jorobado; charalito elegante; matalote jorobado; Cuenca Alta del Río Colorado; Río Colorado; Programa de Implementación de la Recuperación de la Cuenca Alta del Río Colorado

RESUMEN

Cuatro peces nativos del sistema del Río Colorado están enlistados como especies en peligro de extinción, según el Acta de Especies en Peligro de los Estados Unidos: El charal del Colorado *Ptychocheilus lucius*, el charal Jorobado *Gila cypha*, el charalito Elegante *Gila elegans*, y el Matalote Jorobado *Xyrauchen texanus*. El programa de implementación de la recuperación para las especies de peces en peligro en la parte alta de la cuenca del Río Colorado

(programa de recuperación) es una sociedad entre las agencias federales y estatales, organizaciones ambientales y desarrollos de aguas privados interesados en recuperar los peces en peligro de la parte alta de la cuenca del Río Colorado, mientras que los desarrollos de usos de agua continúan. En los primeros seis años de existencia las metas principales del programa de recuperación incluyen: (1) la operación de varios reservorios federales que han sido modificados para ayudar a encontrar los requerimientos de flujo de agua del pez, (2) el agua y los derechos de agua que han sido adquiridos, proporcionan flujos de agua en varios ríos críticos, (3) refugios genéticos han sido establecidos para varios de la mayoría de los stocks de peces en peligro; (4) líneas provisionales han sido desarrolladas para reservas de peces no nativos en la cuenca alta, y (5) un intenso esfuerzo de educación y difusión ha sido implementado. Alrededor de 150 opiniones biológicas favorables han sido hechas sobre proyectos de abatimiento de aguas desde el inicio del programa en 1988. Las actividades del programa de recuperación, actualmente están enfocadas en la adquisición y protección legal de flujos de aguas, expansión de refugios para especies en peligro, restauración de hábitats inundables, disposición de pasajes para peces en varias estructuras históricas de desviación de agua, control de poblaciones de especies no nativos en brazo de ríos seleccionados, e implementación de un programa experimental de reservas de Matalote Jorobado.

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Colorado River Recovery Program activities related to the Gunnison River and operation of the Aspinall Unit of the Colorado River Storage Project

Programa de Recuperación del Río Colorado, actividades relacionadas al Río Gunnison y operación del Programa de Almacenamiento de la Unidad Aspinall del Río Colorado

KEYWORDS: Gunnison River; Colorado River; Aspinall Unit; Colorado squawfish; razorback sucker; humpback chub

ABSTRACT

The Aspinall Unit was built on the Upper Gunnison River by the Bureau of Reclamation during the period 1962 to 1976. The Unit consists of three reservoirs: Blue Mesa, Morrow Point, and Crystal. The reservoirs were built upstream from areas occupied by Colorado squawfish *Ptychocheilus lucius* and razorback sucker *Xyrauchen texanus*, but their operation has significantly altered native fish habitat within the Gunnison River. Water temperatures have decreased and springtime flows have been reduced by 40 to 50%. The streamflow changes have also affected the Colorado River because the Gunnison composes about 25 to 50% (depending on season and year) of the Colorado's flow below their confluence.

The Fish and Wildlife Service and Bureau of Reclamation have begun the process that will lead to a Biological Opinion on operation of the Aspinall Unit. The Bureau of Reclamation is releasing test flows from the Unit that mimic a natural hydrograph and the Recovery Program is funding a series of studies to assess the effect of those flows on the native fishes as well as the Gunnison and Colorado rivers themselves. These studies are being conducted by the Fish and Wildlife Service, the Colorado Division of Wildlife, and Utah Division of Wildlife Resources and include: 1-inventorying the fish community of the Gunnison River; 2-assessing reproductive success of native and introduced fishes; 3-assessing the relationship of YOY Colorado squawfish to backwater habitat and how that habitat changes under different flow regimes; 4-assessing the relationship of the invertebrate and native fish community to longitudinal differences in the Gunnison and Colorado rivers; 5-understanding humpback chub *Gila cypha* biology and habitat use and their relationship to flow regime; 6- determining physical changes in the Gunnison and Colorado rivers and the relationship to the altered flow regime; and 7-understanding the relationship of substrate movement and channel maintenance to peak flows.

Related activities include construction of a fish passage structure at the Redlands Diversion Dam, located about 4 km upstream from the confluence with the Colorado River. Redlands was constructed in 1918 and has blocked fish movement into the Gunnison since then. We are also working with the Bureau of Reclamation to determine and then provide minimum streamflows below the Dam. Restoration of flooded bottomlands is also an issue in the Gunnison River and we are working to determine the flow levels necessary to flood these important habitats. The Gunnison River has also been identified as a reintroduction site for razorback sucker.

CLAVES: Río Gunnison; Río Colorado; Unidad Aspinall; charal del Colorado; matalote jorobado; charal jorobado

RESUMEN

La unidad Aspinall fue construida en la parte superior del Río Gunnison por el Buró de Reclamación, durante el período 1962-1976. La unidad consiste en tres embalses: Blue Mesa, Morrow Point y Crystal. Los embalses fueron construidos río arriba en áreas ocupadas por el charal del Colorado (*Ptychocheilus lucius*) y el matalote jorobado (*Xyrauchen texanus*), pero su operación altera significativamente el habitat de los peces nativos del Río Gunnison. La temperatura del agua ha disminuido y los flujos primaverales han sido reducidos en un 40% a 50%. Los cambios

de las corrientes han afectado al Río Colorado porque el Gunnison compone cerca del 25 al 50% (dependiendo de la estación y el año) la corriente del Colorado abajo de su confluencia.

El Servicio de Pesca y Fauna Silvestre y el Buró de Reclamación han empezado el proceso que conducirá una opinión biológica en operación de la Unidad Aspinall. El Buró de Reclamación está liberando flujos de prueba de la unidad que imiten una hidrografía natural y el Programa de Recuperación financiando una serie de estudios para valorar los efectos de esos flujos en los peces nativos tan bien como en los mismos ríos Colorado y Gunnison. Estos estudios están siendo conducidos por el Servicio de Fauna Silvestre y Pesca, la División de Fauna Silvestre de Colorado y la división de Recursos y Fauna Silvestre de Utah e incluye: 1.- Inventario de las comunidades de peces del Río Gunnison; 2.- Valoración del éxito reproductivo de peces nativos e introducidos; 3.- Valoración de las relaciones de hábitats apartados de los peces del año (YOY) del charal del Colorado y como estos habitas cambian bajo diferentes regímenes de flujo; 4.- Valoración de las relaciones de invertebrados y comunidades de peces nativos en diferencias longitudinales en los ríos Gunnison y Colorado; 5.- Comprensión de la biología del charal jorobado (*Gila cypha*), uso de habitat y sus relaciones con el régimen de flujo; 6.- Determinación de cambios físicos en los ríos Gunnison y Colorado y las relaciones en la alteración del régimen de flujo; y 7.- Comprensión de las relaciones de movimientos del substrato y mantenimiento del canal en flujos pico.

Actividades afines incluyen construcción de estructuras de tránsito de peces en la desviación de la presa Redlands, localizada aproximadamente a 4 Km río arriba de la confluencia con el Río Colorado. Redlands fue construida en 1918 y ha bloqueado el movimiento de los peces hacia dentro del Gunnison desde entonces. Estamos además trabajando con el Buró de Reclamación para determinar y entonces proveer el mínimo de la corriente hacia abajo de la presa. La restauración de las tierras bajas inundadas es también un asunto en el Río Gunnison y estamos trabajando para determinar los niveles de flujo necesarios para inundar estos hábitats importantes. El Río Gunnison además ha sido identificado como un sitio de reintroducción para el matalote jorobado.

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Upper Colorado Recovery Implementation Program:
directions for management of non-native and native fish interactions

Programa de Implementación de Recuperación del Alto Colorado:
direcciones para el manejo de interacciones de peces nativos y no nativos

KEYWORDS: non-native fishes; native fishes; interactions

ABSTRACT

Past efforts to manage non-native and native fish interactions in the Upper Basin were generally limited to researching and documenting interactions between species. In many cases, documented interactions were required before program cooperators would permit significant management actions to be taken. In recent years, however, efforts towards non-native fish management in the program have intensified. We reviewed information on life history requirements for over 20 non-native species, reviewed past experiences with controlling these species throughout their range, and initiated experiments to evaluate options to control and/or manage negative interactions. This information is summarized. Specific examples of control options are discussed for sportfish and cyprinid species. A conceptual plan that defines an approach for managing negative interactions between native and non-native species in the Upper Basin, including research efforts, is presented.

CLAVES: peces no nativos; peces nativos; interacciones

RESUMEN

Esfuerzos anteriores para manejar las interacciones de peces nativos y no nativos en la Alta Cuenca, generalmente estuvieron limitadas a investigar y documentar interacciones entre especies. En muchos casos, las interacciones documentadas fueron requeridas antes que los cooperadores del programa permitiera se tomaran acciones de manejo significantes. En años recientes, sin embargo, esfuerzos dirigidos al manejo de peces no nativos en el programa se han intensificado. Revisamos información sobre requerimientos de historia de vida para más de 20 especies no nativas, revisamos experiencias pasada en el control de estas especies através de su rango distribucional, e iniciamos experimentos para evaluar las opciones para controlar y/o manejar las interacciones negativas. Esta información es resumida. Ejemplos específicos de opciones de control son discutidas para especies de pesca deportiva y de ciprínidos. Se presenta un plan conceptual que define un acercamiento al manejo de interacciones negativas entre especies nativas y no nativas en la Cuenca Alta, incluyendo esfuerzo de investigación.

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Developing genetics management guidelines: endangered fish species in the upper Colorado River basin

Desarrollo de lineamentos de manejo genético: especies en peligro en la cuenca alta del Río Colorado

KEYWORDS: genetics; habitat; sustainability; priorities; opportunities; strategies; risks; propagation; reintroduction; evaluation

ABSTRACT

A general Genetics Management Guidelines document was developed in 1994 to aid in protecting, managing, and recovering endangered big river fishes in the upper Colorado River basin. The document was produced for the Recovery Implementation Program with input from a panel of fish culture, genetics, management, and conservation experts. Principle participants in the Recovery Implementation Program are the Fish and Wildlife Service, Bureau of Reclamation, Western Area Power Administration, Colorado, Utah, Wyoming, water users and environmental groups.

Genetics Management Guidelines is a conceptual document based on fundamental genetic conservation principles, evolutionary theory, and improved habitat and fish management practices. It presents a systematic approach to developing, implementing, and evaluating strategic and tactical genetics management plans. Genetics Management Guidelines is used by resource managers in better identifying and understanding genetics issues, making management decisions, and providing general oversight and direction for executing recovery actions. The guidelines document emphasizes recovery benefits provided by conserving natural amounts and patterns of genetic diversity within and among endangered fish populations. Further, the document contends that protecting a stable, naturally sustaining population in suitable habitat is the most effective strategy for long-term management of genetic resources.

General genetics management goals are avoidance of immediate population extinction and protection of genetic characteristics of wild and captive populations. Specific genetic management goals are based in part on broad genetic surveys designed to identify and characterize target species: Colorado squawfish Ptychocheilus lucius, razorback sucker Xyrauchen texanus, bonytail Gila elegans, and humpback chub G. cypha. Geographic, demographic, behavioral, physiological, morphological, and ecological data provide additional information for finer resolution of genetic conservation units. Complete data sets permit more accurate assessment of relative population status and trends. Comprehensive evaluation of population health or condition allows prioritization among species, among populations within species, and selection of appropriate management interventions.

The guidelines suggest a work plan be developed for each genetic conservation unit and integrated into the comprehensive, long- term recovery action plan. Work plans include definition of goals, objectives, and tasks. Specific guidance is provided to address each management opportunity with the most appropriate production strategy that reduces the likelihood of negative genetic impacts to both the target other endemic fish populations. Although natural production strategies are preferred, artificial production strategies may be appropriate. Artificial propagation strategies include development of genetic refuges and captive brood stocks from high priority endangered fish populations. Artificial propagation and reintroduction of fish to restore extirpated populations or to augment declining populations to achieve sustainability is also discussed. Success of work plan implementation must be evaluated in terms of change in population status over time - unknown, stable, improved, declined, or extirpated.

It is expected that the Genetics Management Guidelines document will be useful in developing similar guidelines for these same species in the lower Colorado River basin. Modification in implementation may depend on differences in population status and trend assessments and priority designations. However, the rationale emphasizing definition of genetic management opportunities, selection of appropriate production strategies, and assessment of genetic risks should apply.

CLAVES: genética; hábitat; sustentabilidad; prioridades; oportunidades; estrategias; riesgos; propagación; reintroducción; evaluación

RESUMEN

Un documento general de Lineamentos de Manejo de Genética fue desarrollado en 1994 para ayudar en la protección, manejo y recuperación de peces en los grandes ríos de la cuenca superior del Río Colorado. Este documento fue producido por el Programa de Instrumentación para la Recuperación con la entrada de un panel de expertos en cultura, genética, manejo y conservación de peces. Los principales participantes son el Fish and Wildlife Service, Buró de Reclamaciones, Western Area Power Administration, Colorado, Utah, Wyoming, grupos ambientales y usuarios de agua.

Los Lineamentos de Manejo Genético es un documento conceptual basado en principios fundamentales de conservación genéticos, teoría evolutivas, mejoramiento de habitat y prácticas de manejo de peces. Este presenta una aproximación sistemática para desarrollar, implementar y evaluar planes de manejo genético estratégicos y tácticos. El lineamento de manejo genético es usado por manejadores de recursos para la mejor identificación y entendimiento de asuntos genéticos, haciendo decisiones de manejo y proporcionando aspectos generales y dirección para la ejecución de acciones de recuperación. Los lineamentos del documento enfatizan los beneficios de la recuperación provistos por

la conservación en cantidades naturales y patrones de diversidad genética dentro y entre poblaciones de peces en peligro. Además, el documento afirma que una protección estable, una población sostenida naturalmente en habitat conveniente es la estrategia más efectiva para manejo a largo plazo de los recursos genéticos.

Las metas generales de manejo genético son evitar la extinción inmediata en poblaciones y proteger las características genéticas de poblaciones silvestres y en cautiverio. Las metas específicas de manejo genético están basados en parte en trabajos genéticos amplios asignados a identificar y caracterizar las especies-objetivo : charal del Colorado (*Ptychocheilus lucius*), matalote jorobado (*Xyrauchen texanus*), charal elegante (*Gila elegans*) y el charal jorobado (*Gila cypha*). Datos geográficos, demográficos, conductuales, fisiológicos, morfológicos y ecológicos proporcionan información adicional para afinar la resolución de unidades de conservación genética. Un conjunto de datos completos permite más precisión en la valoración de las tendencias y estatus de poblaciones relativas. Una evaluación extensa de la salud de la población o condiciones que permiten la priorización entre especies, entre poblaciones dentro de las especies y selección de intervenciones de manejo apropiadas.

Los lineamentos sugieren se desarrolle un plan de trabajo por cada unidad de conservación genética e integre dentro de un plan de acciones de recuperación extenso y de largo plazo. Los planes de trabajo incluyen definición de metas, objetivos y tareas. El sentido específico es dar dirección a cada oportunidad de manejo con la producción de estrategias más apropiadas que reduce la probabilidad de impactos genéticos negativos a las dos a las objetivo y a otras poblaciones de peces endémicas. Si bien, las estrategias de producción natural son preferidas, las estrategias de producción artificial pueden ser apropiadas. Las estrategias de propagación artificial incluyen el desarrollo de refugios genéticos y de progenie en cautiverio de poblaciones de peces en peligro de alta prioridad. La propagación artificial y la reintroducción de peces es restaurar las poblaciones extirpadas o aumentar las poblaciones en declive, lograr la sustentabilidad es también discutible. El éxito de la implementación del plan de trabajo puede ser evaluada en términos de cambios en estatus poblacional en el tiempo (desconocido, estable, mejorado, declinado o extirpado.

Es esperado que el documento de manejo genético sea útil en el desarrollo de lineamentos generales para esas mismas especies para estas mismas especies en la cuenca baja del Río Colorado. La modificación en la implementación puede depender en diferencias es estatus poblacional y valoración de tendencias y designaciones prioritarias. Sin embargo, el énfasis fundamental de definición de oportunidades de manejo genético, la selección de estrategias de producción apropiadas y la valoración de riesgos genéticos podrían se aplicadas.

WYDOSKI,R.S. (U.S. Fish and Wildlife Service, Upper Colorado River Recovery Implementation Program, Denver, CO)

Genetics management of endangered fishes in the upper Colorado River basin

Manejo genético de peces en peligro en la cuenca alta del Río Colorado

KEYWORDS: Colorado River; Upper Basin; Recovery Implementation Program; endangered fish; genetics

ABSTRACT

The Program philosophy is to maintain the genetic integrity of wild and captive-reared endangered fishes in the upper Colorado River basin while preventing irreversible losses of genetic diversity that may result from management interventions or lack of action. Initial efforts are to protect the genetic diversity of wild endangered fish stocks in the upper basin and to aid in enhancing wild stocks by removing or significantly reducing limiting factors that have caused population declines.

Genetics management of endangered fishes in the upper Colorado River basin is covered in three Recovery Implementation Program (Program) documents: Genetics Management Guidelines, Genetics Management Plan, and individual stocking plans. The Genetics Management Guidelines provides a conceptual framework for genetics management and rationale for maintaining genetic diversity in wild and captive endangered fish stocks in the upper basin. A Genetics Management Plan identifies and characterizes endangered fish stocks in the upper basin, determines status and trends, and establishes priorities for management actions by species and stocks. Individual stocking plans provide details and rationale for proposed stocking efforts such as species, origin of stock, size of fish, time of release, location of release, genetic risks, and a description of how the stocking effort will be evaluated.

Genetics Management Guidelines were prepared and distributed to interested parties in May, 1994. This document was prepared in concert with a Genetics Panel composed of nationally recognized fishery geneticists and fishery biologists in the upper basin. A draft Genetics Management Plan has been prepared as a working document that will be revised as needed when new information becomes available. A draft augmentation plan has been prepared for the razorback sucker in the Upper Colorado River and a stocking plan for restoration of the bonytail in the upper basin is currently being prepared.

Broodstocks of razorback sucker and Colorado squawfish are being developed to protect the genetic diversity of priority stocks of endangered fish. Captive propagation and stocking will be used as a temporary management tool to facilitate recovery of the endangered fishes in the upper basin while preserving the genetic diversity inherent to wild stocks. Criteria used to identify and characterize endangered fish stocks in the upper basin include geographic distribution and relative abundance, identified or suspected spawning sites, migrations, known movement and

interchange between stocks, and genetic characterization. Criteria used to determine status and trends of the endangered fish stocks in the upper basin include the distribution and relative abundance of the stocks, documentation of spawning and recruitment, identification of the potential for the extinction of the stocks from catastrophic risks, and estimating the probability for imminent extinction.

Three presumptive stocks of razorback suckers, five stocks of humpback chub, and four stocks of Colorado squawfish were identified in the upper basin. Stocks are defined as randomly breeding groups of individuals that have spatial, temporal, or behavioral integrity from other randomly breeding groups of the same species. Only occasional bonytails are captured in the upper basin with great spatially and temporally separation in captures so that stock identification was not possible. The assignment of these presumptive stocks was conservative to ensure preserving their genetic diversity because all stocks may be important in the recovery effort. Priorities for placing fish in genetic refuges or developing broodstocks were based on available information (i.e., objective information) on distribution, relative abundance, recruitment, and trends as well as other contributing information (i.e., subjective information) such as the potential for catastrophic losses or the probability for immediate extinction as old individuals die and are not replaced through recruitment.

An adaptive management approach will be used in the implementation of the genetics guidelines and management plan. All available information on the endangered fish stocks will be reviewed annually by a Genetics Panel of nationally recognized fishery geneticists and the Biology Committee. Revisions will be made in the Genetics Management Plan as required when new information becomes available.

CLAVES: Río Colorado; Cuenca Alta; Programa de Implementación de Recuperación; peces en peligro; genéticas

RESUMEN

La filosofía del programa es mantener la integridad genética de peces raros y en peligro silvestres y cautivos en la cuenca alta del Río Colorado para prevenir las perdidas irreversibles de la diversidad genética que puede ser resultado de intervenciones de manejo o falta de acción. Los esfuerzos iniciales son para proteger la diversidad genética de los stocks de peces en peligro silvestres en la cuenca alta y ayudar a levantar los stocks por la remoción o reducción significativa de los factores limitantes que han causado la declinación de las poblaciones.

El manejo genético de peces en peligro en la cuenca alta del Río Colorado es cubierto en la implementación de tres documentos de programas de recuperación (programas): Manejo de líneas genéticas, Plan de manejo Genético y planes de stocks individuales. El manejo de líneas genéticas provee un trabajo conceptual para manejo genético y mantenimiento racional de la diversidad en peces en peligro silvestres y cautivos en la cuenca alta. Un plan de manejo genético identifica y caracteriza los stocks de peces en peligro en la cuenca alta, determina el estatus, las tendencias y establece prioridades para acciones de manejo por especie y stocks. Los planes para stocks individuales proveen detalles esfuerzos racionales tanto para stocks propuestos como especies, origen del stock, tamaño del pez, tiempo de liberación, localidad de liberación, riesgos genéticos y descripción de como los esfuerzos por stock pueden ser evaluados.

Los lineamentos de manejo genético fue preparado y distribuido a las partes interesadas en Mayo de 1994. Este documento fue preparado en concertación con un grupo de genetistas compuesto de genetistas pesqueros y biólogos pesqueros reconocidos nacionalmente en la cuenca alta. Un bosquejo de plan de manejo genético ha sido preparado como un documento de trabajo que puede ser revisado según se necesite cuando la nueva información este disponible. Un bosquejo de aumento del plan ha sido preparado para el matalote jorobado en el alto Río Colorado y un plan de restauración de stocks para el charal elegante en la parte alta de la cuenca del Río Colorado a sido consecuentemente preparado.

Los stocks de reproducción del matalote jorobado y el charal del Colorado ha sido desarrollado para proteger la diversidad genética de los stocks prioritarios de peces en peligro. La propagación de stocks cautivos puede ser usada como una herramienta temporal de manejo para facilitar la recuperación de los peces en peligro en la cuenca alta, preservando en el tiempo la diversidad genética inherente a los stocks silvestres. Los criterios usados para la identificación y caracterización de los stocks de peces en peligro en la cuenca alta incluye distribución geográfica y abundancia relativa, identificando o sospechando los sitios de desove, migraciones, conocer los movimientos, el intercambio entre los stocks y la caracterización genética. Los criterios usados para determinar el estatus y las tendencias de los stocks de peces en peligro en la cuenca alta incluye la distribución y abundancia relativa de los stocks, la documentación del desove y reclutamiento, identificación del potencial por extinción de los stocks debido a riesgos catastróficos y la estimación de la probabilidad por extinción eminente.

Tres presuntos stocks de matalote jorobado, cinco stocks de charal jorobado y cuatro stocks de charal de Colorado fueron identificados en la parte alta de la cuenca. Los stocks fueron definidos aleatoriamente como grupos de individuos que tienen una integridad espacial, temporal o de comportamiento de otros grupos reproductores aleatorios de la misma especie. Solo ocasionalmente los charalitos elegantes han sido capturados en la parte alta de la cuenca con una gran separación espacial y temporal en las capturas por lo que la identificación de los stocks no fue posible. La asignación de estos presuntos stocks fue conservadora para asegurar la preservación de su diversidad

genética porque todos los stocks pueden ser importantes en el esfuerzo de recuperación. Las prioridades para colocar a los peces en lugares de refugio genético o stocks de desarrollo de clases se baso en la información disponible (i.e. información objetiva) sobre distribución, abundancia relativa, reclutamiento, tendencias tan bien como la contribución de cualquier otra información (i.e. información subjetiva) así como el potencial por perdidas catastróficas o la probabilidad por extinción inmediata, como la muerte de individuos viejos y que no son reemplazados en el reclutamiento.

Una adaptación aproximada del manejo puede ser usada en la implementación de líneas genéticas y planes de manejo. Toda la información disponible sobre stocks de peces en peligro puede o debe ser revisada anualmente por un panel o grupo de genetistas reconocidos nacionalmente y un comite biológico. Las revisiones deben ser hechas en el plan de manejo genético tal y como sean requeridas cuando la nueva información este disponible.

NELSON,P.C.* (U.S.D.I. Fish and Wildlife Service, Division of Ecological Services, Denver, Colorado)

The flooded bottom lands restoration program of the upper Colorado River basin

El programa de restauración de tierras bajas inundadas de la parte alta de la cuenca del Río Colorado

KEYWORDS: razorback sucker; habitat restoration; flood plain habitats; flooded bottom lands; upper Colorado River basin

ABSTRACT

Much of the flood plain of the upper Colorado River basin has been lost due to channelization and flow regime alteration. Many believe that loss of flood plain habitats has contributed to the decline of the endangered fishes of the upper basin. The purpose of the Flooded Bottom Lands Restoration Program is to restore flood plain habitats to assist in recovery of the endangered fishes. The Program will focus initially on restoring habitats for the razorback sucker *Xyrauchen texanus*, based on the assumption that razorback suckers require flood plain habitats to complete their life cycle.

Restoration of flood plain habitats will entail reestablishing the hydrologic connection of the habitat to the main channel of the river such that the habitat will flood at near-historical timing, frequency, and duration. This will require lowering the flood plain elevation, flow management, construction of hydraulic controls, and/or pumping.

Initially sites will require water and fish control structures to manage flooding and to control predation. If managed sites are successful, then additional sites will be restored and allowed to behave more naturally.

The Flooded Bottom Lands Restoration Program is a component of the Recovery Implementation Program for the endangered fishes of the upper Colorado River basin. It is being funded by the U.S. Bureau of Reclamation under the Capital Projects Program.

CLAVES: matalote jorobado; restauración de hábitats; hábitats de planicies inundadas; tierras bajas inundadas; cuenca superior del Río Colorado

RESUMEN

Muchas de las planicies inundadas de la parte superior de la cuenca del Río Colorado han sido perdidas debido a la canalización y alteración en el régimen del flujo. Muchos creen que la pérdida de los hábitats de las planicies inundadas ha contribuido a declinar los peces en peligro cuenca arriba. El propósito del Programa de Restauración de las Tierras Bajas Inundadas es restaurar los hábitats de las tierras inundadas para ayudar a en la recuperación de los peces en peligro. El programa se enfocará inicialmente en la restauración de hábitats para el matalote jorobado (*Xyrauchen texanus*), basado en la suposición de que los matalote requieren hábitats de planicies inundadas para completar su ciclo de vida.

La restauración de los hábitats de planicies inundadas supondrán el restablecimiento de conexiones hidrológicas a los hábitats de los canales principales del río, tal que el habitat se inundará en tiempo, frecuencia y duración parecidos al histórico. Esto requerirá rebajar las elevaciones de las planicies inundadas, manejo del flujo, construcción de controles hidráulicas y/o bombeo.

Inicialmente los sitios requerirán estructuras de control de agua y peces, manejar la inundación y controlar la depredación. Si los sitios de manejo son exitosos, entonces se agregaran sitios que serán restaurados y se permitirá comportar más naturalmente.

El Programa de Restauración de Tierras Bajas Inundadas es un componente del Programa de Instrumentación para la Recuperación de Peces en Peligro de la Parte Superior de la Cuenca del Río Colorado. Esto está siendo financiado por el Buró de Reclamación de los Estados Unidos bajo el Programa de Proyectos de la Capital.

LYNCH,J.M.*;MCELROY,D.M.; DOUGLAS,M.E. (JML and MED - Department of Zoology & Museum, Arizona State University, Tempe, 85287-1501; DME - Department of Biology, Western Kentucky University, Bowling Green, 42101)

Geometric analysis of morphological variation in Colorado River chub (*Gila cypha* and *G. robusta*)

Análisis geométrica de variación morfológica de charales del Río Colorado (*Gila cypha* y *G. robusta*)

KEYWORDS: *Gila cypha*; *Gila robusta*; landmark analysis; discriminant analysis; shape coordinates; relative warps; hybridization

ABSTRACT

Traditionally, studies of morphometric variation in fishes have been based on multivariate analysis of linear distances. In recent years, techniques have been developed which allow direct analysis of homologous landmarks among and between organisms. These techniques allow explicit quantification and visualization of size and shape. In this study, we utilize relative warp and discriminant analyses of shape coordinates to describe within- and between-species variation in upper Colorado River basin *Gila cypha* and *G. robusta*. A morphological index of hybridization was constructed using a discriminant analysis of lower basin *G. robusta* and Little Colorado River *G. cypha*. This index was used to test eleven other upper basin populations for evidence of morphological homogeneity between species. Relative warp analysis was used to ordinate all eighteen samples in a space of reduced dimension. Morphological convergence and evidence for hybridization is discussed in light of ongoing genetic and ecological studies.

CLAVES: *Gila cypha*; *Gila robusta*; análisis del paisaje; análisis de discriminantes; coordenadas de forma; hibridación

RESUMEN

Tradicionalmente, los estudios de la variación morfológica en peces ha estado basada en los análisis multivariados de las distancias lineales. En años recientes, las técnicas han sido desarrolladas permitiendo análisis directos de sitios análogos y entre organismos. Estas técnicas permiten una cuantificación explícita y la visualización del tamaño y la forma. En este estudio, nosotros utilizamos un análisis de deformidad relativa (relative warp) y análisis de discriminantes de formas coordinadas para describir variaciones intra e interespecíficas entre *Gila robusta* y *G. cypha* en la cuenca del alto Río Colorado. Un índice morfológico de hibridación fue utilizado para probar otras once poblaciones de la cuenca alta para evidenciar la homogeneidad morfológica entre especies. El análisis de deformidad relativa fue usado para ordenar las dieciocho muestras en un espacio con dimensiones reducidas. La convergencia morfológica y la evidencia por hibridación es discutida mediante estudios ecológicos y genéticos.

STARNES,W.C. (Department of Vertebrate Zoology, Smithsonian Institution, Washington, DC)

Preliminary report of results of *Gila* Taxonomy Project

Reporte preliminar de los resultados del Proyecto Taxonómico de *Gila*

KEYWORDS: Cyprinidae; chubs; genetics; Colorado basin; Mexico; Colorado River Recovery Implementation Program; *Gila robusta*; *Gila elegans*; *Gila cypha*

ABSTRACT

To provide information pertinent to recovery efforts by the Colorado River Recovery Implementation Program, a comprehensive study of genetic and morphological variation was conducted on cyprinid populations of the *Gila* complex throughout the Colorado River basin and in several drainages of Mexico south to the Culiacan. Over 1200 specimens were sampled between 1991 and 1993 to be subjected to studies of allozyme and mtDNA variation and multivariate morphological analyses; morphological and possibly mtDNA studies were to be supplemented by museum specimens. Results of morphological studies are given in a companion presentation to this one; mtDNA studies are in very preliminary stages. Patterns of allozyme variation reveal several entities in Mexican drainages which are discrete from Colorado basin populations. Populations of the Gila and Bill Williams portions of the Colorado basin have no fixed differences among them, are closely related to populations in the Rio Grande and Guzman basins, and show distinctness from more northerly populations except Pahranagat and Little Colorado. Bonytails from Lake Mohave are distinct from all other populations but have close affinities with Virgin and Moapa river populations and Grand Canyon; a derivation of upper basin populations from these populations is indicated. There are no fixed differences among or within upper basin populations which is probably indicative of ancient hybridization events, though preliminary results indicate that at least two types of mtDNA persist. Tests for the degree of reproductive isolation within polymorphic populations are currently being performed. A comparison of non-recombinant mtDNA data with the recombinant allozyme data may facilitate an assessment of the history and implications of ancient and recent hybridization events.

CLAVES: Cyprinidae; charales; genética; cuenca del Colorado; México; Programa de Implementación de la Recuperación de la Cuenca Alta del Río Colorado; *Gila robusta*; *Gila elegans*; *Gila cypha*

RESUMEN

Para proporcionar información pertinente a los esfuerzos de recuperación del Programa de Implemetación de la Recuperación en el Río Colorado, fue realizado un estudio extenso de variaciones genéticas y morfológicas en poblaciones de ciprinidos del complejo *Gila* en toda la cuenca del Río Colorado y en varias cuencas de México al Sur de Culiacán. Más de 1200 especímenes fueron muestreados entre 1991 y 1993 para estudios de variación de aloenzimas y ADNmt y análisis morfológicos multivariados; los estudios morfológicos y posiblemente de ADNmt fueron suplementados por especímenes de museo. Los resultados de los estudios morfológicos se dan en una presentación que acompaña a esta misma; los estudios de ADNmt están en etapas muy preliminares. Los patrones de variación aloenzimática revelan varias entidades en los drenajes mexicanos, los cuales son unidades discretas de las poblaciones de la cuenca del Colorado. Las poblaciones del Gila y porciones de Bill Williams de la cuenca del Colorado no presentan diferencias fijas entre ellas, están cercanamente relacionadas a las poblaciones en las cuencas Río Grande y Gúzman, y muestran distinciones de poblaciones más cercanas, excepto con el Pahranagat y del Little Colorado. El charal elegante del Lago Mohave es distinto de todas las otras poblaciones, pero tienen afinidades cercanas con las poblaciones de los ríos Virgin y Moapa y Gran Cañón; una derivación de las poblaciones cuenca arriba de estas poblaciones es señalada. No hay diferencias fijas entre o dentro de las poblaciones cuenca arriba, lo cual probablemente es indicador de sucesos de hibridación antiguas, aunque los resultados, preliminarmente, indican que por lo menos dos tipos de ADNmt persisten. Las pruebas para el grado de aislamiento reproductivo dentro de poblaciones polimórficas están recientemente siendo presentadas. Una comparación de datos de ADNmt no recombinado con los datos de aloenzima recombinada, pueden facilitar una valoración de la historia e implicaciones de sucesos de hibridación recientes y antiguos.

CROWL,T.A.*; LENTSCH,L.D.; BISSONETTE,G. (TAC and GB - Utah State University, Logan; LDL - Utah Division of Wildlife, Salt Lake City)

Upper Colorado Recovery Implementation Program: investigations and management directions for bonytail *Gila elegans* reintroduction

Programa de implementación de la recuperación en el Alto Río Colorado: direcciones de manejo e investigación para la reintroducción del charalito elegante *Gila elegans*

KEYWORDS: bonytail; reintroduction; interactions; red shiner; physiological; adaptations; management

ABSTRACT

Past attempts to reintroduce bonytail into waters of the upper Colorado River basin failed. We are currently developing a reintroduction plan that attempts to integrate physiological conditioning, habitat preference, and species interaction information into a sequential-hierarchal framework. The initial research has been aimed at understanding the basic ecological requirements of bonytail needed for successful reintroduction. Studies are being performed in large, artificial streams located at the USU/BOR/UDWR Endangered Fish Experiment Station, located on the USU campus. Preliminary results suggest that physiological adaptations to flow regime, such as changes in the proportion of white and red muscle fibers and their diameters, occur very quickly with minimal flow training in YOY fish and result in individuals that have greatly enhanced swimming abilities. Individuals that have undergone three months of training in intermittent flow (0.07 m/s) selectively inhabit higher velocities in stream channels and feed exclusively in high flow, high turbulent habitats. These changes result in significant reductions in niche overlap with red shiners. Bonytail that have undergone flow training spend a large proportion of their time near the substrate in high velocity, high turbulent areas, feeding on drifting organisms while red shiners show a preference for lower velocity habitats feeding mainly from the mid-water and surface. Bonytail that have been raised exclusively in a non-flowing (pond) situation exhibit the same flow and feeding preferences as red shiners. These data suggest that some flow training will be beneficial to the reintroduction of bonytail individuals, at least in the short- term, and we are currently conducting experiments to determine the optimal timing and duration of the training regime. We discuss how this information, coupled with other research and management actions will be integrated into a reintroduction plan.

CLAVES: charalito elegante; reintroducción; interacciones; red shiner; fisiológico; adaptaciones; manejo

RESUMEN

Intentos anteriores para reintroducir el charalito elegante en aguas de la cuenca alta del Río Colorado, fallaron. Actualmente estamos desarrollando un plan de reintroducción que intenta integrar el condicionamiento fisiológico, preferencia de hábitat, e información sobre interacción de especies en un esquema de trabajo prioritario-secuencial. La investigación inicial ha sido orientada a entender los requerimientos básicos del charalito elegante, necesarios para una reintroducción exitosa. Los estudios están siendo realizados en grandes arroyos artificiales, localizados en la Estación Experimental de Peces en Peligro USU/BOR/UDWR, localizada sobre el campo USU. Los resultados preliminares sugieren que las adaptaciones fisiológicas al régimen de flujo, tales como la proporción de fibras de

músculo blanco y rojo, y sus diámetros, ocurren rápidamente con entrenamiento de flujo mínimo en el pez YOY, y resulta en peces que han aumentado sus capacidades de nado. Los individuos que han permanecido tres meses en entrenamiento en flujo intermitente (0.07 m/s) selectivamente habitan en canales de corrientes de velocidades más altas y se alimentan exclusivamente en hábitats de flujos altos y alta turbulencia. Estos cambios resultan en reducciones significantes de traslapos de nicho con red shiner. Los charalitos elegantes que han estado en un flujo de entrenamiento, consumen una gran proporción de su tiempo cerca del substrato a altas velocidades, en áreas de alta turbulencia, alimentándose de organismos que derivan, mientras que el red shiner muestra una preferencia por hábitats de bajas velocidades, alimentándose en la superficie y a media agua. Los charalitos elegantes que han sido mantenidos sin flujo (pozas) presentan las mismas preferencias de flujo y alimentación que los red shiner. Estos datos sugieren que algunos flujos de entrenamiento serán benéficos para la reintroducción individuos de charalitos elegantes, a corto plazo, actualmente estamos conduciendo experimentos para determinar el tiempo óptimo y duración del régimen de entrenamiento. Nosotros discutimos como esta información, se acopla con otras acciones de manejo e investigación que será integrada en un plan de reintroducción.

HAMILL,JOHN F. (Upper Colorado River Recovery Program, U.S. Fish and Wildlife Service, Denver, CO 80225)

Panel discussion: Is the Recovery Program working on the right things and are we making progress towards recovery?

Panel de discusión: ¿esta trabajando el Programa de Recuperación en la forma correcta y estamos haciendo progresos suficientes en la recuperación?

KEYWORDS: Colorado squawfish; humpback chub; bonytail; razorback sucker; Upper Colorado River Basin; Colorado River; Colorado River Recovery Implementation Program

ABSTRACT

A panel discussion will be held among all participants in the Upper Colorado River Basin Recovery Implementation Program Symposium and the audience to address this question.

CLAVES: charal del Colorado; charal jorobado; charalito elegante; matalote jorobado; Cuenca Alta del Río Colorado; Río Colorado; Programa de Implementación de la Recuperación de la Cuenca Alta del Río Colorado

RESUMEN

Un panel de discusión ha sido establecido con todos los participantes en el simposio del Programa de Implementación de la Recuperación de la Cuenca Alta del Río Colorado y asistentes para contestar esta pregunta.

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Movement of threatened Ozark cavefish in Logan Cave National Wildlife Refuge, Arkansas

Movimientos del amenazado Ozark cavefish en Logan Cave National Wildlife Refuge, Arkansas

KEYWORDS: cavefish; movements; Arkansas

ABSTRACT

Evaluation of the visual method of determining population size and status of threatened Ozark cavefish in Logan Cave (AR) was found to be deficient, as more fish were visual implant tagged during six months of the study (n=80) than had been observed in that locality in the previous 10 years. A consistent rate of untagged cavefish was collected during each sampling period, and a similar number of tagged individuals disappeared, suggesting Logan Cave cavefish moved into and out of areas of the cave not accessible to collectors. Movement of individual fish within the cave ranged up to a kilometer over the six months of the study, including traversing a small cascade. This movement and mobility of Ozark cavefish indicate that at least in Logan Cave the habitat of this species exceeds the boundaries of the accessible cave habitat. Habitat protection for this threatened species should include the aquifer as well as the immediate cave habitat.

CLAVES: Pez cavernícola; movimientos; Arkansas

RESUMEN

La evaluación del método visual de determinación del tamaño de la población y el estatus del amenazado Ozark cavefish en Logan Cave (AR) fue deficiente, ya que fueron marcados mas peces con marcas visuales durante los seis meses de estudio (n=80) que los que habían sido observados en ésta localidad en los 10 años anteriores. Una tasa consistente de peces sin marca fueron colectados durante cada período muestreado, y un número similar de individuos marcados desaparecieron, sugiriendo que el pez cavernícola de Logan Cave se mueve dentro y fuera de áreas no accesibles de la cueva. Los movimientos individuales de peces en la cueva variaron arriba de un kilómetro en los seis meses del estudio, incluyendo travesías en pequeñas cascadas. Estos movimientos y la movilidad del cavefish Ozark indican que un mínimo del hábitat de la Caverna Logan excede las fronteras del hábitat accesible de la caverna. La

protección del hábitat de estas especies amenazadas deberá incluir el acuífero así como el hábitat inmediato de la caverna.

HENDRICKSON,D.A. (Texas Natural History Collection / R4000, Texas Memorial Museum, University of Texas, Austin 78712-1100)

Miscellaneous notes on biogeography and biology of Mexican blind catfish of the genus *Prietella*

Notas misceláneas sobre la biogeografía y biología del bagre ciego Mexicano del género *Prietella*

KEYWORDS: Mexican blindcat; cavefish; blind fish; México; Coahuila; Tamaulipas; Nuevo León; behavior

ABSTRACT

The Mexican blindcat *Prietella phreatophila* Carranza 1954, is an obligate troglobitic ictalurid, formerly thought to be endemic to springs adjacent to, or within about a 50 km radius of, the town of Muzquiz, Coahuila. Recent discoveries of congeneric populations far to the northwest (very near the Texas border) and southeast (in southernmost Tamaulipas) extend the range to more than 600 km, transecting many major surficial drainages. Recent attempts by expert cave divers failed to capture additional specimens from southern Tamaulipas localities, but specimens from two series of 38 from the northernmost locality are now being held alive, frozen and preserved at University of Texas and Dallas Aquarium for further studies. Preliminary morphological observations indicate that these differ little from *P. phreatophila*, but variation in the type population has yet to be assessed. The single specimen from the southernmost locality is being described as a new species. Behavioural observations indicate total lack of light perception, keen chemosensory and auditory capabilities, orientation by learning spatial aspects of surroundings, and occassional agressive encounters including biting and locking of jaws by pairs for periods of as much as 11 hours. Examination of otoliths of one specimen revealed absence of daily increments and only occassional marks probably related to preiods of stress.

CLAVES: bagre ciego Mexicano; pez cavernícola; pez ciego; México; Coahuila; Tamaulipas; Nuevo León; comportamiento

RESUMEN

El bagre ciego Mexicano *Prietella phreatophila* Carranza 1954, es un ictalúrido troglobítico obligado, del cual se pensó primeramente que era endémico a manantiales adyacentes o dentro de un radio aproximado de 50 Km del pueblo de Muzquiz, Coahuila. Descubrimientos recientes de poblaciones congenéricas lejos al noroeste (muy cerca de la frontera con Texas) y sureste (muy al sur de Tamaulipas) ampliaron el rango sobre más de 600 Km, transectando muchos drenajes superficiales mayores. Intentos recientes de expertos buzos de cavernas por capturar especímenes adicionales del sur de Tamaulipas y de otras localidades potenciales fallaron, pero especímenes de dos series de 38 de la localidad más norteña están ahora siendo mantenidos vivos, congelados y preservados en la Universidad de Texas y en el Acuario de Dallas para estudios posteriores. Observaciones morfológicas preliminares indican que éstos difieren un poco de *P. phreatophila*, pero la variación en la población tipo tiene todavía que ser determinada. El espécimen único del la localidad más sureña está siendo descrito por investigadores independientes como una nueva especie. Observaciones conductuales preliminares indican carencia total de percepción a la luz, capacidades quimiosensores y auditivas agudas, y orientación por el aprendizaje de aspectos espaciales de los alrededores. Existen experimentos en progreso para cuantificar capacidades quimiosensores y de percepción de luz. Se han observado encuentros agresivos ocasionales, incluyendo mordeduras y traba de mandíbulas entre pares por períodos de hasta 11 horas. La examinación de láminas delgadas de secciones de otolitos de un espécimen adulto con microscopio de luz y de electrones, revelaron ausencia de incrementos diarios y sólo marcas ocasionales probablemente relacionadas a períodos de estrés. La determinación de la edad no es posible.

HEINRICH,J.E.*;HOLDEN,P.B.; FILBERT,R.G. (JEH-Nevada Division of Wildlife, Region III, Las Vegas, Nevada; PBH and RBF, Bio/West, Inc., 1063 West 1400 North, Logan, Utah 84321)

Examination of several marking techniques on the woundfin minnow in the laboratory and on the Virgin River, Nevada

Examen de diversas técnicas de marcaje en el woundfin minnow en laboratorio y en el Río Virgin, Nevada

KEYWORDS: woundfin; marking; tagging; Virgin River; florescent dye; coded wire; Nevada

ABSTRACT

Two marking techniques were tested on 1500 woundfin minnows, *Plagopterus argentissimus* received from Dexter National Fish Hatchery and Technology Center. Florescent dye marking and coded wire tags were used to monitor woundfin movement and survival along portions of the lower Virgin River and evaluated in the laboratory.

Dye marking using an air compressor caused an initial mortality rate as high as 15% and dye marks were not retained by fish for long periods of time. Magnetic coded wire tags caused no mortality and proved to be a reliable permanent mark. Fifteen and twenty-three marked woundfin were recovered in surveys by Bio/West from the Virgin

River, three and four months, respectively, after the release date. A single fish was captured eight months after release. Proportionately, dye marked fish were represented more often in field collections than wire tagged fish.

CLAVES: marcaje; etiquetado; Río Virgin; Colorante fluorescente; alambre codificado; Nevada

RESUMEN

Dos técnicas de marcaje se probaron en 1500 woundfin minnow, *Plagopterus argentissimus* recibidos del Dexter National Fish Hatchery and Technology Center. Se utilizaron marcajes por colorantes fluorescentes y etiquetas de alambres codificados, para monitorear el movimiento y sobrevivencia del woundfin a lo largo de porciones del bajo Río Virgin y se evaluaron en laboratorio.

El marcaje con colorantes utilizando un compresor de aire originó una mortalidad inicial de hasta el 15% y las marcas de color no permanecieron en los peces por largos períodos de tiempo. Las etiquetas de alambres magnéticamente codificados no causaron mortalidad y han mostrado ser una marca permanente confiable. Quince y veintitrés woundfin marcados fueron recuperados en evaluaciones del Río Virgin llevadas a cabo por Bio/West a los tres y cuatro meses, respectivamente, después de la fecha de liberación. Un sólo pez fue recuperado después de ocho meses de su liberación. Proporcionalmente, los peces marcados con colorantes se encontraron mas frecuentemente representados en las colectas de campo que los peces marcados con etiquetas de cable.

HAINES,G.B.*; MODDE,T. (GBH and TM, U.S. Fish and Wildlife Service, Colorado River Fish Project, Vernal, UT)

An evaluation of marking techniques to estimate population size and first year survival of young Colorado squawfish

Una evaluación de las técnicas de marcaje para estimar el tamaño de la población y sobrevivencia en el primer año de juveniles de charales del Colorado

KEYWORDS: fish marking; mark-recapture; population estimate; overwinter survival; simulation

ABSTRACT

Three marking methods, dental inoculator with tattoo-ink, syringe injection of an elastic polymer and fin clipping, were tested to determine a suitable technique for estimating population size, survival and movement of age-0 Colorado squawfish *Ptychocheilus lucius*. Laboratory tests indicated that all three marks were retained for sufficient duration to make initial population estimates over a 21 d period. However, the dental inoculator marks resulted in greater mortality and the fin clips had poor mark retention through the 142 d study period. The syringe injection of the elastic polymer had good survival and retention for 250 d. No differences were observed in vulnerability to predation between all three marks and unmarked fish.

A field test of the elastic polymer showed that this marking technique was easy to use in the field, caused low mortality and produced marks that were readily visible. The field test indicated that population size and winter survival could be estimated using mark-recapture methods. The basic assumptions of a closed population were met and valid population and survival estimates obtained. Comparison of the mark-recapture estimates of survival with catch per unit of effort estimators indicated that the former was more accurate and precise than the latter. Simulations adjusting size of area collected and collecting efficiency are provided to describe potential impacts of bias and observed movement in and out of the collection area.

CLAVES: marcado de peces; captura-recaptura; estimación poblacional; sobrevivencia postinvernal; simulación

RESUMEN

Tres métodos, un inoculador dental con tinta para tatuajes, una jeringa de inyección con un polímero elástico y etiqueta en aletas, fueron probadas para determinar una técnica adecuada para estimar el tamaño de la población, sobrevivencia y movimiento del charal del Colorado de la clase de edad cero *Ptychocheilus lucius*. Las pruebas de laboratorio indicaron que en total las tres marcas fueron retenidas por una duración suficiente para hacer estimaciones iniciales de las poblaciones sobre un período de 21 días. No obstante las marcas con el inoculador dental resultaron en una gran mortalidad y las marcas en las aletas, tuvieron una pobre retención de la marca a través de los 142 días del período de estudio. La inyección por jeringa del polímero elástico mostraron buena sobrevivencia y retención por un período de 250 días. No se observaron diferencias en la vulnerabilidad hacia la depredación entre las tres marcas y los peces no marcados.

Una prueba de campo del polímero elástico mostró que estas técnicas de marcaje son fáciles de utilizar en el campo, causan baja mortalidad y produjo marcas fácilmente visibles. Las pruebas de campo indicaron que el tamaño de la población y la sobrevivencia invernal podrían ser estimados usando métodos de captura-recaptura. Se consideró como presunción básica una población cerrada y se obtuvieron estimaciones validas de la población y su sobrevivencia. Comparaciones entre las estimaciones de sobrevivencia mediante el método de captura-recaptura y la estimación mediante los estimadores de captura por unidad de esfuerzo, indicaron que el primero era mas exacto y

preciso que el último. La simulación del ajuste del area de colecta y la eficiencia de colección fueron provistas para describir impactos potenciales de sesgos y movimientos observados dentro y fuera del area de colecta.

IRVING,D.B.*; MODDE,T. (DBI and TM, Colorado River Fish Project, U.S. Fish and Wildlife Service, Vernal, Utah)

Migrational behavior and stock differentiation of Colorado squawfish in the White River

Comportamiento migracional y diferenciación del stock del charal del Colorado en el Río White

KEYWORDS: telemetry; spawning migration; home-range; stock; Colorado squawfish; potamodromy

ABSTRACT

Radio transmitters were implanted into twelve Colorado squawfish *Ptychocheilus lucius* collected from the tailwaters of Taylor Draw Dam on the White River. Six fish were implanted in September 1992 and six fish in April 1993. Four of the twelve fish stayed in the tailwaters of the dam from September 1992 through June 1993. The other eight fish were relocated 30 km upstream of the dam in April 1993. The latter fish established new home-ranges in historic range upstream of the dam and remained there from April through June 1993.

All twelve fish migrated down the White River between May and July 1993. Seven squawfish traveled up the Green River to the spawning site in the Yampa River Canyon. Five fish migrated down the Green River to the spawning site in Grey/Desolation Canyon.

All radio-tagged fish migrated back to the White River after spawning. These fish exhibited long-distance freshwater spawning migration (potamodromy). They averaged 644 km during a 97-d period from May through October 1993. Two fish were recaptured in September 1993 and relocated 0.8 km upstream of Taylor Draw Dam in Kenney Reservoir.

In April 1994 five fish were found in the tailwaters below the dam and two fish (relocated upstream of the dam in September 1993) were tracked further upstream of the dam. In July these seven fish and the remaining five fish were found either upstream in the Yampa River spawning site or downstream in the Green River spawning site. All twelve fish returned to the same spawning areas in 1994.

This study suggests that two Colorado squawfish populations use the White River. Based upon stock recruitment relationships, the White River represents a mixed stock population of Colorado squawfish and should be managed accordingly.

CLAVES: telemetría; migración de desove; rango casero; stock; charal del Colorado; potádromo

RESUMEN

Radiotransmisores fueron implantados en doce charales del Colorado *Ptychocheilus lucius* colectados del vertedor de la presa Taylor Draw sobre el Río White. Seis peces fueron implantados en Septiembre de 1992 y seis en Abril de 1993. Cuatro de los doce peces permanecieron en el vertedor de la presa, desde Septiembre de 1992 a Junio de 1993. Los otros ocho peces fueron relocalizados 30 kilómetros aguas arriba de la presa, en Abril de 1993. Estos últimos establecieron nuevos rangos caseros en el rango histórico aguas arriba de la presa y permanecieron allí de Abril a Junio de 1993. Los doce peces emigraron aguas abajo en el Río White, entre Mayo y Junio de 1993. Siete peces viajaron al Río Green, a los sitios de desove en el Yampa River Canyon. Cinco peces emigraron hacia abajo del Río Green, a los sitios de desove en Grey/Desolation Canyon.

Todos los peces marcados con radio regresaron al Río White después del desove. Estos peces mostraron migración de largas distancias para desovar en aguas dulces (potádromos). Estos peces promediaron 644 kilómetros durante un período de 97 días, de Mayo a Octubre de 1993. Dos peces fueron recapturados en Septiembre de 1993 y relocalizados 0.8 kilómetros aguas arriba de la Presa Taylor Draw en el Reservorio Kenney.

En Abril de 1994 cinco peces fueron encontrados en el vertedor abajo de la presa y dos peces (relocalizados aguas arriba de la presa en Septiembre de 1993) fueron rastreados más allá de aguas arriba de la presa. En Julio, estos siete peces y los restantes cinco fueron encontrados aguas arriba en el sitio de desove del Río Yampa, o aguas abajo en el sitio de desove del Río Green. Los doce peces regresaron a las mismas áreas de desove en 1994.

Este estudio sugiere que dos poblaciones del charal del Colorado usan el Río White. Basados en las relaciones del reclutamiento del stock, el Río White representa una población con stock mixto del charal del Colorado y deberá ser manejado de acuerdo a esto.

SCHAUGAARD,C.J.*; CROWL,T.A. (CJS and TAC - Ecology Center and The Department of Fisheries and Wildlife, Utah State University, Logan, UT)

The effects of temperature regime and food availability on growth rates of Colorado squawfish (Ptychocheilus lucius) in the Green River, Utah

Los efectos de los regímenes de temperatura y disponibilidad de alimento sobre las tasas de crecimiento del charal del Colorado (*Ptychocheilus lucius*) en el Río Green, Utah

KEYWORDS: squawfish; temperature; competition; non-natives; Green River; Utah

ABSTRACT

Summer growth rates of young-of-the-year Colorado squawfish (*Ptychocheilus lucius*) are important for their survival into the next year. Changes to the Colorado River system such as dams and introductions of non-native fish have been implicated in decreased squawfish growth rates. Dams decrease water temperatures which result in lower growth rates, while non-native species may compete for a limited food supply and predate upon small native fishes. To help assess these impacts, we conducted both lab and field experiments to determine whether squawfish are food-limited in different areas of river backwaters where juveniles rear. Preliminary data collected in the summer of 1993 suggests that gradients of temperature and food availability exist in these backwaters and that squawfish may face a trade-off. Higher food densities may occur at temperatures that are not optimum for growth. To test this hypotheses, aquarium and field enclosure experiments were conducted to determine optimum temperature regimes and food availabilities that result in highest growth rates. These two driving variables were examined both independently and in concert. Our results suggest that squawfish may be spending time in less than optimum habitats due to food limitations that are a result on non-native fish competition.

CLAVES: charal del Colorado; temperatura; competencia; no nativos; Río Green; Utah

RESUMEN

Las tasas de crecimiento de verano de los juveniles del año del charal del Colorado (*Ptychocheilus lucius*) son importantes para su sobrevivencia en el año siguiente. Los cambios en el sistema del Río colorado tales como presas e introducciones de peces no nativos han estado implicadas en la baja en las tasas de crecimiento del charal del Colorado. Las presas bajan la temperatura del agua lo cual resulta en tasas de crecimiento más bajas, mientras que las especies no nativas pueden competir por un limitado suministro de alimento y predan sobre peces nativos pequeños. Para ayudar a evaluar estos impactos, conducimos estudios de campo y laboratorio para determinar si el charal del Colorado está limitado por el alimento en diferentes áreas del río donde los juveniles se refugian. Los datos preliminares recolectados en el verano de 1993, sugieren que los gradientes de temperatura y disponibilidad de alimento existen en este refugio y que los charales del Colorado pueden hacer frente a este cambio. Las necesidades de alimento más altas pueden ocurrir a temperaturas que no son óptimas para el crecimiento. Para probar esta hipótesis, fueron conducidos experimentos de campo y en acuarios, para determinar los regímenes de temperatura óptima y disponibilidad de alimento en donde se alcanzan las tasas más altas de crecimiento. El manejo de estas dos variables fueron manejadas independientemente y en conjunto. Nuestros resultados sugieren que el charal del Colorado puede estar perdiendo tiempo en hábitats menos óptimos debido a las limitantes de alimento que son resultado de la competencia con peces no nativos.

TIBBETS,C.A. (Department of Zoology, Arizona State University)

Geographic variation in the cyprinid fish, *Agosia chrysogaster*, as detected by cytochrome b sequences

Variación geográfica en el ciprinido, *Agosia chrysogaster*, detectada por la secuencia del citocromo b

KEYWORDS: *Agosia chrysogaster*; Arizona; New Mexico; Mexico; biogeography; cytochrome b

ABSTRACT

Agosia chrysogaster is a cyprinid minnow native to the lower Colorado River drainage of Arizona and New Mexico, and river drainages of northwestern Mexico. Previous morphological and allozyme studies have produced incongruent results describing relationships of Mexican drainages with those of the United States. To further resolve biogeographic relationships among drainages inhabited by *A. chrysogaster*, sequence analysis of the mitochondrial cytochrome b gene will be utilized. Preliminary sequence data has been obtained from ten U.S. and one Mexican sample. Cladistic analysis has been able to resolve relationships among all samples, with the majority of nodes highly supported by bootstrap analysis. Although the results are similar to those of morphological and allozyme data sets, direct comparisons cannot yet be made due to the lack of Mexican samples.

CLAVES: *Agosia chrysogaster*; Arizona; Nuevo México; biogeografia; citocromo b

RESUMEN

Agosia chrysogaster es un ciprinido nativo a los drenajes de las partes bajas del río Colorado en Arizona y Nuevo México. Estudios previos morfológicos y aloenzimáticos han producido resultados incongruentes describiendo relaciones entre las cuencas mexicanas y de los Estados Unidos. Para resolver mas al fondo relaciones biogeográficas entre las cuencas habitadas por *A. chrysogaster*, análisis de secuencia del gen del citocromo b mitocondrial serán utilizados. Datos preliminares de secuencias han sido obtenidos de diéz poblaciones de los Estados Unidos y uno de México. Un análisis cladístico ha podido resolver las relaciones entre todas las muestras, con la mayoría de los nudos altamente apoyados por un análisis "bootstrap". No obstante que los resultados son muy similares a aquellos de los juegos de datos morfológicos y aloenzimáticos, una comparación directa aun no se puede hacer debido a la ausencia de muestras mexicanas.

LENTSCH,L.D.*; MADDUX,H.R.; PERKINS,M.J. (LDL , MJP - Utah Div. Wildlife, Salt Lake City; HRM - US Fish and Wildlife Service, Salt Lake City)

A conservation strategy for Virgin spinedace *Lepidomeda mollispinis mollispinis*

Una estrategia de conservación para "Virgin spinedace" *Lepidomeda mollispinis mollispinis*

KEYWORDS: Virgin River; management; conservation

ABSTRACT

A Conservation Agreement for the Virgin spinedace, *Lepidomeda mollispinis mollispinis* has been initiated to reduce threats to the species, stabilize populations, and to ensure that the component ecosystem processes that it depends on are maintained. The Virgin spinedace was proposed for listing as a threatened species pursuant to the Endangered Species Act (ESA) of 1973, as amended, on May 18, 1994 (50 CFR Part 17). This small minnow is endemic to the Virgin River drainage basin in Utah, Arizona, and Nevada. Land ownership in the basin is approximately 38% federal, 3% state, 5% Piaute Tribe and 54% private. The species was once common throughout clearwater tributaries of the Virgin River basin, and in the mainstem river above Pah Tempe Springs, Utah. There has been a 37-40% (approximately 52 miles) reduction in its historic range (approximately 140.7 miles). Current populations are highly fragmented, and occur almost exclusively within Utah. Human activities such as water development, agriculture, mining, urbanization, and the introduction of non-native fishes, have altered the Virgin River ecosystem. The subsequent alteration of fish habitat has resulted in the declining status of the Virgin spinedace. The primary purpose of this paper is to review threats to the species, and present management actions that will be required to ensure that those threats are alleviated.

CLAVES: Río Virgin; manejo; conservación

RESUMEN

Se ha iniciado un Acuerdo de Conservación para el "Virgin spinedace, *Lepidomeda mollispinis mollispinis*, con el fin de reducir las amenazas a la especie, estabilizar las poblaciones, y asegurar el mantenimiento de aquellos procesos del ecosistema de los que depende. El "Virgin spinedace" fue propuesto para enlistarlo como una especie amenazada en concordancia con el Acta de Especies en Peligro de los Estados Unidos (Endangered Species Act (ESA)) de 1973, enmendada en mayo 18, 1994 (50 CFR Part 17). Este pequeño charal es endémico de la cuenca del Río Virgin en Utah, Arizona, y Nevada. La propiedad de los terrenos en la cuenca es aproximadamente 38% federal, 3% estatal, 5% tribu Paiute y 54% privada. La especie en un tiempo fue común através de las aguas claras de los tributarios de la cuenca del Río Virgin, y en la corriente principal río arriba de Pha Tempe Springs, Utah. Allí ha estado reducido en un 37-40% (aproximadamente 52 millas) de su rango histórico (aproximadamente 140.7 millas). Las poblaciones actuales están altamente fragmentadas, y ocurre casi exclusivamente en Utah. Actividades humanas tales como desarrollos de agua, agricultura, minería, urbanización, y la introducción de peces no nativos, han alterado el ecosistema del Río Virgin. La subsecuente alteración del hábitat del pez ha resultado en un estado de declinación del Virgin spinedace. El propósito principal de este escrito es revisar las amenazas a la especie, y acciones de manejo presentes que sean requeridas para asegurar que aquellas amenazas sean aliviadas.

WHITE,J.N.*; MONTGOMERY,W.L. (JNW, WLM - Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ 86011-5640)

Non-native predation: Direct and indirect effects on Little Colorado spinedace, *Lepidomeda vittata* (Teleostei: Cyprinidae)

Depredación por no nativos: Los efectos directos e indirectos sobre el Little Colorado spinedace, *Lepidomeda vittata* (Teleostei: Cyprinidae)

KEYWORDS: Little Colorado spinedace; *Lepidomeda vittata*; crayfish; behavior; predation; exotic species

ABSTRACT

Predation by introduced species may play a major role not only in the decline of Little Colorado spinedace (*Lepidomeda vittata*), but in the overall decline of Colorado River basin fishes. Crayfish (*Orconectes virilis*) are a relatively recent addition to a growing list of introduced species. Spinedace and crayfish occupy similar habitats in the East Clear Creek drainage, a tributary to the Little Colorado River and designated critical habitat of spinedace. Male crayfish were captured more often than females with meat-baited traps, suggesting that males may be more carnivorous than females and may seek out high energy foods such as fish eggs. In two preliminary trials, male crayfish consumed an average of 94.6% of spinedace eggs in 72 hours. Crayfish may also alter spinedace behavior or limit spinedace access to refugia. Schooling behavior and refuge use of spinedace were studied in wading pools. In these pools, and in the absence of crayfish, spinedace travelled in schools 95% of the time, occupied a cement block refuge 58% of the time, and maintained a position near the substrate (0-7cm in 24cm depth) 68% of the time. Crayfish occasionally displaced small schools (5 fish) of spinedace from cover, and while under cover fish appear to be more widely dispersed in the absence of crayfish than when crayfish are present.

CLAVES: Little Colorado spinedace; *Lepidomeda vittata*; langostino; comportamiento; depredación; especies exóticas

RESUMEN

La depredación por especies introducidas puede jugar un papel importante no solamente en la declinación del Little Colorado spinedace, si no también en todas las especies de la Cuenca del Río Colorado. El langostino (*Orconectes virilis*) es una adición relativamente reciente a una lista creciente de especies introducidas. El spinedace y el langostino ocupan hábitats similares en el drenaje del East Clear Creek, un tributario del Pequeño Río Colorado (Little Colorado River) y designado como hábitat crítico para el spinedace. Los langostinos machos fueron capturados con mas frecuencia que las hembras en trampas con carnada, lo que sugiere que los machos pueden ser más carnívoros que las hembras y quizás busquen alimentos de alta energía como los huevos de peces. En dos ensayos preliminares, los langostinos machos consumieron un promedio de 94.6% de huevos de spinedace en 72 horas. Los langostinos también pueden alterar el comportamiento del spinedace o limitar su acceso a refugios. El comportamiento de escuela y uso de refugio del spinedace fueron estudiados en estanques. En estos estanques, y en la ausencia de langostinos, los spinedace se movieron en escuelas el 95% del tiempo, ocuparon un bloque de cemento como refugio un 58% del tiempo, y mantuvieron una posición cerca del substrato (0-7 cm en 24 cm de profundidad) el 68% del tiempo. Los langostinos ocasionalmente desplazaron de su cobertura a pequeñas escuelas de spinedace (5 peces), y mientras estuvieron bajo la cobertura los peces parecieron mas ampliamente dispersos en ausencia de langostinos que cuando estuvo presente.

HOLDEN,P.B. (BIO/WEST Inc., Logan, Utah)

Where do the fish go when the river is dewatered? The lower Virgin River, 1994

¿Hacia donde van los peces cuando el río es desecado? El bajo Río Virgin, 1994

KEYWORDS: Virgin River; woundfin; dewatering

ABSTRACT

During 1993 our studies found a group of endangered woundfin, *Plagopterus argentissimus* in the lower Virgin River of Nevada. River flows were relatively high throughout 1993. During 1994, flows in the Virgin River were more typical, with irrigation withdrawals diverting all of the river at its lower end. This paper describes how the fish community responded to dewatering of the river, and the kinds of habitats that were utilized by woundfin and other species to survive this period.

CLAVES: Río Virgin; woundfin; desecación

RESUMEN

Durante 1993 nuestros estudios encontraron un grupo del woundfin *Plagopterus argentissimus* en el bajo Río Virgin de Nevada. El Río fluyó relativamente alto en 1993. Durante 1994, el flujo en el Río Virgin fue más típico, con escurrieras de irrigación en todo el río en su parte baja. Este articulo describe

como la comunidad de peces responde a la desecación del río y el tipo de hábitats que fueron utilizados por el woundfin y otras especies para sobrevivir este período.

REYNOSO-MENDOZA,F. (Museo de História Natural, Universidad Autónoma de Baja California Sur, A.P. 219-B, La Paz, 23080. Baja California Sur, México)

A new population of *Fundulus lima* Vaillant 1894 (Cyprinodontidae) in Baja California, México

Una nueva población de *Fundulus lima* Vaillant 1894 (Cyprinodontidae) en Baja California, México

KEYWORDS: distribution; Baja California; México; freshwater fishes

ABSTRACT

A new population of *Fundulus lima* Vaillant 1894 (Cyprinodontidae) was found in the oases of San Luis Gonzaga, where 28 specimens we collected during summer of 1992. The meristic counts of the specimens are shown, as is a brief description of this locality.

CLAVES: distribución; Baja California; México; peces continentales

RESUMEN

En el oasis de San Luis Gonzaga se encontró una población de *Fundulus lima*, Vaillant 1894 (Cyprinodontidae), en donde se colectaron 28 ejemplares durante el verano de 1992. Se presentan los datos merísticos de los ejemplares colectados así como una descripción de esta localidad.

ALANÍZ-GARCÍA,J.*; RUIZ-CAMPOS,G. (JA and GR - Facultad de Ciencias, Universidad Autónoma de Baja California, México)

Trophic interaction between the endemic cyprinodontid *Fundulus lima* and the poeciliid *Xiphophorus helleri* in the San Ignacio oasis, B.C.S., México

Interacción trófica entre el ciprinodóntido endémico *Fundulus lima* y el poecílido exótico *Xiphophorus helleri* en el oasis de San Ignacio, B.C.S., México

KEYWORDS: *Fundulus lima*; *Xiphophorus helleri*; trophic overlap; San Ignacio Oasis; Baja California Sur

ABSTRACT

Trophic interaction between the endemic cyprinodontid *Fundulus lima* (Vaillant) and the exotic poeciliid *Xiphophorus helleri* (Heckel) was studied during spring and summer conditions. The fishes were collected during 24-h periods using minnow traps. The stomach contents and the ecomorphological characteristics of both species were qualitatively and quantitatively analysed. The trophic overlap, niche breadth, and prey size were measured for these species.

CLAVES: *Fundulus lima*; *Xiphophorus helleri*; traslape trófico; Oasis San Ignacio; Baja California Sur

RESUMEN

La interacción trófica entre el ciprinodóntido endémico *Fundulus lima* (Vaillant) y el poecilído exótico *Xiphophorus helleri* (Heckel) fue estudiada durante condiciones de primavera y verano. Los peces fueron colectados con trampas tipo "minnow" durante ciclos de 24 horas. Los contenidos estomacales y las características ecomorfológicas de ambas especies fueron cuali- y cuantitativamente analizadas. El traslape trófico, amplitud de nicho, y tamaño de presa fue medido para ambas especies.

BUKTENICA,M.W. (U.S. National Park Service, Crater Lake National Park, Oregon)

Bull trout restoration and brook trout eradication at Crater Lake National Park, Oregon

Restauración de la trucha toro (Bull trout) y erradicación de la trucha de arroyo (brook trout) en el Parque Nacional Crater Lake, Oregon

KEYWORDS: restoration; eradication; antimycin; electroshocking; barrier construction; hybridization

ABSTRACT

A survey of fish populations and instream habitat in Sun Creek, Klamath River Basin, Oregon, during the summer of 1989 revealed a remnant population of resident bull trout *Salvelinus confluentus* sympatric with introduced brook trout *Salvelinus fontinalis* in a 1.9 km reach near an upper edge of useable habitat. Hybridization and competition with the brook trout appeared to threaten the bull trout population with a high risk of extinction. A bull trout restoration plan

was drafted and peer reviewed in October, 1991. The objectives of the plan were to restore the remnant population of bull trout to historic numbers and distribution in Sun Creek (within the park), remove the brook trout, and prevent re-invasion of non-native species in the future.

During the summer of 1992, a restoration program was initiated. Brook trout were removed from Sun Creek with electroshockers within and upstream of the bull trout zone, and with a piscicide, antimycin, downstream of the bull trout. Two log and rock barriers were constructed near the park boundary to prevent re-invasion of non-native fishes. Genetic analysis on a small sample of trout suggested that identification of bull trout-brook trout hybrids from field marks was not reliable. Brook trout removal will continue and a monitoring program is in place to evaluate bull trout and macroinvertebrate recovery.

CLAVES: restauración; erradicación; antimicina; electropesca; construcción de barreras; hibridación

RESUMEN

Una evaluación de las poblaciones de peces y hábitat de arroyos en Sun Creek, Cuenca del Río Klamath, Oregon, durante el verano de 1989 revelan una población remanente de truchas toro residentes *Salvelinus confluentus* simpátrica con la trucha de arroyo *Salvelinus fontinalis* en un hábitat disponible de 1.9 Km. La hibridación y competencia con la trucha de arroyo aparenta una amenaza para la población de la trucha toro con una alta tendencia a la extinción. Un plan de restauración de la trucha toro fue bosquejado y revisado en Octubre de 1991. Los objetivos del plan fueron para restaurar la población remanente de la trucha toro a sus números históricos y distribución en Sun Creek (dentro del parque), remover la trucha de arroyo, y prevenir la re-invasión de especies no nativas en el futuro.

Durante el verano de 1992, un programa de restauración fue iniciado. La trucha de arroyo fue removida desde el Sun Creek con electropesca arroyo arriba de la zona, y con pesticidas, antimicina, arroyo abajo respecto de la trucha toro. Dos barreras con leños y rocas fueron construidos cerca del límite del parque para prevenir la re-invasión de peces no nativos. Los análisis genéticos en una pequeña muestra de la trucha sugieren que la identificación de la trucha híbrida producto de la cruza entre la trucha toro y de arroyo, considerando marcas en campo, no es segura. La remoción de la trucha de arroyo continuará, y un programa de monitoreo esta en proceso para evaluar la recuperación de la trucha toro y los macroinvertebrados.

CLARKSON,R.W.*;WILSON,J.R. (Research Branch, Arizona Game and Fish Department, Phoenix, AZ; Department of Decision and Information Systems, Arizona State University, Tempe, AZ)

Trout biomass and stream habitat relationships in the White Mountains area, east-central Arizona

Relaciones de biomasa de trucha y habitat en el área de las White Mountains, Arizona este-central

KEYWORDS: trout; Apache trout; Arizona; habitat; model; grazing; geomorphology

ABSTRACT

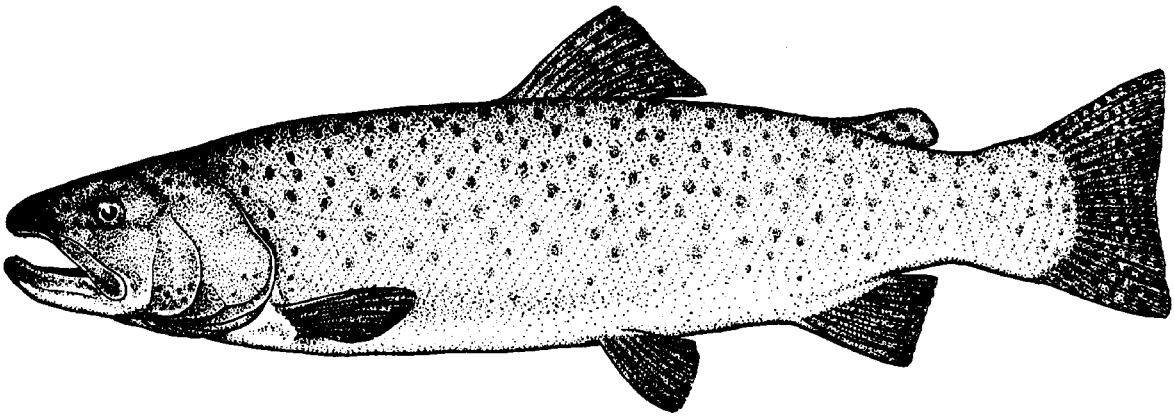
We surveyed stream habitats and fish populations at 243 stations among 21 high elevation trout streams in the Apache-Sitgreaves National Forest and White Mountain Apache Reservation in the White Mountains area, east-central Arizona, from 1986-1990. The White Mountains area comprises the majority of historic habitat for the federally threatened Apache trout, *Oncorhynchus apache*. A generalized linear model relating trout biomass and stream, riparian, and geomorphic habitat variables was developed (R^2=0.68). Among the significant variables in the systematic components of the model, bank ungulate damage was the only variable solely influenced by land management practices. We attribute the bulk of the bank damage to domestic cattle grazing, and conclude that better cattle management is necessary for improvement of trout habitats. Another significant variable, channel width, was partly dictated by geomorphology, but also correlated with bank ungulate damage. Three significant variables in the model were completely geomorphic (station elevation, channel type, riparian area width) and thus not useful for management purposes. The model coefficient of determination was relatively low in comparison with some other trout-habitat models developed in the West. This result may indicate that trouts in our study area are limited less by physical habitat than by climatic events or predation/competition influences.

CLAVES: trucha; trucha Apache; Arizona; hábitat; modelo; pastoreo; geomorfología

RESUMEN

Se estudiaron hábitats de arroyos y poblaciones de peces en 243 estaciones en 21 arroyos de gran elevación en el Bosque Nacional Apache-Sitgreaves y la reservación Apache White Mountains en el area de estas montañas, Este-central de Arizona, desde 1986-1900. El área de White Mountains comprende la mayor parte de los hábitats históricos para la federalmente en peligro de extinción trucha apache. Un modelo lineal generalizado que relaciona la biomasa de la trucha y el arroyo, y variables de hábitats riparios y geomórficos, fue desarrollado (R^2=0.68). Entre las variables mas significativas en el modelo de componentes sistemáticos, los daños causados por ungulados fue la única variable, individualmente influenciada por el manejo del terreno. Atribuimos la mayor parte del daño al pastoreo por ganado vacuno, y concluimos que un mejor manejo del ganado es necesario para lograr la mejoría del habitat de

la trucha. Otra variable significativa fue la amplitud del canal, que en parte fue dictada por la geomorfología, también correlacionada con el daño ocasionado por los ungulados. Tres variables significativas fueron completamente geomórficas (altitud de la estación, tipo de canal y la amplitud del area riparia) y por lo tanto no son útiles para propósitos de manejo. El coeficiente de determinación del modelo fue relativamente bajo en comparación con alguno de los otros modelos de trucha-habitat desarrollados en el Oeste Estos resultados indican que las truchas en nuestra area de estudio están menos limitadas por el habitat físico que por eventos climáticos o por influencias de depredación/competencia.



Drawing of *Oncorhynchus clarki* courtesy of University of Nevada Press, Reno, Nevada from "Fishes and Fisheries of Nevada" by Ira La Rivers.

***RINNE,J.N.; ALEXANDER,M.** (United States Forest Service, Southwest Forest Science Complex, 2500 S. Pineknoll Drive, Flagstaff, AZ 86001)

Non-native salmonid predation on two threatened native species: preliminary observations from field and laboratory studies

Predación de salmónidos no nativos sobre dos especies nativas amenazadas: resultados preliminares de los estudios campo y laboratorio

KEYWORDS: predation; salmonids; exotic species; cyprinids; turbidity

ABSTRACT

Results of field enclosure (net cages) and laboratory studies suggest that introduced rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) are effective predators on the native Little Colorado spinedace (*Lepidomeda vittata vittata*). Under field conditions and at low (< 20 NTU) to intermediate (60-80 NTU) turbidities, experimental spinedace populations (40-70 mm) were reduced by 50 to 95% within 7 to 12 days. At turbidities of 80 to 106 NTU, loss of prey ranged from 0 to 60% (mean 30%). Reduction in spinedace numbers in net cages was inversely related to turbidity of water. Laboratory studies using native Apache trout (*Oncorhynchus apache*) fry (50-70 mm) as prey and brown trout as the predator indicate that substantial predation occurs at turbidities of => 200 NTU. Similarly, addition of cover up to 35% failed to effectively reduce predation. Laboratory studies in clear waters (<5 NTU) suggest rate of predation on Apache trout fry by brown and rainbow trout is dramatic (50-60% in 24 hours). These data substantiate that predation in the wild by introduced trouts is a major contributor to the decline of these two native species.

CLAVES: depredación; salmónidos; especies exóticas; cyprínidos; turbidez

RESUMEN

Los estudios de campo en encierros (jaulas) sugieren que la trucha arcoiris introducida (*Oncorhynchus mykiss*) y la trucha café (*Salmo trutta*) son predadores efectivos sobre las poblaciones del pez nativo Little Colorado spinedace (*Lepidomeda vittata vittata*). En 7 a 12 días y en turbideces bajas (< 20 NTU) a intermedias (60-80 NTU), las poblaciones experimentales de la especie nativa (40-70 mm) fueron reducidas del 50 al 95%. A turbideces de 80 a 106 NTU, la pérdida de presas variaron de 0 a 60% (media del 30%). Los estudios de laboratorio usando como presa pececillos (50-70 mm) de trucha apache nativa (*Oncorhynchus apache*), y como depredador a la trucha café indican que ocurre una predación sustancial a turbideces de 200 NTU y no decrece significativamente hasta alcanzar turbideces de 300 NTU o más. Los estudios de laboratorio en aguas claras (<5 NTU) sugieren que la tasa de depredación de los pececillos de la trucha apache por las trucha café y trucha arcoiris es dramática (50-60% en 24 horas) Estos datos apoyan que la depredación en el medio silvestre por truchas introducidas es el factor principal de declinación de estas dos especies nativas.

CONTRIBUTED PAPER

INTRODUCTION - Non-native fish introductions in the Southwestern United States have resulted in reduction and replacement of many native species. Interspecific interactions may come either singularly or as a combination of competition, hybridization or predation (Rinne 1994). The mechanism of hybridization is well documented for introduced salmonids and southwestern native trouts (Rinne 1985, 1988, 1994; Rinne and Minckley 1985; Rinne et al. 1986), and predation by introduced species, though difficult to demonstrate in the wild, is increasingly being demonstrated as an important factor in the reduction and replacement of native fishes. Minckley (1982) first suggested that decline of the threatened razorback sucker, *Xyrauchen texanus*, resulted from predation by introduced species on eggs and fry of this species. Meffe (1985) demonstrated that the introduced western mosquitofish, *Gambusia affinis*, was an effective predator on the native, endangered Gila topminnow, *Poeciliopsis occidentalis*. Marsh and Brooks (1989) reported the marked effect of ictalurid catfish predation on young of introduced razorback sucker. Blinn et al. (1992) reported that rainbow trout, *Oncorhynchus mykiss*, may have a significant impact on the distribution and abundance of the native, threatened Little Colorado spinedace, *Lepidomeda vittata vittata*.

The primary objective of this combined laboratory and field study was to build upon and expand results of those of Blinn et al (1993). Accordingly, introduced salmonid predators, brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*), were used in addition to rainbow trout.

MATERIALS AND METHODS - Hatchery-reared fingerlings (60-100 mm TL) of the native Apache trout, *Oncorhynchus apache*, were used in laboratory experimentation. This species was used, in part, because it was readily available from the Williams Creek National Fish Hatchery as a by product of the U. S. Fish and Wildlife Service's Apache trout rearing program. Further, potential predation effects on this species in the wild could be estimated. Finally, because of morphology

and behavioral traits the Apache trout could serve as a"surrogate" for the much rarer and difficult to obtain spinedace. Because introduced trouts and the native spinedace occur in the same reaches of stream, a final objective was to determine the roles of turbidity of water and cover as factors in reducing introduced trout predation on the spinedace.

Predation relative to turbidity was conducted under field conditions in net enclosures constructed of 3.1 mm (1/8 inch) mesh and 1.5 m X 3.0 m in size. Nets were deployed in Nutrioso Creek (see Blinn et al. 1993) below Nelson Reservoir in summer for periods of 7 to 12 days. Turbidities of water in nephelometric turbidity units (NTU) were estimated from water samples taken at surface, mid-water, and bottom at three locations within each cage and analyzed with a Hach turbidly meter. Spinedace (the prey) and trout (the predator) were measured, counted, and placed in the cages. At conclusion of the experiment, all remaining fishes were removed and counted to determine the percent predation.

Laboratory studies were designed to permit controlled and elevated levels of turbidity in artificial, circular raceways (Frigid Units) 3 to 7 m in length. Fines used in studies were sieved from substrate materials collected in streams from the White Mountain region where all species occur in the wild. Water temperature was controlled by a Frigid Units chiller. Water temperatures ranged from 10 to 13° C during experimentation. Water was circulated by a 1 HP pump

Table 1. Results of laboratory predation studies using introduced salmonids and hatchery-reared Apache trout (*Oncorhynchus apache*).

		Number of Prey		%	Duration
Predator	N	Start	End	loss	(days)
Rainbow	2	25	9	64	1
Rainbow	2	25	8	68	1
Rainbow	2	25	10	60	1
Rainbow	2	25	10	60	1
Rainbow	2	25	9	64	1
Rainbow	2	25	8	68	1
Brown	2	25	10	60	1
Brown	2	25	10	60	1
Brook	2	10	6	30	3

to sustain turbidity. At conclusion of experiments, predator and prey were enumerated to permit calculation of percentage predation over the duration of the experiment. Additional laboratory studies were conducted in presence of the abiotic influence of cover and with neither cover or turbidity present. Cover was comprised of stream cobble (150- 300 mm) placed in raceways. Percent cover was calculated as the percentage of surface area of the cobble relative to that of the total experimental area.

RESULTS - Initial laboratory experiments in absence of either turbidity or cover were conducted with rainbow and brown trout as predators (Table 1).In a period of 24 hours rainbow trout reduced Apache trout fingerlings from 60 to 68% (mean = 60%). Similar results occurred using brown trout as the predator, however, brook trout reduced Apache trout numbers by only 30% in three as opposed to one day.

Table 2. Results of laboratory predation studies with Brown trout (> 200 mm) and Apache trout (75-100 mm) at varying, artificially-created turbidities.

Number of predator	Number of Prey Start	End	% loss	Duration (days)	Turbidity (NTUs)
4	45	15	66	4	214
4	40	30	25	3	200
2	20	6	70	3	195
2	45	35	22	4	200-300

Similar experiments using brown trout as the predator in artificially high turbidities (>195 NTU) showed a somewhat reduced average loss of prey species (Apache trout; mean = 45%) in a 3-4 day period (Table 2). By comparison, imposed cover from 13 to 35% did not reduce predation efficiency of either brown

Table 3. Results of laboratory predation studies using brown and rainbow trout as predators and Apache trout fingerlings as prey with varying percentages of cover.

		Number of Prey		%	Duration	%
Predator	N	Start	End	loss	(days)	cover
Rainbow	2	14	1	93	3	13
Rainbow	2	14	4	71	3	25
Brown	2	25	8	68	4	15
Brown	2	25	6	76	3	35

or rainbow trout (Table 3) In fact mean loss (77%) was greater than in clear waters with no cover (mean of 60%; Table 1).

Field experiments using rainbow trout, hybrid Apache X rainbow trout, and brown trout in presence of turbidity indicated that as turbidity increased, loss of prey decreased (Table 4).

Compared to lab experiments conducted for about half the time period (4 *vs* 8 days), and at significantly lower turbidities (85 vs 200 NTU), there was no difference in comparative loss of prey species to predation. This assumes there is no difference in prey (Apache trout vs spinedace) response to the predator (brown trout).

Table 4. Results of field predation studies in cage enclosures using introduced salmonids (>175 mm, TL) and their hybrids as predators and Little Colorado spinedace (40-60 mm, TL) as prey. Studies were conducted at naturally-occurring turbidities in Nutrioso Creek on the Apache Sitgreaves National Forest.

		Number of Prey		%	Duration	Turbidity
Predator	N	Start	End	loss	(days)	(NTUs)
Rainbow	0	40	27	33	10	no data
Rainbow	4	35	3	89	10	no data
Rainbow	4	35	1	97	10	no data
Rainbow	2	20	9	55	7	13
Rainbow	2	20	14	30	12	82
Rainbow	4	20	20	0	9	103
Hybrid	2	20	2	90	7	9
Hybrid	2	20	3	85	12	63
Hybrid	2	5	2	60	9	82
Brown	2	20	8	60	7	18
Brown	2	20	9	55	12	76
Brown	4	10	7	30	9	160

DISCUSSION-- Rinne and Janisch (in press) recorded the extensive introductions of non-native salmonid and non-salmonid species in the White Mountains of east-central Arizona over the past half century. They attributed the decline in range and numbers of the threatened Apache trout and Little Colorado spinedace, in part, to these extensive introductions. Results of both field and laboratory predation studies indicate that indeed, predation as a mechanism of interaction with non-native trout may certainly be significant in the reduction and replacement of these two threatened native species. For example, many streams on the Fort Apache Indian Reservation that once were considered to be a stronghold for the native trout (Rinne 1985) are now almost totally occupied by the introduced brown trout. Further, rainbow x Apache trout hybrids occupy the upper reaches of Nutrioso Creek above the town of Nutrioso, where spinedace, formerly present, is now absent.

Turbid waters exist below Nelson Reservoir in Nutrioso creek where introduced trouts and spinedace co-occur. These turbidities may reduce the effectiveness of predation, however, potential loss to predation is yet significant (ca. 60% in a week to 10days). Similarly, cover up to 35% did not effectively reduce predation efficiency of either rainbow or brown trout.

MANAGEMENT IMPLICATIONS - Based on distributions in the wild, results of Blinn et al (1993), and these field and laboratory studies, it appears that sustaining and enhancing the threatened native Apache trout and Little Colorado spinedace will necessitate removal of non-native salmonid predators. Renovations of native Apache trout streams involving removal of non-native trout has been (Rinne and Turner 1991), and will continue to be (Rinne and Janisch, in press) a necessary component of a successful restoration of this species to its native range. The combination of hybridization with and predation by non-native salmonids effectively will extirpate the native Apache trout. Similarly, any restoration of the Little Colorado spinedace must be in streams free of introduced trouts and secure from invasion by them.

LITERATURE CITED

BLINN, D. W., C. RUNCK, D. A. CLARK, AND J. N. RINNE. 1993. Effects of rainbow trout predation on Little Colorado spinedace. **Trans. Amer. Fish. Soc**. 122: 130-143.

MARSH, P. C. AND J. L. BROOKS. 1989. Predation by ictalurid catfishes as a deterrent to re-establishment of introduced razorback suckers. **Southwest. Nat.** 34: 188-195.

MEFFE, G. K. 1985. Predation and species replacement in American southwestern fishes: A case study. **Southwest. Nat**. 30 173-187.

MINCKLEY, W. L. 1982. Status of razorback sucker, *Xyrauchen texanus*, in the lower Colorado River basin. **Southwest. Nat.** 28: 165-187.

RINNE, J. N. 1985. Variation in Apache trout populations in the White Mountains, Arizona. **N. Amer. J. Fish. Mgmt**. 5:147-158.

_____. 1988. Native southwestern (USA) trouts: status, taxonomy, ecology, and conservation. **Pol. Arch. Hydrobiol**. 34 (3-4): 305-320.

_____. 1994. Declining southwestern aquatic habitats and fishes: Are they sustainable? Sustainability Symposium. **USDA Forest Service, Gen. Tech. Rep.** RM-247: 256-265.

_____. AND W. L. MINCKLEY. 1985. Patterns of variation and distribution in Apache trout (*Salmo apache*) relative to co-occurrence with introduced salmonids. **Copeia** 1985: 285-292.

_____. AND P. R. TURNER. 1991. Reclamation and alteration as management techniques, and a review of methodology in stream renovation, pp 219-246. In, W.L. Minckley and J. E. Deacon. (eds.), **Battle Against Extinction: Native Fish Management in the American West**. Univ. Ariz. Press, Tucson.

_____. AND J. JANISCH. In press. **Coldwater fish stocking and native fishes in Arizona: Past, present and future**. Amer. Fish. Soc. Sympos., N. Amer. J. Fish. Manage. 15.

_____., R. SORENSON, AND S. C. BELFIT. 1986. An analysis of F1 Hybrids between Apache (*Salmo apache*) and rainbow trout (*Salmogairdneri*). **J. Ariz.-Nev. Acad. Sci.** 20(2):63-69.

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Competitive interactions between exotic brook trout and native Colorado cutthroat trout in high mountain streams

Interacciones competitivas entre la trucha exótica de arroyo y la trucha nativa Colorado cutthroat en los arroyos de altas montañas

KEYWORDS: cutthroat trout; brook trout; interference competition; streams

ABSTRACT

Since being introduced, brook trout populations have expanded in range and relative density, possibly at the expense of native Colorado River cutthroat trout. One hypothesis for the gradual replacement is that brook trout outcompete the natives for food resources. While the exact mechanism is not yet know, we hypothesize that brook trout are more general in their feeding behaviors and less gape-limited than the native salmonids. During the summer of 1993, we collected diet samples of both brook trout and cutthroat trout from streams with cutthroat only and brook and cutthroat together. Feeding behavior of cutthroat trout and brook trout was also studied experimentally in artificial laboratory streams and in a natural stream, partitioned by fencing, to examine the importance of interference and exploitative competition. Our results suggest that cutthroat trout feeding efficiency is lower due to interference competition with brook trout. The observed decreased feeding efficiency in the presence of brook trout results in significantly decreased growth rates during the relatively short summer growing season and may result in decreased overwinter survival due to limited lipid storage.

CLAVES: trucha cutthroat; trucha de arroyo; competencia de interferencia; arroyos

RESUMEN

Desde que fue introducida, las poblaciones de trucha de arroyo (brook trout) se han expandido en su rango de distribución y densidad relativa, posiblemente a expensas de la trucha nativa Colorado River cutthroat. Una de las hipótesis para el reemplazo gradual es que la trucha de arroyo compite con las especies nativas por los recursos alimenticios. Mientras que el mecanismo exacto aún se desconoce, nuestra hipótesis es que la trucha de arroyo es más general en sus hábitos alimenticios y menos limitada para comer que los salmónidos nativos. Durante el verano de 1993, colectamos muestras juntas de dietas de la trucha de arroyo y la trucha cutthroat. El comportamiento alimenticio de la trucha cutthroat y la trucha de arroyo también fue estudiada experimentalmente en arroyos artificiales y en un arroyo natural, fraccionados en partes con cercas, para examinar la importancia de la competencia de interferencia y explotación del hábitat. Nuestros resultados sugieren que la eficiencia alimenticia de la trucha cutthroat es más baja debido a la competencia de interferencia con la trucha de arroyo. El decremento en la eficiencia alimenticia observada, en presencia de la trucha de arroyo resulta en una significativamente decreciente tasa de crecimiento durante la relativamente corta estación de crecimiento de verano, y puede resultar en una sobrevivencia decreciente en invierno, debido a los limitados lípidos almacenados.

MATTHEWS,K.R.*; BERG,N.H. (Pacific Southwest Research Station, US Forest Service, Berkeley, California)

Rainbow trout habitat use in pools in the Sespe River, California during periods of thermal stress and low oxygen conditions

Uso del hábitat por la trucha arcoiris en estanques en el Río Sespe, California durante períodos de estrés termal y condiciones de bajo oxígeno

KEYWORDS: rainbow trout; water temperature; dissolved oxygen; thermal stress; hypoxia

ABSTRACT

We conducted a study to determine rainbow trout *Oncorhynchus mykiss* habitat use in a southern California stream where the summer water temperatures typically exceed trout lethal limits. During August 1994, we monitored water temperature and dissolved oxygen in two adjacent pools in Sespe Creek, Ventura County, where summer water temperatures can reach 28oC. From August 1-11, 1994 water temperatures ranged from the coolest of 21.5oC at the bottom (4.1 m) to 28.5oC at the surface in pool 1. After August 5, trout were no longer found in this pool suggesting that trout moved out of the high temperature water or died. In the adjacent, shallower (1.5 m) pool 2, surface water temperatures also were warm (up to 27.5oC) but temperatures on the bottom were cooler and ranged from 17.5-21oC presumably due to groundwater seeps that were observed. Consistent aggregations of trout were observed in Pool 2 throughout the study period. The seeps apparently brought in water with low dissolved oxygen (DO) conditions (hypoxia) as the DO in many locations on the bottom ranged from <1 mg/l to 5 mg/l over 24 hrs; hypoxia was common from 2400-0600 hours. Trout were typically found close to the bottom and were never observed feeding during our study. Although DO was higher at the surface (5 to 10.5 mg/l), the warmer temperatures likely precluded trout use of

the more oxygenated waters. These warm water periods common to southern California streams are stressful and may force rainbow trout to trade off between lethal levels of water temperature and hypoxia.

CLAVES: trucha arcoiris; temperatura del agua; oxígeno disuelto; estrés termal; hipoxia

RESUMEN

Conducimos un estudio para determinar el uso del hábitat de la trucha arcoiris (Oncorhynchus mykiss) en un arroyo del sur de California donde las temperaturas del agua en verano típicamente exceden los límites letales de la trucha. Durante Agosto de 1994, monitoreamos la temperatura y el oxígeno disuelto en dos estanques adyacentes en Sespe Creek, Condado de Ventura, donde las temperaturas del agua en verano pueden alcanzar 28.5°C. Del 1 al 11 de Agosto de 1994 las temperaturas del agua variaron de la más fría de 21.5°C en el fondo (4.1 m) a 28.5°C en la superficie en el estanque 1. Después de Agosto 5, las truchas no se encontraron más en este estanque, sugiriendo que las truchas se movieron o murieron. En el adyacente estanque 2, más somero (1.5 m) las temperaturas del agua en la superficie también fueron calientes (arriba de los 27.5°C), pero las temperaturas en el fondo fueron más frías y variaron de los 17.5 a los 21°C presumiblemente debido a las emanaciones de agua subterránea que fueron observadas. Agregaciones consistentes de truchas fueron observadas en el estanque 2 durante todo el período de estudio. Aparentemente las emanaciones introdujeron agua con condiciones de bajo oxígeno disuelto (OD) (hipoxia), pues el OD varió en muchas localidades en el fondo desde <1 mg/l a 5 mg/l en 24 horas; la hipoxia fue común desde las 2400 a las 1600 horas. Las truchas se encontraron típicamente cerca del fondo y nunca fueron observadas alimentándose durante nuestro estudio. Aunque el OD fue más alto en la superficie (5 a 10.5 mg/l), las temperaturas más calientes probablemente impiden el uso por las truchas, de aguas más oxigenadas. Estos períodos de agua caliente, comunes a los arroyos del sur de California son estresantes y podrían forzar a la trucha arcoiris a elegir entre niveles letales de temperatura del agua y la hipoxia.

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An examination of impacts of population fragmentation in Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*

Un examen de los impactos de la fragmentación de la población de la Lahontan cutthroat trout, *Oncorhynchus clarki henshawi*

KEYWORDS: cutthroat trout; demography; fragmented populations; genetics; Nevada

ABSTRACT

Habitat fragmentation is commonly observed in western streams. While this can result from natural processes associated with changes in runoff and discharge, it is increasingly the product of human-caused stream modification and water diversion. Human-caused habitat fragmentation is often more persistent and may occur at a different spatial scale and at different localities than naturally occurring fragmentation.

Habitat fragmentation can isolate small populations of organisms resident in such systems. The consequences of population fragmentation may include impacts on ecological, demographic and genetic characteristics of the remnant population fragments. It can be hypothesized that subpopulations with connected basins ought to be more similar to one another in both demographic and genetic characteristics than are fragmented populations. Migration among connected population units ought to provide an a mechanism to disperse demographic and genetic variation among units. Persistently fragmented units may be subject to more local variation and have no opportunity to exchange genetic material.

Although Lahontan cutthroat trout *Oncorhynchus clarki henshawi* were formerly widespread and locally abundant within the Lahontan Basin, over-exploitation, habitat destruction and establishment of exotic species have extirpated Lahontan cutthroat over 90% of their historic range. Most remaining cutthroat populations in the Great Basin are restricted to small, isolated streams, often in headwater areas including habitat less suitable for or inaccessible to non-native salmonids. Relatively intact drainage networks containing populations less affected by fragmentation remain in only three basins: South Fork Little Humboldt River, Maggie Creek and Marys River. The latter is by far the largest and perhaps most representative of historic conditions. Here, we report preliminary results from an investigation of the impacts of stream habitat fragmentation and population isolation on Lahontan cutthroat trout in tributaries of the Upper Humboldt River, northeast Nevada.

We are comparing ecological and genetic characteristics of Lahontan cutthroat populations in four fragmented populations in the Rock Creek and North Fork Humboldt River basins, and in four connected tributary streams in the Marys River basin.

Ecological investigations include annual examination of fish populations to assess extinction-recolonization, size and age structure of populations, and individual movements. Genetic studies are comparing both the amount and distribution of mitochondrial D-loop and DNA microsatellite variation among fragmented and connected populations.

Patterns of demographic variation varied among fragmented and connected basins and also differed between years. In both 1993 and 1994, demographic comparisons indicated that connected populations in the Marys River Basin were more similar to one another than were the fragmented populations. In 1993, Marys River basin populations consisted primarily of relatively large individuals at relatively low densities. The fragmented popualations examined contained greater numbers of fish and had larger biomass per unit area. Patterns of reproduction varied greatly between population groups and fragmented and connected groups. Marys River populations apparently reproduced after the mid August 1993 sampling, as indicated by fish caught during 1994. The relatively low densities of fish in the Marys River basin was unexpected and previously unreported.

Although these observations may be attributable to the impacts of population fragmentation, other factors, including stream gradient and elevation, differences in the timing of spawning and recruitment may play important roles. Thus, it appears that both within-stream (e.g. physical and biotic habitat) and among-stream (e.g. dispersal, migration and correlated environments) processes may be operating simultaneously. A more detailed analysis of physical and biotic habitat variables is underway to assess within-habitat processes and to examine the issue of environmental correlation.

Analysis of genetic variation within and among connected and fragmented streams detected no variation in mitochondrial D-loop sequences among our populations. However, preliminary results from microsatellite analyses indicate levels of variation among fragmented populations in the North Fork Humboldt River are greater than those among connected populations in the Marys River. If these results hold, it is reasonable to conclude that fragmentation has indeed isolated populations that formerly exchanged individuals via migration and/or dispersal in the recent past.

CLAVES: trucha cutthroat; demografía; poblaciones fragmentadas; genética; Nevada

RESUMEN

La fragmentación del hábitat es común observarla en las corrientes de agua, que puede ser resultado de un proceso natural asociado con los cambios en la corriente y la descarga, esto es producto cada vez más de las modificaciones de las corrientes y desviaciones del agua causada por los humanos. La fragmentación del hábitat por causas humanas es más persistente y puede ocurrir en una escala espacial diferente y en localidades diferentes que la fragmentación ocurrida naturalmente.

La fragmentación puede aislar pequeñas poblaciones de organismos residentes en muchos sistemas. Las consecuencias de la fragmentación de la población puede incluir impactos sobre la ecología, demografía y características genéticas de los fragmentos remanentes de la población. Puede ser hipotetizado que las subpoblaciones con cuencas conectadas deben ser más similares una con otra tanto en demografía como en características genéticas que las poblaciones fragmentadas. La migración entre las unidades poblacionales conectadas deben de proveer un mecanismo para la dispersión demográfica y la variación genética entre las unidades. Unidades fragmentarias persistentes pueden estar sujetas a más variaciones locales y no tener oportunidad para el intercambio de material genético.

Si bien la Lahontan cutthroat trout *Oncorhynchus clarki henshawi* fue localizada ampliamente distribuida y localmente abundante en la cuenca del Lahontan, la sobreexplotación, destrucción de hábitat y el establecimiento de especies exóticas, ha extirpado la Lahontan cutthroat trout sobre el 90% de su rango histórico. La mayoría de las poblaciones remanentes de cutthroat en la gran cuenca esta restringida a pequeñas y aisladas corrientes, frecuentemente en áreas incluyendo hábitats menos convenientes o inaccesibles.

Estos drenajes relativamente intactos contienen poblaciones remanentes menos afectadas por la fragmentación en solo tres cuencas: Río South Fork Little Humboldt, arroyo Maggie y el Río Marys. El ultimo es con mucho el más grande y posiblemente el más representativo de la condición histórica. Aquí, nosotros reportamos resultados preliminares de una investigación de impacto de la fragmentación de hábitats en la corriente y el aislamiento poblacional de la Lahontan cutthroat trout en los tributarios de el Alto Río Humboldt al Noreste de Nevada.
Nosotros hacemos una comparación ecológica y de características genéticas de las poblaciones de Lahontan cutthroat en cuatro poblaciones fragmentadas en las cuencas del Arroyo Rock y el Río North Fork Humboldt y en cuatro corrientes tributarias conectadas en la cuenca del Río Marys.

Investigaciones ecológicas incluyen la examinación anual de las poblaciones de peces para evaluar la extinción-recolonización, tamaño y edad, estructura de la población y movimientos individuales. Los estudios de genética son una comparación entre la cantidad y distribución del D-Loop mitocondrial y la variación del ADN microsatélite entre las poblaciones fragmentadas y conectadas.

Los patrones de la variación demográfica varían entre las cuencas fragmentadas y conectadas y también difieren entre años. En 1993 y 1994, las comparaciones demográficas indican que las poblaciones conectadas en la cuenca del Río Marys fueron más similares una con otra que las poblaciones fragmentadas.
En 1993 las poblaciones de la cuenca del Río Marys consistieron primordialmente de individuos grandes a bajas densidades.

Las poblaciones fragmentadas examinadas contuvieron un gran numero de peces y gran biomasa por unidad de área. Los patrones de reproducción variaron grandemente entre grupos de poblaciones y grupos de poblaciones fragmentadas y conectadas. Las poblaciones del Río Marys aparentemente se reproducen después de los muestreos de mediados de Agosto de 1993 como lo indican los peces capturados durante 1994. Las relativamente bajas densidades de peces en la cuenca del Río Marys fueron inesperadas y no reportadas previamente.

Sin embargo estas observaciones pueden ser atribuidas a los impactos de la fragmentación poblacional, otros factores que incluyen los gradientes y elevación de las corrientes, diferencias en el tiempo de desove y reclutamiento; pueden jugar un papel importante. Así esto aparentemente indica que ambos procesos, la corriente (e.g. hábitat físico y biótico) y la cantidad de la corriente (e.g. dispersión, migración y correlación del medio ambiente) pueden operar simultáneamente. Un análisis más detallado de los hábitats, variables físicos y bióticos es necesario para evaluar los procesos dentro del hábitat y para examinar la correlación con el medio ambiente.

El análisis de la variación genética dentro y a lo largo de las corrientes conectadas y fragmentadas detectadas no varia las secuencias del D-Loop mitocondrial a lo largo de nuestras poblaciones. Sin embargo resultados preliminares de los análisis microsatélites indican niveles de variación entre las poblaciones fragmentadas del Río North Fork Humboldt son más grandes que las de las poblaciones conectadas del Río Marys. Si este resultado se mantiene, es razonable concluir que la fragmentación muestra en verdad que las poblaciones aisladas que anteriormente mostraron cambios vía migración y/o dispersión en un pasado reciente.

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Notes on the current distribution of Rio Grande cutthroat trout, *Oncorhynchus clarki virginalis*, and its co-occurrance with the Rio Grande sucker, *Catostomus plebeius*, on the Carson and Santa Fe National Forests, New Mexico

Notas sobre la distribución actual de la trucha cutthroat del Río Grande, *Oncorhynchus clarki virginalis*, y su co-ocurrencia con el matalote del Río Grande, *Catostomus plebeius*, en los bosques Nacionales de Carson y Santa Fe, Nuevo Mexico

KEYWORDS: New Mexico; Catostomidae; Salmonidae; *Oncorhynchus*; *Catostomus plebeius*; *Oncorhynchus clarki virginalis*; Forest Service

ABSTRACT

Studies were initiated on June 6, 1994 by the USDA Forest Service, Rocky Mountain Range and Experiment Station to update current knowlegde on the distribution of the Rio Grande cutthroat trout, a sensitive species, and its co-occurance with the Rio Grande sucker, a fish that is now listed in the State of Colorado. The Rio Grande cutthroat trout was found to co-ocurr with the Rio Grande sucker in the Tusas Creek, Carson National Forest; In the Rio De Las Vacas, Canones Creek, American Creek, and Rito De Las Palomas on the Santa Fe National Forest. Six new locations were added to the distributional records of the Rio Grande cutthroat trout. All these streams are located in the Carson National Forest. They are: Canada De Osha (n=13), Comales Creek (n=12), Agua Piedras (n=8), Leandro Creek (n=5), Italianos Creek (n=14), and Yerba Creek (n=24). Two new locations were added to the distributional records of the Rio Grande sucker. They were: Polvedera Creek and Canones Creek. Both are tributaries to Abiquiu Reservoir and located adjacent to the Santa Fe National Forest. Future objectives are to identify the role of physical and biological factors in fragmenting the distribution of Rio Grande cutthroat trout.

CLAVES: Nuevo México; Catostomidae; Salmonidae; *Oncorhynchus*; *Catostomus plebeius*; *Oncorhynchus clarki virginalis*; Servicio Forestal

RESUMEN

Los estudios fueron iniciados en Junio 6 de 1994 por el Servicio Forestal USDA, en la Sierra de las Montañas Rocallosas y la estación experimental para conocer el estatus actual de la distribución de la trucha cutthroat del Río Grande, una especie sensitiva y su co-ocurrencia con el matalote del Río Grande, un pez que es ahora enlistado en el estado de Colorado. La trucha cutthroat del Río Grande fue encontrada en co-ocurrencia con el matalote del Río Grande en el Tusas Creek en el Bosque Nacional de Carson: En el Río De Las Vacas, Canones Creek, American Creek, y Rito De Las Palomas en el Porque Nacional Santa Fe. Seis nuevas localidades fueron descritas para los registros de distribución de la cutthroat trout del Río Grande. Todas estas corrientes se localizan en el Bosque Nacional Carson. Estas son: Canada De Osha (n=13), Comales Creek (n=12), Agua Piedras (n=8), Leandro Creek (n=5), Italianos Creek (n=14), and Yerba Creek (n=24). Dos nuevas localidades fueron adicionadas para los registros de distribución del matalote del Río Grande. Estas fueron: Polvedera Creek y Canones Creek. Ambos son tributarios del reservorio Abiquiu y localizados adyacentes al Bosque Nacional de Santa Fe. Objetivos futuros son identificar el papel de los factores físicos y biológicos en la fragmentación y distribución de la Trucha Cutthroat del Río Grande.

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Mitochondrial haplotype diversity in cutthroat trout

Diversidad de haplotipo mitocondrial en la trucha cutthroat

KEYWORDS: mitochondrial DNA; PCR; genetic diversity

ABSTRACT

We used mitochondrial DNA to determine the phylogenetic associations of 26 cutthroat trout populations from Utah. The fish fell into three distinct clades representing the Yellowstone Cutthroat trout, the Colorado River Cutthroat trout, and the Bonneville Cutthroat trout. Cutthroat trout from the Bear River drainage of the Bonneville Basin were part of the Yellowstone Cutthroat clade rather than the Bonneville Cutthroat clade, implying a polyphyletic origin of the Bonneville Cutthroat trout. Considerable within subspecies genetic diversity was also documented for all three subspecies indicating that no single population can be expected to represent the genetic diversity of an entire subspecies. In maintaining genetic diversity of the native cutthroat, managers will need to focus on preserving as many isolated populations as possible.

CLAVES: ADNmt; PCR; diversidad genética

RESUMEN

Nosotros usamos el ADN mitocondrial para determinar la asociación filogenética de 26 poblaciones de cutthroat trout de Utah. Los peces entraron en tres distintas ramas representadas por la cutthroat trout de Yellowstone, la cutthroat trout del Río Colorado y la cutthroat trout de Bonneville. La cutthroat trout del Río Bear desciende de la cuenca del Bonneville siendo parte de la rama de la cutthroat trout de Yellowstone más que de la rama de cutthroat trout de Bonneville, implicando un origen polifilético de la cutthroat trout de Bonneville. Una considerable variación genética entre subespecies fue documentada para las tres subespecies indicando que no una población sencilla puede ser esperada para representar la diversidad genética de una subespecie entera. En el mantenimiento de la diversidad genética de las cutthroat nativas, es necesario enfocar el manejo sobre la preservación sobre muchas poblaciones aisladas como sea posible.

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Archeoichthyological studies in Mexico

Estudios arqueoictiólogicos en México

KEYWORDS: archeology; osteology; marine fishes; Central America; Mexico; excavation

ABSTRACT

Considerable effort has been devoted by Mexican and foreign archeologists to learning about the way of life of ancient Mesoamericans. Material remains, however, are relatively scarce and isolated. I present here a case study in which an attempt was made to reconstruct fish capture preferences and daily diet from archeological excavations of fish remains from Puerto Márquez Acapulco, in the state of Guerrero, Mexico. For the identification of fish remains we used reference material in the osteological collection of the Ichthyology and Limnology Laboratory and the Mexican Marine Fishes Collection, both at the Escuela Nacional de Ciencias Biológicas, of the Instituto Politécnico Nacional.

According to information provided by the Archeological Rescue Department of INAH, the fish remains were found in different strata of shafts excavated in what used to be a fishing and farming village of the Preclassic (3000-2400 years before present (ybp)) and Classic (1800-1350 ybp) periods. With the fish remains were ceramic elements similar to those of stage IV of the cultural development of Teotihuacan and of the Olmecs. A total of 649 anatomical pieces were identified from 9 taxa *Caranx hippos*, *Caranx vinctus*, *Paralabrax* sp., *Paralabrax maculatofasciatus*, *Lutjanus guttatus*, *Lutjanus novemfasciatus*, *Halichoeres* sp., *Scarops perico*, and *Diodon cf. hystrix*. All are still captured and commercialized in the area today. The most common bones were mandibles and vertebrae (primarily of jurels and puffers) and other bones of *C. hippos*.

CLAVES: arqueología; osteología; América Central; peces marinos; México; excavación

RESUMEN

Se han desarrollado gran cantidad de esfuerzos por parte de arqueólogos mexicanos y extranjeros para obtener información sobre la forma de vida de los antiguos pobladores de Mesoamérica, pero los restos materiales son pocos y aislados, en este caso en particular nos permite determinar la preferencia en la captura de algunos peces marinos que debieron formar parte esencial dentro de la dieta diaria. Se presentan los resultados del estudio de una excavación arqueológica realizada en Puerto Márquez Acapulco, Guerrero, México. Para la identificación de los restos se trabajó con el material biológico de las Colecciones Osteológicas del Laboratorio de Ictiología y Limnología y la de peces Marinos Mexicanos de Ciencias Biológicas, I.P.N.

De acuerdo a los datos proporcionados por el Depto. de Rescate Arqueológico del INAH, los restos óseos se hallaron en diversos estratos de los pozos excavados de lo que fue una aldea de pescadores y agricultores desarrollada entre los períodos históricos: Preclásico (3,000-2,400 a.p.) y Clásico (1,800 - 1,350 a.p.). Junto con los restos se encontraron elementos cerámicos similares a los identificados para la etapa IV Teotihuacan y de un período de influencia Olmeca que permitieron el fechaje del material óseo. Se identificaron 649 piezas anatómicas correspondientes a nueve taxa (*Caranx hippos*; *Caranx vinctus*; *Paralabrax* sp.; *Paralabrax maculatofasciatus*; *Lutjanus guttatus*; *Lutjanus novemfasciatus*; *Halichoeres* sp.; *Scarops perico*; *Diodon cf. hystrix*), todas ellas capturadas y comercializadas aún en nuestros días, las piezas anatómicas predominantes en las muestras corresponden a elementos mandibulares, vértebras, (principalmente de jureles y peces erizo) y huesos masivos llamados hiperostósicos pertenecientes a *C. hippos*.

[MILLER STUDENT PAPER COMPETITOR]

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Food habits and electivity indices of the endangered humpback chub, *Gila cypha* from the Colorado River in Grand Canyon National Park

Habitos alimenticios e indices de electividad del charal jorobado *Gila cypha* del Río Colorado en el Parque Nacional del Gran Cañón

KEYWORDS: diet; electivity; Colorado River; Arizona; humpback chub

ABSTRACT

The diets of humpback chub from the Colorado River in Grand Canyon National Park were analyzed from three locations along the river during 1991, '92, and '93. A total of 168 chub were pumped and variation between season and location determined for stomach contents both by volume and abundance. The amphipod, *Gammarus lacustris*, chironomids, simuliids, terrestrial invertebrates, and the green alga, *Cladophora glomerata* dominated stomach contents. Significant variation in invertebrate numbers and volume of gut contents occurred between locations sampled. Significant seasonal variation within locations was also determined for some food items. Chub stomachs sampled from locations away from the Little Colorado River (LCR) had significantly greater numbers and volumes of terrestrial and other forms of aquatic invertebrates. Electivity indices (Ivlev 1961) were calculated to compare food habits of humpback chub to food availability from instream drift. Chub above the LCR showed a more generalized feeding strategy than below the LCR which selected for *Gammarus*. Chub from the Middle Granite Gorge tended to select terrestrial and other aquatic invertebrates.

CLAVES: dieta; electividad; Río Colorado; Arizona; charal jorobado

RESUMEN

La dieta del charal jorobado del Río Colorado en el Parque Nacional del Gran Cañón fueron analizadas de tres lugares a lo largo del río durante 1991, '92 y '93. Un total de 168 charalitos fueron muestreados y la variación entre temporadas y localidades fue determinada por el contenido estomacal tanto en volumen como en abundancia. El amfípodo *Gammarus lacustris*, chironomidos, simulidos, invertebrados terrestres y el alga verde *Cladophora glomerata* dominando el contenido estomacal. Una significativa variación en el numero de invertebrados y el volumen del contenido de las viseras ocurre entre las localidades muestreadas. Una variación estacional significativa en las localidades fue también determinada para algunas muestras de alimentos. Los estómagos de los charales muestreados de las localidades mas allá del Pequeño Río Colorado (LCR) tienen un gran numero y volumen significativo de invertebrados terrestres y otras formas acuáticas. Los índices de electividad (Ivlev, 1961) fueron calculados para comparar los hábitos alimenticios del charal jorobado para la disponibilidad de alimento de las corrientes de escurrideros. Los charales más allá del LCR fueron selectivas para *Gammarus*. El charal de Middle Granite Gorge tienden a seleccionar invertebrados terrestres y acuáticos.

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Arizona Game and Fish Department 1994 activities

Actividades del Departamento de Caza y Pesca de Arizona en 1994

KEYWORDS: Arizona Game and Fish Department; monitoring; Little Colorado spinedace; loach minnow; spikedace; razorback sucker; Colorado squawfish; Heritage Fund

ABSTRACT

Major activities for 1994 include long term annual monitoring programs for: 1) Little Colorado spinedace - A total of thirty sites were surveyed within Nutrioso, Chevelon and Clear Creeks and the Colorado River, during the second year of this monitoring program. 2) spikedace *Meda fulgida* - A total of 12 sites in the Verde River between

Paulden and Sycamore Creek were surveyed during the second year of this monitoring programs. 3) loach minnow *Tiaroga cobitis* - 12 sites were surveyed along the Blue River, between Campbell Blue Creek and the San Francisco River during the first year of this program. Monitoring sites comprise permanent 200 m locations, combined with several 200 m randomly chosen locations. 4) Fifty-one reintroduced and eight natural topminnow sites were monitored during 1994.

Boat and canoe mounted electrofishing surveys for razorback sucker *Xyrauchen texanus* and Colorado River squawfish *Ptychocheilus lucius* were again conducted along the Salt and Verde rivers. A total of 100 razorback suckers were recaptured during 1994. Ninety eight razorback suckers were recaptured in the upper Verde, where they had been stocked in March of 1993. In addition, one adult razorback sucker was recaptured from the lower Verde River, and one razorback was recaptured within the stomach of a flathead catfish in the Salt River. No squawfish were recaptured during 1994.

The State Lottery supported Heritage Fund provided funding for several projects benefitting native fish in Arizona. The public Grant Program funded 7 projects for a total of $106,000 in grants involving native fish for 1994. The Heritage land acquisition program, is a program dedicated to the purchase of land for the conservation of endangered, threatened or candidate species of wildlife. Last year, the acquisition program purchased two properties, for which the primary purpose was the conservation of the Little Colorado spinedace. The two properties were the 1285 acre White Mountain Hereford Ranch, with water rights for over 1800 acre feet in Rudd and Riggs Creeks, and the 205 acre Wenima riparian corridor containing the 8th and 13th water rights for the valley, which date back to 1881. This year, management plans, for the conservation of LC spinedace were drafted for both properties.

CLAVES: Departamento de Caza y Pesca de Arizona; monitoreo; Little Colorado spinedace; sardinita adornada; spikedace; matalote jorobado; charal del Río Colorado; Heritage Fund

RESUMEN

Las principales actividades para 1994 incluyen programas de monitoreo a largo plazo para: 1) Little Colorado spinedace (pececito de espina del pequeño Río Colorado)- Un total de 30 sitios fueron monitoreados en los arroyos el Nutrioso, Chevelon y Clear y el Río Colorado, durante el segundo año de este programa de monitoreo. 2) spikedace *Meda fulgida*- Un total de 12 sitios en el Río Verde entre Paulden y el arroyo Sycamore fueron muestreados durante el segundo año de este programa de monitoreo. 3) La Sardinita adornada *Tiaroga cobitis*- 12 sitios fueron supervisados a lo largo del Río Azul entre el arroyo Campbell Azul y el Río San Francisco durante el primer año de este programa. Los sitios de monitoreo permanentes tienen 200 m, combinadas con varias localidades de 200 m elegidas al azar. 4) 51 sitios de reintroducción y 8 naturales para el topminnow fueron monitoreados durante 1994.

Equipos de electropesca montados en botes y canoas para el matalote jorobado *Xyrauchen texanus* y el charal del Río Colorado *Ptychocheilus lucius* fueron conducidos a lo largo de los ríos Salt y Verde. Un total de 100 matalotes jorobados fueron recapturados en lo alto del Río Verde, donde ellos fueron soltados en Marzo de 1993. En adición a estos, un adulto de matalote jorobado fue recapturado del Bajo Río Verde y uno mas fue recuperado del estómago de un bagre de cabeza plana en el Río Salt. Ningún charal fue recapturado durante 1994.

La lotería estatal ayudada por la Heritage Fund proveen fondos para varios proyectos que benefician peces nativos en Arizona. El Public Grant Program soporta a 7 proyectos por un total de $106,000 dólares en investigaciones que involucran peces nativos para 1994. El programa de adquisición de tierras de Heritage Fund, es un programa dedicado para la compra de tierras para la conservación de especies de Vida Silvestre en peligro, amenazadas o candidatas a serlo. El ultimo año, el programa de adquisición compro dos propiedades, con el propósito primario de conservación del spinedace del pequeño Colorado. Las dos propiedades constan de 1285 acres en el White Mountain Hereford Ranch, con derechos de agua sobre 1800 pies/acre en los arroyos Rudd y Riggs y 205 acres en el corredor ripario de Wenima conteniendo el octavo y treceavo lugar en derechos de agua para el valle, los cuales datan de más allá de 1881. Este año, el plan de manejo para la conservación del Little Colorado spinedace fueron realizados para ambas propiedades.

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Distribution, Habitat, and Current Status of the San Pedro Mártir Rainbow trout, *Oncorhynchus mykiss nelsoni* (Evermann)

La distribución, hábitat, y estatus actual de la trucha arcoiris de San Pedro Mártir, *Oncorhynchus mykiss nelsoni* (Evermann)

KEYWORDS: current status; habitat; San Pedro Mártir; Baja California

ABSTRACT

The distribution, habitat, and current status of *Oncorhynchus mykiss nelsoni* (Evermann) were evaluated in the two main drainages of the western slope of the Sierra San Pedro Mártir (Santo Domingo and San Rafael), Baja California, México. The known localities of distribution (type locality and transplant sites) as well as other previously unsurveyed localities, were monitored during a period of seven years (January 1987 to March 1994) to document occurrence of the trout and to evaluate their habitat characteristics. The conservation status for this subspecies was determined as stable in the two main drainages which range in altitude from 500 to 2,030 m above sea level. Recommendations for future conservation and management of the trout and their habitats are established here.

CLAVES: estatus actual; hábitat; San Pedro Mártir; Baja California

RESUMEN

La distribución, hábitat, y estatus actual de *Oncorhynchus mykiss nelsoni* (Evermann) fueron evaluados en los dos sistemas hidrológicos principales de la pendiente occidental de la Sierra San Pedro Mártir (Santo Domingo y San Rafael), Baja California, México. Las localidades conocidas de distribución (localidad tipo y sitios de introducción), además de otras previamente no investigadas, fueron muestreadas durante un período de siete años (Enero 1987 a Marzo 1994) para documentar la ocurrencia de la trucha y para evaluar sus características de hábitat. Su estatus de conservación fue determinado como estable para los dos sistemas hidrológicos principales a través de un rango altitudinal de 500 a 2,030 msnm. Recomendaciones para la futura conservación y manejo de esta trucha y de sus hábitat son aquí establecidas.

ST. GEORGE, D. (USDI Fish and Wildlife Service, Ash Meadows National Wildlife Refuge, Pahrump, NV)

Status of endangered fish populations and restoration projects at Ash Meadows National Wildlife Refuge

Estatus de las poblaciones de peces en peligro y proyectos de restauración en el Refugio Nacional de la Vida Silvestre de Ash Meadows

KEYWORDS: trend data; populations; pupfish; speckled dace; largemouth bass; restoration

ABSTRACT

Five years of trend data collected from biannual surveys of endangered fish populations from 6 springs at Ash Meadows National Wildlife Refuge (NWR) showed Warm Springs pupfish (*Cyprinodon nevadensis pectoralis*) and Ash Meadows Speckled Dace (*Rhinichthys osculus nevadensis*) to be stable and Ash Meadows Amargosa pupfish (*Cyprinodon nevadensis mionectes*) to be declining. A survey of 8 additional springs on the refuge conducted in 1989 and 1993 found similar population trends.

The five year trend in adult to juvenile ratio from the 6-spring survey varied among species. Ash Meadows Amargosa pupfish showed a slight decline, Warm Springs pupfish fluctuated widely from year to year and Ash Meadows speckled dace ration remained similar 4 of 5 years samples. Adult to juvenile ration in the 8-spring survey found declines in speckled dace and Warm Spring pupfish and stable ratios for Ash Meadows Amargosa pupfish.

The decline in Ash Meadows Amargosa pupfish numbers was caused primarily by exotic largemouth bass (*Micropterus salmoides*) in Forrest and Crystal Springs and lower Big Spring stream. Bass are also present in Crystal Reservoir and Point-of-Rocks Ponds. In 1994 a bass eradication program was initiated with over 100 bass removed from the refuge.

Management efforts on the refuge to restore habitat and water courses to historic (pre-agricultural) conditions are ongoing. Crystal Reservoir water source is being diverted to endangered species habitat in the southern portion of the refuge. In approximately 2-3 years the reservoir will dry, removing the exotic bass from the Crystal Spring drainage. Future plans at Point-of- Rocks include draining the ponds as part of a restoration project to recreate stream habitat for the threatened Ash Meadows Naucorid (*Ambrysus amargosus*). Additional restoration plans are being developed to return Crystal Spring drainage, and other spring outflows that are currently in irrigation ditches, to their historic channels. Habitat restoration in North Carson Slough, southern Nevada's largest historic wetland, was initiated in June 1994 when 240 acres of exotic saltcedar (*Tamarix* sp.) were aerially sprayed with herbicide.

CLAVES: tendencia de datos; poblaciones; pez perrito; pez moteado; lobina bocona; restauración

RESUMEN

Tendencias de datos colectados en cinco años de muestreos anuales de poblaciones de peces en peligro de seis manantiales en el Refugio Nacional de Vida Silvestre de Ash Meadows (RNVS) muestran al pez perrito de manantiales cálidos *Cyprinodon nevadensis pectoralis* y el pececito moteado de Ash Meadows *Rhinichthys osculus nevadensis* estables y el pez perrito de Amargosa en Ash Meadows *Cyprinodon nevadensis mionectes* en declinación. Una muestra adicional de ocho manantiales en el refugio conducida en 1989 y 1993 encontró tendencias similares en la población.

La tendencia de cinco años en el porcentaje de juveniles a adulto, provenientes de seis manantiales muestreados varían de acuerdo a la especie. El pez perrito de Amargosa en Ash Meadows muestra una suave declinación, el pez perrito de manantiales cálidos fluctúa ampliamente año con año y el pez moteado de Ash Meadows mantiene un remanente similar en muestras de cuatro de cinco años. La proporción de juvenil a adulto en los ocho manantiales muestreados se encontró una declinación en el pez moteado y el pez perrito de manantiales cálidos y estabilidad en la proporción para el pez perrito de Amargosa en Ash Meadows.

El decline en el pez perrito de Amargosa fue causado principalmente por la especie exótica, lobina negra (*Micropterus salmoides*) en los Ojos de agua Forrest y Crystal Springs y la parte baja del arroyo de Big Spring. La lobina esta presente también en Crystal Reservoir and Point-of-Rocks Ponds. In 1994 un programa de erradicación fue iniciado con removación de mas de 100 lobina del refugio.

Manejo en el refugio para restauración de habitat y de cauces de agua a condiciones históricas (pre-agricultura) siguen. El fuente de agua de Crystal Reservoir esta desviado completamente ahora a habitat de especies en peligro de extinción en la parte sur del refugio. Entonces se espera que en aproximadamente 2-3 años se secará completamente esta presa, asi removando la lobina exotica de la cuenca de Crystal Springs. Planes futuros para Point-of-Rocks incluyen drenaje de los charcos como parte de un proyecto de restauración de habitat de arroyo para la amenazada Naucorido de Ash Meadows (*Ambysus amargosus*). Otros planes para restauraciones estan en desarrollo para volver a poner agua de Crystal Spring, y otros ojos de agua actualmente en zanjas de reigo, nuevamente a sus cauces naturales. Restauración de habitat en North Carson Slough, la ciénega histórica mas grande de la parte sur de Nevada, fue iniciada en Junio de 1994 cuando 240 acres de la exotica “saltcedar” (*Tamarix* sp.) recibieron aplicaciones aereas de herbicida.

CONNER, C. (Organ Pipe Cactus National Monument, National Park Service, Ajo, Arizona)

Life on the border for Quitobaquito desert pupfish

La vida en la frontera para el pez perrito del desierto de Quitobaquito

KEYWORDS: Quitobaquito Spring; Organ Pipe Cactus National Monument; Arizona; desert pupfish

ABSTRACT

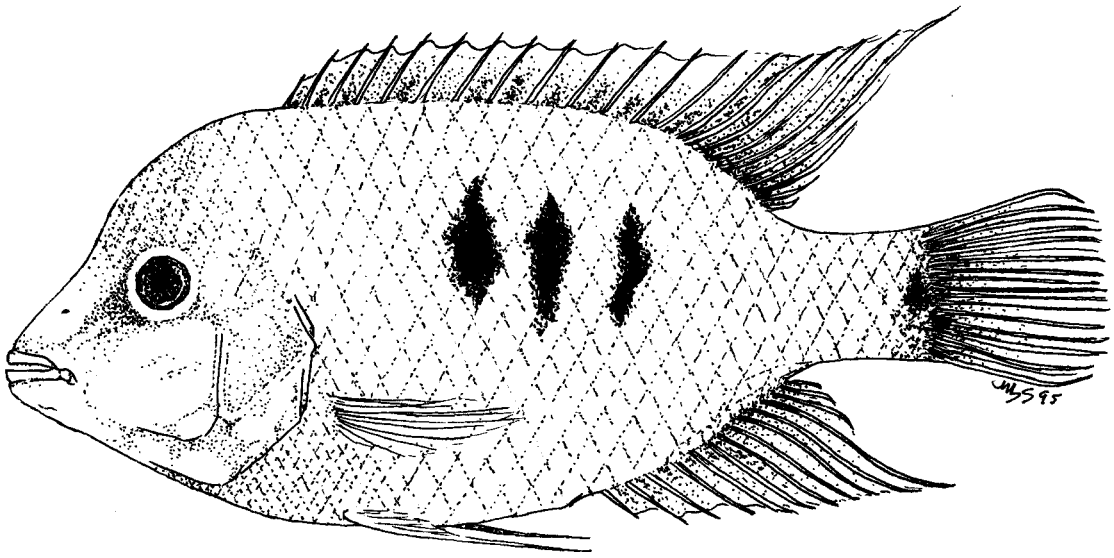
The Quitobaquito desert pupfish, *Cyprinodon macularius eremus* has as its sole habitat the springs, pond and connecting 700 foot channel at Quitobaquito, in the southwest corner of Organ Pipe Cactus National Monument, Arizona. The Quitobaquito complex lies directly on the U.S./Mexico border and is also less than 100 meters from Mexican Highway 2, a heavily traveled highway that is the only land link between mainland Mexico and Baja California, which includes the major agricultural region of northern Baja and the cities of Mexicali and Tijuana. The area poses a unique, interesting, and at times, frustrating challenge for park management: 1) the pond, springs and channel are designated critical habitat for the endangered Quitobaquito desert pupfish; 2) the area has been nominated to the National Register of Historic Places due to the depth of prehistoric and historic resources; 3) the area is known as one of the best bird watching areas in the state and receives heavy use from Monument visitors as well as travelers crossing the fence from Mexico; 4) there is considerable history of vehicle break-ins at the visitor parking lot; 5) the area is used today by the Hi-ced O'0dham for religious ceremonies; 6) the area immediately south of the border is agricultural, with associated water pumping and aerial pesticide spraying; 7) the border region is a hotbed of smuggling (in both directions) and counternarcotics operations; 8) there are other sensitive species at Quitobaquito, such as the Sonoran mud turtle (*Kinosternon sonoriense longifermorale*) and the Quitobaquito springsnail (*Tryonia quitobaquitae*); 9) Quitobaquito is also located in federally designated wilderness.

CLAVES: Manantial de Quitobaquito; Monumento Nacional de Organ Pipe Cactus; Arizona; pez perrito del desierto

RESUMEN

El pez perrito del desierto de Quitobaquito *Cyprinodon macularius eremus* tiene un único hábitat que es el manantial, la poza y el canal de 700 pies en Quitobaquito, en la esquina Noroeste del Monumento Nacional de Organ Pipe Cactus, Arizona. El complejo de Quitobaquito se encuentra directamente sobre la frontera de México/Estados Unidos y también a menos de 100 metros de la carretera federal numero 2, una carretera con trafico muy intenso, la única que une México continental con Baja California, la cual incluye una de las mayores regiones agrícolas del Norte de Baja California y las ciudades de Mexicali y Tijuana. El área posee un único e interesante y al mismo tiempo frustante reto para el manejo del parque: 1) la poza, el manantial y el canal son designados como hábitat critico para el pez perrito del desierto de Quitobaquito en peligro; 2) el área ha sido denominada para Registro Nacional de Lugares Históricos para recursos Históricos y Prehistóricos; 3) el área es conocida como una de las mejores para observación de aves en los Estados Unidos y recibe un fuerte uso por parte de los visitantes al Monumento Nacional así como el cruce de viajeros desde México; 4) tiene una considerable historia de robos de vehículos en el estacionamiento para visitantes; 5) el área es usada aun en la actualidad por el Hi-ced O'Odam para ceremonias religiosas; 6) el área inmediatamente al Sur de la frontera es agrícola, con bombeo de agua asociado con rociado aéreo de pesticidas; 7) la región fronteriza es un lugar adecuado para actividades de contrabando y antinarcóticos (en ambas direcciones); 8) se presentan otras especies sensibles en Quitobaquito como son la tortuga del lodo de Sonora *Kinosternon sonoriensis longifemorale* y el caracol de manantial de Quitobaquito *Tryonia quitobaquitae*; 9) Quitobaquito también es localizado en un lugar Silvestre designado federalmente.

Cichlasoma minckleyi - Cuatrociénegas, Coahuila, México. Illustration by Matt J. Stephens.



MINUTES OF THE BUSINESS MEETING

Report on the November 18, 1994 Business Meeting of the Desert Fishes Council

Executive Secretary Phil Pister called the business meeting to order at 3:30 PM, and reiterated the Council's delight over recent passage of S. 21, the California Desert Protection Act, which has created the greatest degree of protection over public land since enactment of the Alaska Lands Act. Death Valley is now a national park, and other areas of the California desert have received added protection. The Council gratefully acknowledged the efforts of retiring Death Valley National Park Superintendent Ed Rothfuss in gaining approval of S. 21. Superintendent Rothfuss keynoted the symposium with a very interesting discussion of some of the highlights of the final hours in Congress of S. 21, which came very close to being shelved for yet another year. Considering the outcome of the November 8 election, passage of similar legislation in the foreseeable future seems highly unlikely.

Phil noted with pleasure a summary of attendance data for this symposium. Represented at this event were 29 North American universities; 15 offices of the U.S. Fish & Wildlife Service; 5 offices of the U.S. Forest Service; 2 offices of the U.S. Bureau of Reclamation; 2 national parks; representatives of the fish and wildlife agencies of Arizona, California, Colorado, Nevada, New Mexico, Texas, and Utah; New York, Dallas, Chicago, and Columbus (OH) aquaria; Smithsonian Institution; Navajo Nation; Las Vegas Valley and Washington County (UT) water districts; and 5 private consulting firms. Total attendance at the symposium was approximately 250.

Letters of regret of inability to attend this meeting were received from Jack and Cindy Williams, Alice and Tony Echelle, and Nancy Norton and Gary Meffe. The recent death of Beula Edmiston, long-time supporter of Desert Fishes Council and desert fish and aquatic habitat conservation in general, was sadly announced.

Discussion of financial status and dues structure was the next item of old business. The Executive Secretary noted that reserves are being depleted. At the current rate, DFC would entirely deplete its reserves before the end of the century. After considerable discussion, the motion was made, accepted, and unanimously approved by the Council to raise dues by $10 for members and $5 for student members. This results in student dues increasing to $10, regular membership to $25, and sustaining membership to $35. During the discussion it was also suggested that since dues are generally paid by individuals, while registration fees are usually paid by agencies and institutions of members, that increases in registration fees for meetings would have less impact on most members than would a dues increase. Meeting registration costs will continue to be determined by local hosts and will be set to cover all meeting-related expenses. As in the past, all proceeds from meetings remaining after payment of expenses will revert to the general fund of the Council.

The Secretary then called for items of new business. Nadine Kanim presented a proposal from the Program Committee suggesting that the concept of Area Coordinators again be implemented within the Council, as was done during the first decade of the Council's existence. Discussion ensued and the Council members present voted to accept the proposal. Area coordinators will maintain a general protective overview of their areas and report to the Chair any matters that, in his/her judgment, should receive input from the Council. For instance, this might include comments concerning species listings, or environmental documents for projects within a given Area.

A major function of Area Coordinators will be to coordinate and prepare the report for his/her area at the annual meeting, both oral at the meeting and written for the Proceedings. This will essentially replace the usual agency report portion of the meeting, which is normally held on the first morning of the symposium. The membership felt that the quality and organization of this section of the annual meeting would be substantially improved by such a measure, and it was agreed to try this approach for a couple of years before making any permanent changes. An advantage of the "Area" approach will be a more cohesive and interesting agency session that fosters intra- and interagency coordination. The various "Areas" would be defined as Upper Colorado, Lower Colorado, Northeastern mainland Mexico, Northwestern mainland Mexico, Baja California, Southeastern Oregon, Lahontan, Death Valley, Bonneville, Interbasin (including White River), Northern California, Southern California, State of Texas, State of New Mexico.

The announcement was made by W.L. Minckley that the basin of Cuatrocienegas had been declared a Biosphere Reserve only about two weeks prior to the meeting. Salvador Contreras confirmed this fact, and briefly outlined a cooperative agreement that has been in development between the DFC and the municipality of Cuatrocienegas. The Council unanimously approved this memorandum of cooperation between the DFC and the municipality of Cuatrocienegas, forming an advisory council to assist with development of plans and coordination with scientists. The mayor, Susana Moncada, had already signed the agreement. As soon as the original is obtained from Cuatrocienegas, appropriate signatures of the DFC Executive Committee will be added to finalize the agreement. In support of this agreement, and the municipality’s continued efforts toward conservation, the following resolution was passed by the Council:

RESOLUTION 94-1 - RELATIVE TO THE PROTECTION OF THE CUATROCIENEGAS BASIN, COAHUILA, MEXICO

WHEREAS The Cuatrociénegas basin, Coahuila, Mexico, has long been recognized as a remarkably unique and valuable center of aquatic and terrestrial biodiversity in the Chihuahuan Desert Region and for that matter the Western Hemisphere; and

WHEREAS preservation of its diverse habitats and biota has been a goal of conservationists for more than three decades; and

WHEREAS a substantial portion of the area was set aside by the Mexican Government this month, November 1994, as a Protected Area; and

WHEREAS the final efforts which succeeded in this endeavour by the residents of Cuatrociénegas through their local citizens and government, the latter under the leadership of Senora Susana Moncada de León, Presidente Municipal, now therefore be it

RESOLVED that the Desert Fishes Council, an international organization numbering in excess of 500 university and agency research scientists and resource specialists, private conservations, and other individuals concerned with the long-term integrity of North America's desert ecosystems, assembled at its Twenty-sixth Annual Symposium on November 18, 1994 in Death Valley National Park, Furnace Creek, California, unanimously and joyously commends and congratulates Señora Moncada de León and her associates in Cuatrociénegas for their fortitude, determination, and accomplishments in this major step in conservation, the Governor of Coahuila for his encouragement and support, and past-President of Mexico, Lic. Carlos Salinas de Gortari, his advisors and staff, for their foresight in setting aside this irreplacable basin for future generations. Be it further

RESOLVED that the Desert Fishes Council by this resolution reaffirms assurances of any assistance that can be provided collectively or by its individual members to help to ensure maintenance of the diverse, functional ecosystems of Cuatrociénegas in perpetuity. Be it further

RESOLVED that copies of this resolution be forwarded with the Desert Fishes Council's best wishes to Señora Moncada de Leon, past-President of México c. Lic. Carlos Salinas de Gortari, President of México c. Lic. Ernesto Zedillo Ponce de León, and other officials in Cuatrociénegas, the state capital in Saltillo, Coahuila, federal offices in Mexico City. and to other parties as appropriate.

PASSED WITHOUT DISSENTING VOTE ATTEST

Edwin P. Pister
Executive Secretary

RESOLUCIÓN 94-1 - RELATIVA A LA PROTECCIÓN DE LA CUENCA DE CUATROCIÉNEGAS, COAHUILA, MÉXICO

CONSIDERANDO que la cuenca de Cuatrociénegas, Coahuila, México, ha sido ampliamente reconocida como un centro remarcadamente único y valuable de biodeiversidad acuática y terrestre en la Región del Deseierto Chihuahuanese y por esto el hemisferio Oeste; y

CONSIDERANDO que la preservación de su diversidad de habitats y biota ha sido una meta de conservacionistas por mas de tres décadas; y

CONSIDERANDO que una parte sustancial del area fue protegida recientemente por el gobierno federal de México en forma de declaración del area como Area Protegido; y

CONSIDERANDO que el empeño final del proceso de obtener esta declaración fue por los residentes de Cuatrociénegas a traves de ciudadanos locales y el gobierno, este último bajo el liderazgo de la Señora Susana Moncada de León, Presidente Municipal, por lo tanto ha

RESUELTO que el Consejo de los Peces del Desierto, una organización internacional cuyo número excede a las 500 cientificos trabajando en universidades y agencias de gobiernos y conservacionistas privadaos y otros individuos comprometidos con la integridad a largo plazo de los ecosistemas desérticos de Norte América, reunidos en su Veinteseis Simposio Anual en noviembre 18 1994 en el Parque Nacional del Valle de la Muerte, Furnace Creek, California, unanimamente y jubilosamente recomienda y felicita a la Señora Moncada de León y a sus asociados en Cuatrociénegas por su fortaleza, determinación y cumplimiento en este importante paso de en la conservación, el Gobernador de Coahuila por su fomento y apoyo, y al ex-Presidente de México c. Lic. Carlos Salinas de Gortari, a sus asesores y equipo de trabajo, por su previsión en considerar esta irremplazable cuenca para futuras generaciones. Además ha

RESUELTO que el Consejo de los Peces del Desierto por esta resolución reafirma seguiridad de cualquier asistencia que pueda ser proporcionada colectivamente o por sus miembros individualmente para ayudar a asegurar el mantenimiento de la diversidad y funcionalidad de los ecosistemas de Cuatrociénegas en perpetuidad. Ademas, ha

RESUELTO que copias de esta resolución sean dirigidas junto con los mejores deseos del Consejo de los Peces del Desierto a la Señora Moncada de León, al ex-Presidente de la República de México c. Lic. Carlos Salinas de Gortari, al Presidente c. Lic. Ernesto Zedillo Ponce de León, a los ejecutivos de gobierno en la ciudad de Cuatrociénegas apropiados e interesados, a la capital del Estado de Coahuila, Saltillo, a los ejecutivos de agencias federales en la ciudad de México, y a otras partes.

APROBADA SIN DISENCIÓN VOTO ATESTIGAR

Edwin P. Pister
Secretario Ejecutivo

Minckley also asked permission of the Council to draft and send another resolution, on behalf of the Council, commending and thanking Sr. Pepe Lugo, for many years of collaboration with various scientists carrying out research in Cuatro Ciénegas. The motion was made by R.R. Miller to allow Minckley to draft this resolution on behalf of the Council, and to have it mailed to appropriate local, state and federal government offices in México. The motion was seconded and approved unanimously. The resolution subsequently drafted by Dr. Minckley follows:

RESOLUTION 94-2 - A COMMENDATION FOR JOSE ("PEPE") LUGO GUAJARDO RELATIVE TO HIS INVALUABLE ASSISTANCE TO RESEARCHERS IN THE VALLEY OF CUATROCIENEGAS DE CARRANZA, COAHUILA, MEXICO

Field research is difficult without local assistance, and far less so if local contacts are sympathetic of intentions, knowledgable of local geography, resources and potentials, and philosophically attuned to the research itself. Sr. José ("Pep• ") Lugo, lifelong resident of Cuatro Ciénegas de Carranza, Coahuila, México, has all these attributes and more relative to biological and other research and researchers in his valley.

Before biologists came to Cuatro Ciénegas, Pepe Lugo already knew of its resources and uniqueness. As soon as they came he gave all that he could to support them in studies of the valley he loves. He and his wife Catalina, now deceased, provided all they could, asking little or nothing but friendship in return. Many attendees of the Twenty-sixth Annual Meeting of the Desert Fishes Council, and others not in attendance, owe him deep personal and scientific debts of gratitude for fond memories of the basin, its habitats and biota, and our successes.

Pepe Lugo is a strong and important advocate of species, habitat, and ecosystem preservation. He worries for the Coahuila box turtle (*Terrapene coahuila*), mojarras (*Cichlasoma* spp.), and the local form of robalo (largemouth bass; *Micropterus salmoides* ssp.). He is deeply concerned of habitat changes he and others observed, such as drying of Río Cañon and decline in levels of some springs. His interpretation of changes based on long-term, practical knowledge of the valley and its environs serves conservation well.

The Desert Fishes Council therefore wishes to emphasize its gratitude and admiration for this man:

WHEREAS A great number of past and present members of the Desert Fishes Council has visited the Valley of Cuatro Ciénegas, depending upon and benefitting from Sr. José Lugo's assistance and enjoying his company; and

WHEREAS his guiding, repair of equipment or arrangments for its repair, cooking, sampling, provision of housing and transportation, translations, support of students, cajoling, consulting, and helping with innumerable others of the things absolutely required resulted in research projects succeeding and researchers surviving and prospering in the process; and

WHEREAS in doing so he contributed far more than he and many others realize to the success of November 1994 when major parts of the Valley were set aside by President of México, Carlos Salinas de Gortari, now therefore be it

RESOLVED that the Desert Fishes Council, an International Organization numbering in excess of 500 university and agency research scientists and resource specialists, private conservationists, and other individuals concerned with the long-term integrity of North America's desert ecosystems, assembled at its Twenty-sixth Annual Symposium in November 1994 in Death Valley National Park, Furnace Creek, California, unanimously acknowledges the immeasurable contributions of Sr. José Lugo Guajardo to biological research and to the well-being of researchers over almost four decades. Without the assistance of this single individual, understanding of the importance of the Cuatro Ciénegas Valley to science and its conservation for humankind might well not have been achieved.

RESOLVED that copies of this resolution be forwarded with the Desert Fishes Council's best wishes to la Alcaldeza del Municipio de Cuatro Ciénegas, Señora Moncada de León, and to other officials in Cuatro Ciénegas, the Governor of Coahuila and other officials in the State Capital in Saltillo, past-President of México c. Lic. Carlos Salinas de Gortari, and President of México c. Lic. Ernesto Zedillo Ponce de León and other officials in Mexico City, and to other parties as appropriate.

PASSED WITHOUT DISSENTING VOTE ATTEST

Edwin P. Pister
Executive Secretary

RESOLUCIÓN 94-2 - COMENDACION DEL CONSEJO DE LOS PECES DEL DESIERTO AL SR. JOSE (“PEPE”) LUGO GUARJARDO RELATIVO A SU INVALIOSA ASISTENCIA PRESTADA A INVESTIGADORES EN LA CUENCA DE CUATROCIENEGAS DE CARRANZA, COAHUILA, MEXICO

RESUELTO que la investigación en el campo es dificil sin ayuda local, y mucho menos dificil si los ciudadanos sean interesados, conocen la geografía local, los recursos y potenciales, y estan de acuerdo con las investigaciones. Sr. José (“Pepe”) Lugo Guajardo, nacido en Cuatrociénegas de Carranza, Coahuila, México, tiene todos estos atibutos y mas relativo a la investigación e investigadores in los alredadores del Valle de Cuatro Ciénegas.

Mucho antes de que llegaron los biólogos al valle, José Lugo conoció sus recursos y y su naturaleza unica. Tan pronto que llegaron los biólogos, el les prestó todo su apoyo en estudios del valle que ama. El y su esposa, Señora Catalina Diaz de León de Lugo, ahora fallecida, proveyeron todo que pudieron, pidiendo poco o nada fuera de amistad en cambio. Muchos miembros del Desert Fishes Council le deben deudas personales y ciéntificas por sus queridas memorias de la cuenca, sus habitats y biota y el exito de los nosotros mismos.

José Lugo llegó a ser un vocal fuerte de las especies, su habitat, y para la conservación de la ecosistema. Preocupó por las tortugos de bisagra de Coahuila (*Terrapene coahuila*), mojarras (*Cichlasoma* spp.) y la forma local de robalo (largemouth bass, *Micropterus salmoides* ssp.). Inquietó también por los cambios de habitats que el y otros vieron, como la desecación del Río Cañon y la declinación de los ojos de agua. Su intrepación de cambios basada en conocimiento practico sobre largo plazo ha servida muy bién para la conservación.

Por lo tanto, El Consejo de los Peces del Desierto, quiere enfatizar su gratitud y admiración para este hombre, para los razones siguientes:

CONSIDERANDO que un gran numero de miembros pasados y actuales del Consejo de los Peces del Desierto ha visitado el Valle de Cuatrociénegas, dependiendo en la asistencia de José Lugo, y disfrutando de su compañia, y

CONSIDERANDO que su servicio como guia, reparación de equipo o asistencia con arreglos, cocina, muestreo de la biota, provisión de alojamiento y transporte, traducciones, apoyo de estudiantes, consultas, y ayuda con otros asuntos inumerables, produjó el exito de proyectos y la sobreviviencia y prosperidad de los investigadores, y

CONSIDERANDO que por hacer todo esto, contribuyó mucho mas que dan cuenta él mismo y muchos otros, al éxito de 1994 cuando terrenos sustanciales e importantes del Valle fueron declarados como Area Protegido, por lo tanto, ha

RESUELTO que el Consejo de los Peces del Desierto, una organización internacional con mas de 500 miembros, todos científicos de universidades y agencias gubernatales, conservacionistas privadas, y otros individuos preocupados con la integridad sobre largo plazo de los ecosistemas desérticos, en asamblea en su vigesimosesto simposio anual en el Parque Nacional del Valle de la Muerte (Death Valley), Furnace Creek, California, unanimamente reconoce las contribuciones inmensurables del Señor José "Pepe" Lugo a la investigación científica y el bienestar de investigadores durante casi cuatro décadas. Y ademas ha

RESUELTO que copias de esta resolución sean dirigidas junto con los mejores deseos del Consejo de los Peces del Desierto al Señor José "Pepe" Lugo Guajardo, a la Señora Moncada de León, al ex-Presidente de la República de México c. Lic. Carlos Salinas de Gortari, al Presidente c. Lic. Ernesto Zedillo Ponce de León, a los ejecutivos de gobierno en la ciudad de Cuatrociénegas apropiados e interesados, a la capital del Estado de Coahuila, Saltillo, a los ejecutivos de agencias federales en la ciudad de México, y a otras partes.

APROBADA SIN DISENCIÓN VOTO ATESTIGAR

Edwin P. Pister
Secretario Ejecutivo

Clark Hubbs asked that the Council officially voice its support of a resolution of the American Society of Ichthyologists and Herpetologists to the State of Texas and the U.S. Fish and Wildlife Service. This ASIH resolution (published in Copeia 1994(4):1106) supports federal listing, as endangered or threatened, of current candidate species, *Trogloglanis pattersoni* and *Satan eurystomus*, blind catfishes known only from deep wells in the Edwards Aquifer underlying the city of San Antonio, Texas, as well as two endemic salamanders and numerous invertebrates from the same aquifer. The motion was made by R.R. Miller to accept this motion, seconded by W.L. Minckley, and approved unanimously by the Council.

The motion was made by the Program Committee to replace the Agency reports with Area Reports. Nadine Kanim outlined a system of Areas, based primarily on hydrographic regions. She had spoken with many individuals and had volunteer coordinators for each area. Coordinators would seek input to their reports from all individuals and agencies doing work in the area and would present at the meeting a 15-minute summary covering all contributions received. A more comprehensive report could be submitted for publication in the Proceedings. It is anticipated tha all contributors would be included as co-authors of the report. After some discussion, the motion was made and seconded to accept this proposal, and it was passed with a single dissenting vote by the membership. Nadine will contact all who volunteered to coordinate area reports, and a list of those persons with telephone and other contacts will be provided to the membership in the first call for papers in the spring of '95. Members will then provide contributions to their appropriate coordinators who will then provide an abstract to the editor of the proceedings by the normal deadline.

Dean Hendrickson reminded members of the Dec. 31 deadline for receipt of full papers for publication in Proceedings of the Desert Fishes Council, and of the request for contributions to the DFC's World Wide Web pages which were demonstrated as a poster (see abstract). Mike Baltzly was acknowledged as the prinicipal programmer who contributed significant time toward completion of the project Web pages. Contributions of additional fish photos and associated text or related files (documents, data sets, etc.) were solicited.

It was announced that Paul Marsh had accepted an invitation from the Executive Committee to become the Membership Secretary. Paul will begin after this meeting managing the membership list and dues accounting. A copy of the membership directory will be placed on the WWW server as soon as the data have been updated and proofed.

An offer from members based in Reno, Nevada, to host the next annual meeting of the Council, was quickly accepted by the membership. Paul Barrett will be the local committee chairperson. An invitation from the Universidad Autónoma de Baja California, to meet in 1996 in La Paz, Baja California, was also accepted, with Francisco Reynoso serving as the local committee chairperson. Adhering to the practice of meeting every third year in Death Valley, the 1997 meeting will again be held at Furnace Creek.

Phil Pister announced that Dean Hendrickson would be assuming the position of Chair of the Desert Fishes Council, effective January 1, 1996.

The final item of business was presentation of the Best Student Paper Awards. Judges this year were Drs. Robert Edwards, Gary Garrett, Jim Johnson and Steve Platania. Sixteen students competed. The Carl L. Hubbs award for the overall best student paper was given to Robert Hines, for his paper "Influence of suspended sediments on larval razorback sucker (*Xyrauchen texanus*) vulnerability to predation". Runner up in this competition was J.B. Ruppert for his paper "Effects of electrofishing fields on embryos and larvae of razorback suckers." The Frances H. Miller award for the best paper presented by a Mexican student was presented to Edmundo Teniente-Nivón for his paper "Archeoichthyological studies in México". Certificates were presented to both winners and the meeting adjourned.

The field trip to Ash Meadows, Devils Hole and other areas took place on Sunday morning, November 20.

INSTRUCTIONS TO AUTHORS - PROCEEDINGS OF DFC

ELECTRONIC FORMAT - All abstracts and manuscripts **must** be submitted in electronic format. Deadlines for abstracts for the Annual Meeting are announced in mailings to the membership each year. Special arrangements for submission of hard copy only of abstracts (strictly for those without access to computers) may be made each year with the Chair of the Local Arrangements Committee who will set an earlier deadline for such submissions. Formats accepted include diskette (all DOS or Macintosh formats) or electronic mail. **Abstracts and manuscripts will be accepted in ASCII format only** and must be formatted as described below.

ASCII (American Standard Code for Information Interchange) format files are easily saved from almost any word processor. Often called "Text" or "Text only" files, they are simply files from which all program-specific formatting codes have been stripped. **Do not** send files saved in your word-processor's unique format (the default way of saving files). To save an abstract as an ASCII file, type text in your word processor, formatting as described below. If sending by E-mail, before saving ASCII file, set margins and/or font so all lines have < 80 characters. If sending a floppy, line lengths < 256 characters are acceptable. Instructions for some word processors follow (actual keystrokes are set in upper case, bold and italicized). If you use another program, consult its documentation.

Ami Pro v.2 (Windows) ***SAVE AS***, ***ASCII*** & ***CR/LF AT LINES*** & ***8 BIT PC-ASCII***
MS Word(Mac)v.5 ***SAVE AS***,***TEXT ONLY***;v.4-***SAVE AS***,***FILE FORMAT***,***TEXT ONLY***
MS Word(Windows) ***TRANSFER SAVE***,***TEXT-ONLY-W-LINE-BREAKS***in***FORMAT***
WordPerfect(DOS)(v. 5.0/5.1) ***CONTROL-F5*** (=Text out), ***T*** or ***1*** (=DOS Text)
WordPerfect (Windows) ***SAVE AS***, specify ***ASCII TEXT (DOS)***
WordStar open non-document file (***N*** from the menu), ***CONTROL-Q-Q-B***

If submitting a file on floppy disk, name it **"DFCABSTR"** (if > 1 file being submitted on a single disk, use numeric extensions, e.g. DFCABSTR.01, DFCABSTR.02) and put your name and address, the **type of computer** you used (Mac or IBM), and **"DFCABSTR"** on disk label. If E-mail, put "DFC Abstract" in subject line. Receipt of E-mail submissions will be immediately acknowledged via return E-mail. Acknowledgement of receipt of floppy disks will be by ordinary mail. Submission of hard copy is not required, but encouraged since it could be useful if problems are encountered.

ABSTRACT FORMAT REQUIREMENTS - All information must be contained in 8 to 10 blocks (fields) of text **separated from each other by a blank line**. Abstract length is not limited, but recall the definition of "abstract" and the fact that space equals money. Also recall that translation of your abstract is provided by volunteers.

Since diacritical marks are not in the standard ASCII set of characters, use vertical bars (|) around single characters that need accents or other diacritical marks (e.g., "ma|n|ana" will be translated to mañana and "M|e|xico" will become México. All single characters bounded by vertical bars will be translated as in Spanish (áéíóúñ) unless special notice is given of exceptions by submission of highlighted hard copy. Italicized words or phrases should be surrounded by braces ({}), e.g. {Cyprinodon diabolis} = *Cyprinodon diabolis*. Each text string so bounded by braces in any part of the file will be placed in the taxonomic index, so any terms (to be italicized or not) which authors wish to have indexed in the taxonomic index should be bracketed. Do not include > 1 name or taxonomic index entry within a single set of brackets. Order, family, and other category names placed in brackets but not normally italicized will be indexed only. Characters bounded by the caret (^) symbol (e.g. ^superscript^) will be set as $^{\text{superscripts}}$ in final copy, and those bounded by underscores (e.g. (_subscript_) will be set as $_{\text{subscripts}}$. Do not use these special characters anywhere in text where these special features are not to be invoked, and always use them in pairs (i.e. start and stop special features). See sample abstract below.

Use **mixed upper and lower case** text throughout (see example). Authors are responsible for checking spelling and grammar. Each line must start on the left margin (i.e. no leading spaces or tabs). **Single blank lines are required between text blocks (do not use multiple blank lines)** and, are allowable within text blocks only in the **abstract text** block. Text blocks must be in the order specified below. Blocks 1-8 are required. Follow instructions carefully.

1. The first block is to contain **complete mailing information** for the author making the presentation or person to whom correspondence should be addressed. Enter as multiple lines exactly as if addressing an envelope.

2. The second block is to contain the **list of authors** for the abstract. Each name is to be entered as surname, a comma, and initials, and (if applicable), another comma and other designation (e.g. Jr.). **Use a semicolon (;) to separate authors' names**, and follow all commas and periods with single spaces. Place an asterisk after name of person presenting paper. Maximum allowable number of authors is six.

3. The third block contains the **affiliations** (Department and Institution or Agency and Office, but not full mailing address) of all authors, in the sequence given in the preceding block of text. Authors' affiliations are to be separated by a semicolon, but use authors initials where possible to indicate multiple authors with the same affiliation.

4. The fourth text block contains the **title** of the presentation. Use mixed case text, **not** upper case only.

5. The fifth block of text contains the actual **abstract text**. Be sure to **always use full taxonomic names at least once for indexing purposes**. Bracketed strings containing periods will be italicized, but not indexed.

6. The sixth block contains **keywords** that describe the research. These will be used to compile a combined subject and geographic index for the Proceedings. Begin this block with "KEYWORDS: ", followed by up to 10 keywords (or key phrases) **separated by semicolons**. There is no need to place taxonomic terms here for indexing since, if they are bracketed elsewhere in the abstract, they will be indexed in the Taxonomic index. Please do not use obvious keywords like "fishes" - this **IS** the Proceedings of the Desert Fishes Council, and it can be expected that most papers will contain the word "fishes." If one author uses "fishes," or other similar words common to many papers (desert, river, etc.) as a keyword, all occurrences of it in the volume will be indexed. KEYWORDS are words which characterize the key topics of your paper, and which distinguish it from the others.

7. The seventh block identifies the **type of presentation**. Begin with "PRESENTATION: ", then "ORAL" or "POSTER".

8. The eighth block determines the **session** in which the presentation will be made. Begin this block with "SESSION: ", then either the word "CONTRIBUTED" or "AGENCY". "AGENCY" refers to presentations made a individual designated by the office of a government or private agency to report on general activities of that office or complex of offices (e.g. a Region). "CONTRIBUTED" refers to reports on individual research or management projects, and not office-wide activity reports, even if the work was done by an agency employee.

9. (Optional) If the presentation is to be considered for a student paper **award**, include a ninth block beginning with "AWARD: " and either "HUBBS", "MILLER", or "BOTH". Eligibility requirements for these awards are given below.

10. (Optional) **other** text. Enter phone/FAX numbers and presentation needs here, but other information and comments are also welcome. Begin block with "OTHER: " then any text you wish. **There is no need for ANY written communication (e.g. Post-it notes, etc.) with submissions - all such extra communications should be entered here).**

ENGLISH/SPANISH - Abstracts will be accepted in either language or both. If submitting both, do so as a single abstract with English and Spanish versions of the title in the title block separated by " / " and with versions of the abstract separated by a blank line in the abstract text block (see sample abstract above). Your submissions will be translated and/or proofed by the Spanish Language subcommittee of the DFC Publications Committee, but please provide bilingual submissions if at all possible.

FULL-LENGTH MANUSCRIPTS - Full length manuscripts of papers or posters presented at the meeting will be accepted for publication in the DFC Proceedings. These must be submitted (to the same address as abstracts) in electronic format (as ASCII or word processor files after consultation with the editor). All tables and figures must be done using appropriate word-processor features for tables and figures - do not use spaces and tabs to construct tables. The deadline for submission of manuscripts of papers presented at annual meetings is December 31 of the year of the meeting. Contact the editor before preparing your manuscript to discuss format for figures and graphs. Other format guidelines follow those of *The Southwestern Naturalist*.

AWARDS - Competitors for the Carl L. Hubbs and Frances H. Miller student paper awards must be the sole author and presenter of the paper and enrolled as a student currently or during the 12 months prior to the presentation. The paper must be based on work done while a student. The Frances H. Miller award additionally stipulates that the recipient be a citizen of a Latin American country. Papers are evaluated by a panel of judges on basis of scientific rigor of research (40%), quality & style of presentation (30%), rigor of analysis and interpretation of data (15%), and quality and use of visual aids (15%). Copies of evaluation forms provided on request.

SAMPLE ABSTRACT

(sample as for floppy submission - reduce lines to < 80 characters for E-mail)

Johnny Fishseed
Agency of Fish and Wildlife Disbursement
Hatchery Row
Somewhere, New Mexico 87107

Fishseed,J.D.^*^;Growem,B.S.,Jr.;Stockem,I.

JDF and BSG - Agency of Fish and Wildlife Disbursement, Main office, Somewhere, NM; IS - Arizona Department of Fish and Game, Regional Office, Littletown, AZ

Status of native fish production and stockings in rivers, streams, springs and other habitats all over the place / Estado actual de producci|o|n de peces y su distribuci|o|n a r|i|os, manantiales y otros habitats sobre toda la regi|o|n

Twenty seven species native to our area have been produced by the billions (10^9^) at our hatchery and stocked all over the place. Some stockings have worked, others have not. Some fish lived, some died for lack of water (H_2_O). Results will be discussed. Future plans include work with {Cyprinodon} species from M|e|xico.

Se han producido billones (10^9^) de ejemplares de 27 especies nativas a nuestra |a|rea en nuestra estaci|o|n de acuacultura, los cuales se han distribuido a muchos lugares. Algunos introducciones han establecido, otros no. Algunos peces sobrevivieron, otros se murieron por falta de agua (H_2_O). Se discutir|a|n los resultados. Planes futuros incluyen trabajos con especies de {Cyprinodon} de M|e|xico.

KEYWORDS: stocking; propagation; New Mexico; Arizona; hatcheries; M|e|xico; Colorado squawfish; razorback sucker; pupfish

PRESENTATION: ORAL

SESSION: AGENCY

AWARD: BOTH

OTHER: Hey Dean - how's it goin? The electronic abstract submission idea is great! But next time don't reduce the instructions to authors to microfische proportions. If problems, my phone/FAX are 1-800-FOR-FISH/1-800-FOR-FAST; need overhead projector; probably best schedule this at end of a session because it is likely that I'll have to cancel it if my agency travel request isn't approved. It would be nice to have it scheduled right after Jose's talk, since he'll be talking about monitoring of the fish we stock. See you in November.

INSTRUCCIONES A LOS AUTORES PARA LAS MEMORIAS DEL DFC

FORMATO ELECTRONICO - Todos los resúmenes y manuscritos **deberán** ser sometidos en formato electrónico. La fecha límite para los resúmenes para la Reunión Anual está anunciada en los envíos de correspondencia a los miembros cada año. Se harán arreglos especiales para someter mecanuscritos sólo de resúmenes (estrictamente para aquellos sin acceso a computadoras) cada año con el Presidente del Comite Local de Arreglos quien establecerá la fecha límite próxima de estas. Los formatos aceptados incluyen diskette (formatos DOS y Macintosh) o correo electrónico. **Los resúmenes y manuscritos serán aceptados sólo en formato ASCII** y deberán estar formatedos como se describe abajo.

Los archivos en formato ASCII (Código Americano Standard para Intercambio de Información) son fáciles de gravar usando casi cualquier procesador de palabras. Frecuentemente llamados archivo de "Texto" o "sólo de Texto" son archivos sencillos que no incluyen códigos especiales de uno u otro programa específico, sino codigos que todos programas pueden interpretar. **No envíe** archivos salvados en el formato nativo de tu procesador de palabras (el camino de default de gravado de archivos). Para gravar un resumen como un archivo ASCII, escribe el texto en tu procesador de palabras formateando como se describe abajo. Si el envío es por Correo-E, antes de salvar el archivo ASCII, inicia márgenes y tipo para que tengan renglones menos de 80 caracteres. Si envías un disco flexible, se aceptan líneas de menos de 256 caracteres. Se indican las instrucciones para algunos procesadores de palabras (teclas actuales están en mayúsculas, negritas y cursivas). Si usas otro programa, consulta la documentación.

Ami Pro v.2 (Windows) - SALVA COMO,ASCII Y CR/LF EN LINEAS Y 8 BIT PC-ASCII
MS Word(Mac)v.5 - SALVA COMO,SOLO TEXTO;v4-SALVA COMO,FORMATO ARCHIVO,SOLO TEXTO
MS Word(Windows) - SALVAR TRANSFER,SOLO-TEXTO-W-LINEA-BREAKSinFORMAT
WordPerferct(DOS) (v.5.0/5.1) - CONTROL-F5(=Texto fuera),**T** o 1(DOS Texto)
WordPerfect(Windows - SALVA COMO, especificar **TEXTO ASCII (DOS)**
WordStar - abrir archivo no-documento (N del menú), **CONTROL-Q-Q-B**

Si sometes un archivo en disco flexible, nómbralo **"DFCABSTR"** (si más de un archivo es sometido en un sólo disco, usa extensiones numéricas, ejem DFCABSTR.01, DFCABSTR.02) y pon tu nombre y dirección, el **tipo de computadora** que usaste (Mac o IBM), y **"DFCABSTR"** en la etiqueta del disco. Si usas Correo-E, pon "DFC Abstract" en la línea de asignación. La recepción de envíos por Correo-E será agradecida inmediatamente vía regreso Correo-E. el agradecimiento de envíos en discos flexibles se hará por correo ordinario. No se requiere el sometimiento de copias de disco duro, aunque será fomentado de ser necesario si se detectan problemas.

FORMATO DE REQUERIMIENTO DEL RESUMEN - Toda la información deberá estar contenida en 8 a 10 bloques (campos) de texto **separados de los otros por un renglón**. La longitud del resumen no está limitada, pero la anulación de la definición de "resumen" y de hecho el espacio, es igual a dinero.

Aunque los signos diacríticos no están en los caracteres ASCII standares, usa barras verticales (|) alrededor de un caracter que necesite acento u otro signo diacrítico (e.g., ma|n|ana, será traducido como mañana y M|e|xico será México. Los caracteres individuales rodeados con barras verticales serán traducidos al Español (áéíóúñ) a menos que un aviso especial muestre las excepciones por sometimiento de copia dura resaltada. Palabras o frases en cursivas deberán rodearse de llaves ({}), e.g., {Cyprinodon diabolis} = *Cyprinodon diabolis*. Cada texto encerrado por llaves en cualquier parte del archivo será puesto en el índice taxonómico, así cualquier término (sea en cursivas o no) que los autores deseen incluir en el indice taxonómico deberá estar entre llaves. No incluya más de un nombre o índice taxonómico dentro de un sólo juego de llaves. Sólo serán indexados ordenes, familias y otros nombres categóricos colocados en llaves pero no en cursivas. Caracteres rodeados por el símbolo ^ (e.g. ^superíndice^) serán puestos como ^{superíndice} en copia final, y aquellos rodeados de códigos bajos (e.g. _subíndice_) serán puestos como $_{subíndice}$. No use estos caracteres especiales en ninguna parte del texto donde estos caracteres no sean invocados, y siempre use los en pares (e.g. rasgos especiales de inicio y alto). Ver resumen de ejemplo abajo.

Use **mayúsculas y minúsculas** a través del texto (ver ejemplo). Los autores son responsables de revisar la ortografía y gramática. Cada línea debe empezar en el margen izquierdo (e.g. sin espacios o tabuladores). **se requiere un renglón en blanco entre párrafos (no use renglones múltiples)** y está permitido sólo dentro de los párrafos del texto en el **texto del resumen**. Los párrafos de texto deberán ir en el orden especificado abajo. Se requieren los primeros 8 párrafos. Siga las instrucciones cuidadosamente.

INSTRUCCIONES A LOS AUTORES

1.El primer bloque es para contener **información completa de la dirección** del autor que hace la presentación o persona a quien corresponda ser enviada. Escriba las líneas exactamente como si rotulara un sobre.
2.El segundo bloque contiene la **lista de autores** del resumen. Cada nombre será escrito como apellido, una coma, e iniciales, y (si es aplicable) otra coma y otra designación (e.g. Jr.). **Use punto y coma (;) para separar los nombres de los autores**, y las siguientes comas y períodos con espacios simples. Ponga un asterisco después del nombre de la persona que presenta el trabajo. El máximo permitido de autores es seis.
3.El tercer bloque contiene la **afiliación** (Departamento e Institución o Agencia y Oficina, pero no la dirección completa) de todos los autores, en la secuencia dada en el bloque de texto precedente. La afiliación de los autores estará separada por un punto y coma, pero utilice iniciales donde sea posible para indicar muchos autores con la misma afiliación.
4. El cuarto bloque contiene el **título** de la presentación. Use mayúsculas y minúsculas, **no** sólo mayúsculas.
5. El quinto bloque del texto contiene el **texto del resumen**. Asegúrese de **siempre usar nombres taxonómicos completos al menos una vez para propósitos de índice**. Lo tecleado en llaves conteniendo períodos estarán en cursivas, pero no indexadas.
6.El sexto bloque contiene las **palabras claves** que describen la investigación. Esto será usado para compilar un índice de materias y geográfico para las Memorias. Inicie este bloque con "KEYWORDS: " seguido por más de 10 palabras claves (o frases claves) **separadas por punto y coma (;)**. Aquí no se necesita lugar para términos taxonómicos como si están las mismas palabras entre llaves en el resumen, serán incluidos en el Indice Taxonómico. Favor usar palabras claves sensibles. Estos es el Proceedings del Consejo de los Peces del Desierto, y si un autor usa la palabra clave "peces" generará indexo a todos los trabajos que contengan esa palabra, o sera a casi todos. Palabras claves son las palabras que caracterizan su trabajo y que lo distinguen de los demas.
7.El séptimo bloque identifica el **tipo de presentación**. Inicie con "PRESENTATION: ", y luego "ORAL" o "POSTER".
8.El octavo bloque determina la **sesión** en la cual la presentación será hecha. Inicie este bloque con "SESSION: ", entonces la palabra "CONTRIBUTED" o "AGENCY". "AGENCY" se refiere a la presentación hecha por un individuo designado por la oficina de un gobierno o agencia privada para reportar sobre las actividades generales de la oficina o complejo de oficinas (e.g. una Región). La "CONTRIBUTED" se refiere a los reportes de un sólo investigador o manejador de proyectos, y no reportes de actividades de oficinas, aun si el trabajo fue hecho por un empleado de una agencia.
9.(Opcional) Si la presentación es considerada como un **premio** para presentación de estudiante, incluye un noveno bloque iniciando con "AWARD: " y después "HUBBS", "MILLER" o "BOTH" (=AMBOS). Los requerimientos para estos premios se dan a continuación.
10.(Opcional) **otro** texto. Escriba número de teléfono/FAX y las necesidades de la presentación, pero información adicional y comentarios serán bien venidas. Inicia el bloque con "OTHER: " y luego el texto que quiera. **No se necesita NINGUNA comunicación escrita (E.G. notas adheribles, etc.) con los resúmenes sometidos - todas las comunicaciones deberán entrar aquí).**

INGLES/ESPAñOL - Los resúmenes serán aceptados en cualquiera de las dos lenguas. Si somete las dos, hágalo como un sólo resumen con versiones en Inglés y Español para el título en el bloque de título separado por "/" y con versiones del resumen separadas por un renglón en blanco en el bloque de texto del resumen (ver ejemplo de resumen abajo). Tus resúmenes sometidos serán traducidos y/o revisados por el Subcomité de Lenguaje Español del Comité de Publicaciones del DFC, pero por favor someta una versión bilingüe si es posible.

MANUSCRITOS COMPLETOS - Los manuscritos completos de trabajos o carteles presentados en la reunión serán aceptados para su publicación en la Memorias del DFC. Estos deben ser sometidos (al mismo nombre y dirección) en formato electrónico (como archivos ASCII). La fecha límite para someter los manuscritos de presentaciones orales de la reunión es Diciembre 31 del año de la reunión. Contacte al editor antes de preparar su manuscrito para discutir el formato para figuras y gráficas. Otras guías de formato siguen las de *The Southwestern Naturalist.*

PREMIOS - Los competidores para los premios Carl. L. Hubbs y Frances H. Miller para trabajos de estudiantes serán para sólo un autor y ponente del trabajo e involucrado como un estudiante actualmente o durante los 12 meses anteriores a la presentación. La presentación deberá estar basada en el trabajo hecho cuando es estudiante. El premio Frances H. Miller estipula adicionalmente que el receptor sea ciudadano de un país de América Latina. Los trabajos serán evaluados por un grupo de jueces sobre bases de rigor científico de investigación (40%), calidad y estilo de la

presentación (30%), rigor en el análisis e interpretación de los datos(15%) y calidad de uso del material audiovisual. Se proveerán copias de las formas de evaluación bajo requisición.

RESUMEN DE MUESTRA

(muestra como para disco flexible - reduce a menos de 80 carácteres en cada línea para Correo-E)

Johnny Fishseed
Agency of Fish and Wildlife Disbursement
Hatchery Row
Somewhere, New Mexico 87107

Fishseed,J.D.^*^;Growem,B.S.,Jr.;Stockem,I.

JDF and BSG - Agency of Fish and Wildlife Disbursement, Main office, Somewhere, NM; IS - Arizona Department of Fish and Game, Regional Office, Littletown, AZ

Status of native fish production and stockings in rivers, streams, springs and other habitats all over the place / Estado actual de producci|o|n de peces y su distribuci|o|n a r|i|os, manantiales y otros habitats sobre toda la regi|o|n

Twenty seven species native to our area have been produced by the billions (10^9^) at our hatchery and stocked all over the place. Some stockings have worked, others have not. Some fish lived, some died for lack of water (H_2_O). Results will be discussed. Future plans include work with {Cyprinodon} species from M|e|xico.

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KEYWORDS: repoblamiento; propagación; granjas; M|e|xico; charal del Colorado; matalote jorobado; cachorrito

PRESENTATION: ORAL

SESSION: AGENCY

AWARD: BOTH

OTHER: Hola Dean - ¿Que tal? ¡La idea de someter resúmenes electrónicos es buena! Mi teléfono y FAX son 1-800-FOR-FISH/1-800-FOR-FAST; necesito proyector de cuerpos opacos; probablemente el mejor horario es al final de una sesión porque parece que tendré que cancelar si mi agencia no aprueba mi petición de viaje. Estaría bien quedar colocado justo después de la de José, como el hablará del monitoreo de los peces que sembramos. Nos vemos en Noviembre.