DRILL,S.L. (Department of Biology, University of California, Los Angeles, Los Angeles, CA)

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]

GORMAN,OWEN T.; TIERSCH,T.R.; WILLIAMSON,J.H.; CARMICHAEL,G.J.* (OTG - U.S. Fish and Wildlife Service, P.O. Box 338, Flagstaff, AZ 86002-0338; TRT - Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge, LA 70803; JHW - U.S. Fish and Wildlife Service, Dexter NFH, P.O. Box 219, Dexter, NM 88230; GJC - U.S. Fish and Wildlife Service, Mora NFH, P.O. Box 689, Mora, NM 87732)

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.

NIEMI,E.G.*; WHITELAW,W.E.; MACMULLAN,E.P. (ECO Northwest; Whitelaw also is University of Oregon)

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]

SNYDER,DARREL E.*; MEISMER,STEVEN M. (DES and SMM - Larval Fish Laboratory, Colorado State University, Fort Collins, Colorado)

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

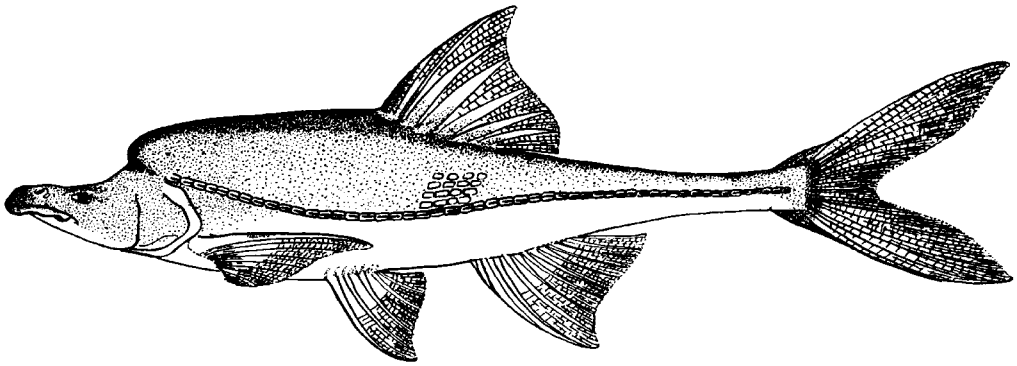
ABSTRACT

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.

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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]

KNOWLES,GLEN W.*; MARSH,PAUL C.; BAGLEY,BRIAN E. (GWK - Arizona State University, Department of Zoology, Tempe, AZ; PCM, BEB - Arizona State University, Center for Environmental Studies, Tempe, AZ)

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]

BOWES,N.*; CROWL,T.A. (NB and TAC - Ecology Center and Department of Fisheries and Wildlife, Utah State University, Logan, UT)

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.

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

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.

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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.

GIDO,K.B.*;PROPST,D.L. (KBG - Museum of Southwestern Biology, University of New Mexico, Albuquerque, NM; DLP - New Mexico Department of Game and Fish, Santa Fe, NM)

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.

***PARMENTER,S.C.*; FUJIMURA,R.W.** (SCP - California Department of Fish and Game, Bishop, CA; RWF - California Department of Fish and Game, Aquatic Toxicology Laboratory, Elk Grove, CA)

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.

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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.