Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

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FOREWORD

The Council continues to flourish. Each year more and better papers are presented, our membership grows and becomes more active, and we take satisfaction from the fact that the newly recognized field of conservation biology is something we have been engaged in for nearly 20 years. The Council's pioneering efforts in this respect were instrumental in pulling back several fishes from the very brink of extinction. As we venture into the future we find ourselves bolstered by laws and methodologies that did not exist when we organized in 1969. However, we must face the hard truth that such assistance can only serve to help us to "hold the line" as demands on aquatic resources of the Desert Southwest reach proportions that are almost incomprehensible at this date. We enter the future optimistically, but realistically. Former Chairman Pete Sanchez (a man blessed with more than an ordinary share of candor and pragmatism) perhaps said it best, following the 1976 Supreme Court decision regarding Devils Hole: "It's good to have won the first round of what will almost certainly be a 15-round event."

However, the resource we are trying to conserve is worth fighting for. If it were otherwise, I seriously doubt that so many would have worked so hard for so many years, and against such overwhelming odds. Following Symposium XVI at San Luis Potosí, México, George Barlow of U.C. Berkeley's Museum of Vertebrate Zoology skillfully combined scientific and philosophical rationale in a thoughtful discussion of why it is important for us to preserve such areas as Mexico's Cuatro Ciénegas. His essay follows as a keynote paper for this compendium.

Phil Pister
Bishop, California
June 3, 1987

The Study of Fish Behavior in Desert Waters

by

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At the hotel where the participants in the meeting of the Desert Fishes Council were lodged the bellhop engaged me in conversation about that meeting. "¿Por que?", he said, and immediately offered his own answer. "You want to discover how to produce food from the desert springs, right?" He was disappointed when I tried to explain to him that we had a larger purpose, and that using desert springs for aquaculture was in many ways counter to our objectives. It was hopeless. He refused to understand that there could be any other reasonable objective. Small wonder, given the burgeoning population of Mexico. But if the bellhop had attended the meetings he would not have had a better understanding of their purpose.

There was no expressed consensus among the participants concerning overarching objectives, though there seemed to be implicit agreement on what we are after. And, surely, the objectives have been discussed at length in earlier meetings.

Just judging from the papers presented, the agenda seems to be to describe the biota of desert waters, to monitor them, and ultimately to conserve them. The speakers appeared to be motivated by a subtle blend of aesthetics, a personal involvement with the bea[illegible]y of the deserts, and ethics, a perception of the great need to protect the fragile aquatic habitats in those arid lands.

Suppose that we are successful, what then? Of what use are those scattered springs, creeks, and pools? Again, ¿por que? The number of answers could be as large as the number of participants, though I doubt that. From my perspective, the biota of the desert waters offer an exceptional opportunity to increase our understanding of the way the world operates in general. I say this because each of those isolated patches of water is in itself a natural experiment. Many of those experiments have been thousands of years in the making and could not be replicated by us even with the budget of the Department of Defense.

It is not just a matter of age. It is also a matter of propitious circumstances. One of these is scale. The spring systems, in particular, present to the investigator bodies of water small enough to be manageable in the context of many types of studies. Further, the water is often exceptionally clear, permitting unimpeded observations, especially where shallow. For one who studies behavior and ecology, such systems are a dream.

Research in behavior and ecology can be done in harmony with the goal of preservation. Such studies are basically nonintrusive. Modification of the environment, or manipulation of the inhabitants, can be minimized to such an extent that the effect is trivial.

There are many directions in which the research could go. I will confine my comments to an area that reflects my own interests yet one that makes the larger point. The area is the evolution of mating systems, which is currently the subject of considerable theorizing. But before proceeding to do that, I must make clear what is meant by a mating system.

Mating systems encompass the interactions of males and females. The emphasis is on the dynamics of getting males and females together. For example, does one male mate with several females (polygyny), or one female with several males (polyandry)? Or does a given male remain paired with a single female (monogamy)? Mode of reproduction, e.g., external or internal fertilization, is a separate issue and is usually more conservative in the course of evolution.

A central feature in theories about mating systems is the search for first causes. A simple scheme goes as follows: In a given species, the distribution of its food in space and time determines the pattern of distribution of the animals. If the food is distributed in discrete patches, the animals tend to bunch up. Given other conditions, such bunching permits one large male to exclude other males and to hold a harem at the patch of food. On the other hand, living in open areas may result in the animals forming groups for protection from predators; the resulting mating system will depend on the sex ratio of the group. One can make similar arguments for such factors as population density and suitable places to leave eggs or to rear young.

The bottom line is that features of the environment impose spatial patterns on the animals living there. Depending on the interaction of a number of variables, and the constraints imposed by the nature of the species and its evolutionary history, different mating systems emerge. Of even greater interest, the same species can show alternative mating systems under different conditions. This, of course, is theory, and one needs to test theory. Some desert springs are especially suited for such testing. Cuatro Ciénegas, in northern Mexico, is a splendid example.

Many springs occur in the geological basin that holds Cuatro Ciénegas. Typically, each spring forms a pool with a stream outlet that may connect to another pool or flow into an evaporative pan. The conditions among the springs vary greatly. They range from large to tiny, from very warm, e.g., 34θ C., to relatively cool, and from productive to nonproductive. The waters are delightfully clear and accessibly shallow. The reproductive season is almost year-round in the warmer springs. And the people in the local community of Cuatro Ciénegas are receptive and helpful.

What makes the springs there further remarkable is the diversity of the fish fauna, 16 species in all. And the species composition of the springs varies greatly. The community structure is itself an important factor. It leads to measurable differences in the trophic structures in different springs because the feeding habits of the fish species range from detrital feeding and herbivory through snail eating and piscivory.

The scope of modes of reproduction among the 16 species of fishes is a fair representation of the scope seen among all fishes. I will run through them quickly, from simplest to most advanced and make a few comments about the social systems where that seems appropriate. In many cases, the reproductive behavior is not yet known. But one can make reasonable guesses about such behavior, based on the general pattern of that family of fishes.

The one cyprinid and one characid probably broadcast their eggs, perhaps on plants. It is unlikely that they engage in parental care. The mating system itself could vary from pair to group spawning, or even lekking (a remarkable mating system in which males gather on an "arena" and are visited by females who come to mate then depart).

I have observed one cyprinodontid, Cyprinodon bifasciatus, spawning in a warm spring in November. Males defended territories over small rocky outcrops on the silty bottom, and females came to them and spawned there. That is typical of many cyprinodontids, and the other two species there probably have similar behavior. The males provide minimal care of the eggs by driving away juveniles and nonspawning females.

Darters, the family Percidae, are diverse but most commonly have a mating system similar to that of the Cyprinodontidae. Males receive eggs of females, which are laid in gravel, under rocks, and the likes. Paternal care is minimal but more extensive than that of the cyprinodontids.

The mating systems of centrarchids are often lek-like, with groups of males building nests together, as in the genus Lepomis. Largemouth bass also build nests; but in keeping with their feeding behavior of a roaming predator, they space their nests. The two types of centrarchids receive one or more females and provide some care of the eggs; the largemouth bass even protects its fry. The two types of centrarchids occur in the basin.

The catfishes, Ictaluridae, with two species in two genera, present another level of reproductive behavior. The male guards and fans the eggs, and he shepherds the baby fish. Sometimes the female remains and assists the male in caring for the young, producing a monogamous pair.

Best known for monogamy and biparental care, however, is the family Cichlidae. Interestingly, the common cichlid in Cuatro Ciénegas may prove to be a maternal caretaking species, an unusual state of affairs for fishes in general. This is one of the most ubiquitous fishes in the basin, and its mating system may well differ among the springs.

The Poecillidae is treated last because of its advanced care of young. The female carries them in her ovary where they develop out of harm's way. The mating system is not known in any detail, but fishes in this family are polygynous.

Thus we see that the situation at Cuatro Ciénegas offers unparalleled opportunities. It is a complex of natural experiments such that the judicious investigator can pick and choose springs appropriate to the hypothesis in question. Because of the shallow clear waters, benign experiments can then be carried out to refine the study.

Now I would like to digress to address briefly two issues. One is the re-establishment of populations where they once existed but have become extinct. The other is the issue of extinction in the larger context.

According to Sewell Wright it is virtually axiomatic that evolutionary change is hastened by small population size. When a small founder population is introduced into a spring, as has happened in attempts to conserve certain of the desert pupfish, rapid genetic change may occur. This, then, becomes a valuable experiment in evolution. From my perspective, I would want to see the behavior of the new population compared to that of the source population. This situation is bound to recur. It is another instance of the importance of desert waters as unique experiments, in this case one occasioned by needless extinction.

The extinction of species is becoming, increasingly, a political issue. Each of us will have different levels of involvement, often emotional, sometimes practical. The forces of progress rightfully question whether each and every species must be conserved, particularly when such conservation stands in the way of some development that is perceived as beneficial to humans. After all, it is now clear that throughout time species have been going extinct at a steady clip. Why worry about a few now, here and there, merely because we are the agents?

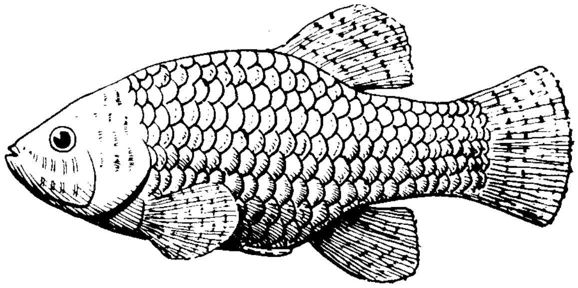
The problem with such arguments is that species have not just gone extinct through time. They have been replaced by other species that are better adapted. When desert fishes go extinct it is usually because of some severe perturbation of the environment, sometimes its total destruction. No new life form will come along to replace the fauna and flora of that body of water. Even if the extinction is brought about by the introduction of exotic species, there is still a net loss of a unique form of life. In this respect, desert waters must be among the most threatened environments in the world.

Having moved to the global level, I would like to return to the study of the behavior of desert fishes to say a few words about its possible general significance. Given the small scale of such systems, the speed of evolution, and the pressing need to be closely tuned to an extreme environment, the adaptiveness of behavior ought to be more apparent. One would hope that we could proceed more efficiently there to derive important generalizations about mating systems as adaptations to the environment.

That might lead to a better understanding of the mechanisms underlying social behavior, in particular, that of aggression because its expression and control is so crucial in the interaction of animals. There is no question in my mind but that the single most frightening malady besetting mankind is our failure to come to grips with aggression, whether at the level of local vandalism or war. This may seem a far cry from studying desert fishes, but in the final analysis everything we learn about the world around us has a message for us.

If nothing else, what we learn about those fishes makes us ask, if only by analogy, whether the same questions ought to be put to human behavior. Then we could seek the answers as best we can. It is the asking of the question, not the findings themselves, that is important. Charles Darwin said, in effect, that certain discoveries evaded him for years because he never asked the right question. Once he did, the solution was relatively simple. The study of desert fishes may hold some surprising questions for us.

EL CONSEJO DE LOS PECES DEL DESIERTO



"DEDICADO A LA PRESERVACION DE LOS PECES DE LOS DESIERTOS DE AMERICA"

DECIMOSEXTO SIMPOSIO ANUAL
SIXTEENTH ANNUAL SYMPOSIUM

UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI
SAN LUIS POTOSI, S.L.P., MEXICO
15-17 NOVIEMBRE, 1984

PREFACE TO SYMPOSIUM XVI

In continuation of a tradition started in 1980 in Nuevo Leon, the Council once again crossed the border to meet with Mexican members and colleagues, this time a El Instituto de Zonas Deserticas de la Universidad Autonoma de San Luis Potosi. Although members travelled to San Luis Potosi by various means and routes, the majority came by way of San Diego, from which we went by bus to Tijuana Airport, from there by Aeromexico DC-8 to Aguascalientes, and then on to San Luis Potosi by University bus. Thus began a symposium highlighted, as usual, by superb Mexican hospitality. The Council is extremely grateful to Institute Director Nicolas Vazquez-Rosillo and his staff for their many kindnesses in our behalf.

Attendance from both nations was excellent, and one of many symposium highlights (which included a superb banquet) was a day-long field trip to La Media Luna, one of North America's most interesting (and endangered) aquatic ecosystems. La Media Luna is inhabited by five fishes and three crustaceans endemic to the intermontane portion of the Rio Verde drainage. As with most other aquatic ecosystems in North America, habitat alteration and the introduction of nonnative species have adversely impacted the native fauna.

Participants were especially grateful to Karl Pister, whose exceptional knowledge of Spanish expedited our travels in countless ways. He also served as a translator during the sessions, along with Arcadio Valdes-Gonzales, Salvador Contreras-Balderas, and Carlos Yruretagoyena-Ugalde.

Following introductory remarks by Chairman Contreras-Balderas, a series of agency reports preceded a variety of technical papers in the following order.

PRESENTATION

DR. JOSE DE JESUS RODRIGUEZ, RECTOR, UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI, REPRESENTED BY LIC. EFRAIN ALVAREZ MENDEZ.

DR. NICOLAS VAZQUEZ ROSILLO, DIRECTOR, INSTITUTO DE INVESTIGACIONES DE ZONAS DESERTICAS, U.A.S.L.P.

DISTINGUISHED AUTHORITIES OF THIS UNIVERSITY, LOCAL COMMITTEE, FRIENDS ALL:
THE DESERT FISHES COUNCIL WAS BORN 16 YEARS AGO, WHEN A GROUP OF ICHTHYOLOGISTS, CONCERNED OVER THE ABUSE OF AQUATIC HABITATS AND THE CONSEQUENTIAL EXTINCTION OF SOME OF THEIR INTERESTING ENDEMIC SPECIES, PARADOXICALLY MET IN THE DEATH VALLEY TO DEFEND THE RIGHT TO LIVE, NOT ONLY OF FISH, BUT OF ALL NATURE, HUMAN BEINGS INCLUDED.

AT FIRST ONLY ICHTHYOLOGISTS, BUT LATER ON RESOURCE MANAGERS, FISH CULTURISTS AND FISHERIES BIOLOGISTS WERE INVOLVED. PRESENT ALSO WERE ENVIRONMENTALISTS AND OTHER INTERESTED PEOPLE. DIFFERENCES WERE OVERCOME, AND TIME LED US TO A BETTER MUTUAL UNDERSTANDING, TO A MORE POSITIVE INTERACTION THRU COMMON BASES IN A FREE AND INFORMAL FORUM, BUT KEEPING SCIENTIFIC OBJECTIVITY. SUBGROUPS HAVE NOW MODIFIED INTO JUST ONE GROUP.

THE SAME SITUATION HAS HAPPENED IN ALL THE AREAS WHERE THE COUNCIL FUNCTIONS, AND MEXICO IS NO EXCEPTION. WE ARE ALSO FOLLOWING THE SAME STEPS. THIS 16th ANNUAL MEETING IS THE SECOND IN MEXICO, AND WE HOPE IT WILL EXCEED THAT OF MONTERREY, JUST AS EACH MEETING IS BETTER THAN THE FORMER, WHICH IS THE WAY OF CONSTRUCTIVE EVOLUTION.

WE GRATEFULLY ACKNOWLEDGE THE INVITATION TO MEET IN THIS CITY OF SAN LUIS POTOSI, TO THE UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI, AND PARTICULARLY TO THE INSTITUTO DE INVESTIGACIONES EN ZONAS DESERTICAS, AND TO ALL PARTICIPANTS FOR THEIR HELP AND SUPPORT.

WE WISH, AND WILL WORK, TO MAKE THIS 16th ANNUAL MEETING BENEFICIAL TO ALL. WELCOME TO EVERYONE, AND THANK YOU VERY MUCH.

SALVADOR CONTRERAS BALDERAS.

PRESENTACION

DR. JOSE DE JESUS RODRIGUEZ, RECTOR, UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI, REPRESENTADA POR EL LIC. EFRAIN ALVAREZ MENDEZ.

DR. NICOLAS VAZQUEZ ROSILLO, DIRECTOR, INSTITUTO DE INVESTIGACIONES DE ZONAS DESERTICAS, U.A.S.L.P.

DISTINGUIDOS FUNCIONARIOS DE LA UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI, GRUPO LOCAL, AMIGOS TODOS:

EL CONSEJO DE PECES DEL DESIERTO NACIO HACE 16 AÑOS, CUANDO UN GRUPO DE ICTIOLOGOS, PREOCUPADOS POR EL ABUSO DEL AGUA Y LA EXTINCION CONSECUENTE DE ALGUNAS DE SUS INTERESANTES ESPECIES ENDEMICAS, PARADOJICAMENTE SE REUNIO EN EL VALLE DE LA MUERTE PARA DEFENDER EL DERECHO A LA VIDA, NO SOLO PARA LOS PECES, SINO PREOCUPADOS POR LA NATURALEZA TOTAL, INCLUIDO EL SER HUMANO

AL PRINCIPIO SOLO ICTIOLOGOS, OCUPADOS EN LA DEFENSA, LUEGO ACUICULTORES Y PESQUEROS, TRABAJANDO EN EL USO, CON INTERES E INFORMACION APARENTEMENTE -- CONTRARIAS, CON RECELOS MUTUOS. NO FALTARON ECOLOGISTAS Y OTROS INTERESADOS EL TIEMPO NOS LLEVO A ENTENDERNOS MEJOR MUTUAMENTE, E INTERACTUAR MAS POSITIVAMENTE POR MEDIO DE LOS ELEMENTOS COMUNES EN UN FORO LIBRE E INFORMAL, PERO MANTENIENDO LA OBJETIVIDAD CIENTIFICA. AMBOS SUBGRUPOS SE HAN MODIFICADO Y SE HAN VUELTO UNO SOLO.

LO MISMO HA PASADO EN TODAS LAS AREAS DONDE EL CONSEJO SE EXPANDE, Y MEXICO NO ES EXCEPCION. TAMBIEN SEGUIMOS LOS PASOS SEÑALADOS. ESTA 16a. REUNION ES LA SEGUNDA EN MEXICO, ESPERAMOS QUE SUPERE A LA DE MONTERREY, COMO CADA REUNION SUPERA A LA ANTERIOR, QUE ES LA RUTA DE LA EVOLUCION CONSTRUCTIVA.

AGRADECEMOS LA INVITACION A ESTA CIUDAD DE SAN LUIS POTOSI, A LA UNIVERSIDAD AUTONOMA DE SAN LUIS POTOSI Y EN PARTICULAR AL INSTITUTO DE INVESTIGACION DE ZONAS DESERTICAS Y A TODOS LOS PARTICIPANTES SUS ATENCIONES Y ASISTENCIA.

DESEAMOS Y TRABAJAREMOS PARA QUE ESTA 16a. REUNION SEA BENEFICA PARA TODOS BIENVENIDOS Y MUCHAS GRACIAS.

SALVADOR CONTRERAS BALDERAS.

TWO NEW INTERGENERIC CYPRINID HYBRIDS FROM THE BONNEVILLE BASIN, UTAH

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Naturally occurring intergeneric cyprinid hybrids involving *Iotichthys phlegethontis*, in combination with either *Gila atraria* or *Rhinichthys osculus*, are described from collections mostly from springs in the Snake Valley region of the western Bonneville Basin, Utah. *Iotichthys*, a monotype genus, is the only genus endemic to the Bonneville Basin. *Iotichthys phlegethontis* was once common in the basin; however, now it is considered a threatened species in Utah. Principal components analysis (PCA) was used to identify 23 *I. phlegethontis* X *R. osculus* hybrids and two *I. phlegethontis* X *G. atraria* hybrids. Discriminant function analysis was utilized as an *a posteriori* test of the PCA. The putative hybrids demonstrated considerable variability and/or little intermediacy. Because of this variability all hybrids are simply classified as being of a mixed species origin. An obvious question raised by the prevalence of hybrids in the collections examined concerns reasons why Bonneville Basin species that have coexisted and coevolved for a long time apparently hybridize so readily. Further research is needed for this complex situation. However, at present, the description of hybridization involving *I. phlegethontis* is noteworthy by calling attention to a potential cause for the decline of a unique species.

Desert Fishes Council Proc.
Tempe, Ariz.

PECES DEL RIO ALAMO, SUBCUENCA DEL BRAVO, MEXICO. I. ICTIOFAUNA E ICTIOGEOGRAFIA.

Gorgonio Ruiz-Campos [1] y Salvador Contreras-Balderas [2]

RESUMEN.

Se describe sistemática y zoogeográficamente la ictiofauna del Río Alamo, Subcuenca del Río Bravo, México, a partir de 15 localidades de colecta en el transecto principal de la cuenca, muestreadas de Marzo de 1981 a Febrero de 1982. La fauna íctica se compone de 34 especies, en 26 géneros y 15 familias, representadas por 16,032 ejemplares depositados en la Colección Ictiológica, Facultad de Ciencias Biológicas, UANL. La mayor parte de la ictiofauna está compuesta zoogeográficamente por elementos de afinidad Neártica (20 especies), en menor cantidad por formas de afinidad Neotropical (8 especies) y Exótica (6 especies), de las cuales diez y ocho son primarias, nueve son secundarias, cuatro son vicarias, con una diadroma, una complementaria y una esporádica. Se agregan 18 nuevos registros para el área.

ABSTRACT.

The ichthyofauna of the Rio Alamo, Rio Grande Sub-basin, México, is systematically and zoogeograpgically described, based on 15 collectings sites in the basin main transect, sampled from March 1981 to February 1982. The ichthic fauna is composed of 34 species, 26 genera and 15 families, studied on 16,032 specimens deposited in the Ichthyological Collection of the Facultad de Ciencias Biológicas, UANL. Most of the ichthyofauna is zoogeographically composed of elements with Nearctic affinitty (20 species), and in a lesser proportion by elements with Neotropical Affinities (8 species), or Exotics (6 species). From these eighteen are primary, nine are secondary, four are vicarious, with one diadromus, one complementary and one sporadic species. Eighteen news records for the area are added.

INTRODUCCION.

El Río Alamo es uno de los afluentes mexicanos principales del Bajo Río Bravo (Grande) localizado al Noreste de Nuevo León y Noroeste de Tamaulipas, entre las cuencas de los ríos Salado y San Juan.

Aunque la mayor parte de los afluentes principales del Bajo Río Bravo han sido estudiados ictiológicamente (cf. Smith y Miller, 1986), poco se

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conoce de la ictiofauna del Río Alamo, empero de ser un tributario importante del Bajo Río Bravo, el cual requiere ser estudiado y considerado -- desde cualquier punto de vista.

La poca información que existe sobre los peces del Río Alamo, es en - su mayor parte reportes parciales o puntuales en la distribución de algunas especies (e.g. Contreras, 1967, 1972, MS). Contreras (1967) cita a -- los Poeciliidae Gambusia affinis y Poecilia mexicana para el Río Alamo, sin especificar localidades de distribución. Posteriormente Contreras - - (1972) da un nuevo registro para Nuevo León del Mugilidae Agonostomus - - monticola en el Río Alamo (Presa Parás 14 km WSW Parás) y menciona además otras 15 especies asociadas en tal localidad. En la misma localidad anterior, Contreras (MS) usó el registro del Lepisosteído Lepisosteus oculatus para la distribución de esa especie en México.

El presente trabajo proporciona una lista sistemática-distribucional de la ictiofauna del Río Alamo, además incluye para cada especie notas -- ecológicas y su status ecológico-zoogeográfico.

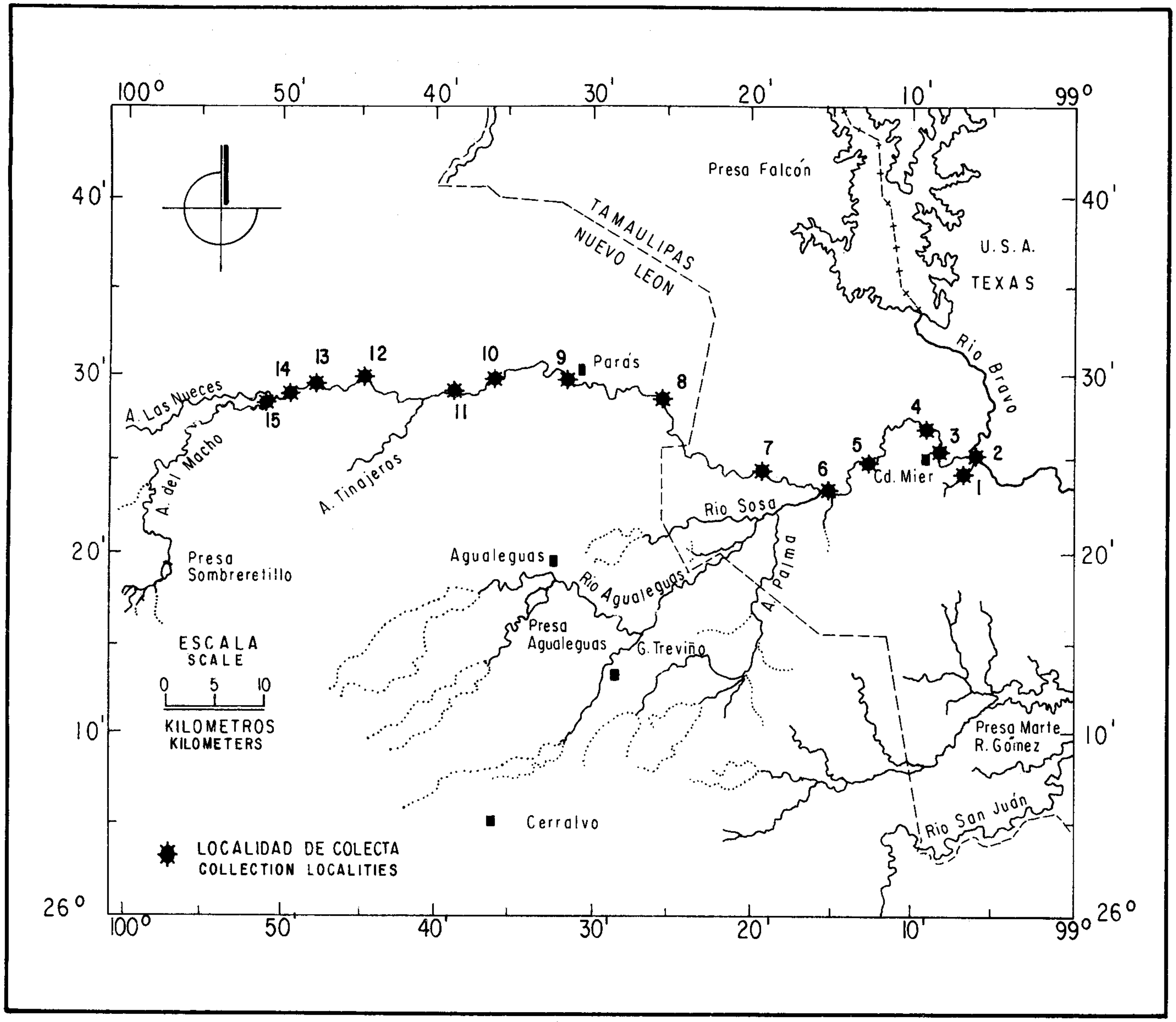
MATERIAL Y METODOS.

Un total de 15 localidades a lo largo del canal principal de la cuenca (ver Mapa 1) fueron colectadas de Marzo 1981 a Febrero 1982), de ellas ocho fueron muestreadas bimestralmente (ver Apéndice 1) durante dicho período. Además se incluye material de otras colectas, de las especies que no fueron colectadas en este período de muestreo, para complementar el -- listado de especies.

El material íctico fué colectado con un chinchorro (3x1.5x1/8'') y - - eventualmente se utilizaron palangres, redes agalleras (2'' luz de malla) y atarraya, para aquellas localidades inaccesibles al muestreo con chinchorro. El material íctico fué fijado y preservado según método de Hall et al. (1962) y se encuentra depositado en la Colección Ictiológica, Facultad de Ciencias Biológicas, UANL, se cita con la clave de localidad - (ver Apéndice 1) y su número de catálogo.

Se consideró parte baja del río las localidades 1 a la 6, parte media de la 7 a la 11 y parte alta de la 12 a la 15.

Para la clasificación de las especies según su status ecológico se siguió a Myers (1951), y para la clasificación zoogeográfica se basó en -



MAPA I - LOCALIDADES DE COLECTA EN EL RIO ALAMO, SUB-CUENCA DEL RIO BRAVO, MEXICO.

el criterio de Darlington (1957) y Smith y Miller (1986). La consideración de las especies exóticas se apoya en la lista de peces exóticos de México dada por Contreras y Escalante (1984).

RESULTADOS.

I. Composición Faunística.

Un total de 16,032 ejemplares fueron colectados pertenecientes a 34 especies, 26 géneros y 15 familias. La relación de especies es como sigue:

FAMILIA LEPISOSTEIDAE

Lepisosteus oculatus (Winchell, 1864). N= 10.
Nombre(s) Común(es): Catán, aguja pinta, spotted gar.
Notas Ecológicas: Habita remansos profundos (lénticos) de abundante vegetación.
(Nuphar sp.) y de fondo cenagoso. Distribuída en todo el río, y es sintópica de L. osseus y L. spatula en la desembocadura.

Lepisosteus osseus (Linnaeus, 1958). N= 1
Nombre(s) Común (es): Aguja, agujón, longnose gar.
Notas Ecológicas: Se encuentra en remansos profundos y abiertos de fondo arenoso. Colectada sólo en la desembocadura del río.

Lepisosteus (=Atractosteus) spatula (Lacépede, 1803). N=1
Nombre(s) Común(es): Catán, pejelagarto, alligator gar.
Notas Ecológicas: Típica de remansos profundos y abiertos (lénticos) de substrato arenoso. Su distribución se limita localmente a la desembocadura del río.

FAMILIA ANGUILLIDAE

Anguilla rostrata (Lesueur, 1817). N= 1
Nombre(s) Común(es): Anguila, american eel.
Notas Ecológicas: El único ejemplar colectado procede de un remanso profundo de fondo arena-cieno en la parte media del río.

FAMILIA CLUPEIDAE

Dorosoma cepedianum (Lesueur, 1818). N= 156

Nombre(s) Común(es): Cuchilla, machete, gizzard shad.

Notas Ecológicas: Frecuenta zonas de remanso y corriente, en substratos - de cieno, arena, grava y manto rocoso. Ampliamente distribuída en la cuenca. Sintópica de *D. petenense* río abajo.

Dorosoma petenense (Günther, 1866). N=178

Nombre(s) Común(es): Topote, threadfin shad.

Notas Ecológicas: Habita remansos profundos y abiertos de fondo arena-cieno, grava y manto rocoso. Confinada distribucionalmente río abajo.

FAMILIA CHARACIDAE

Astyanax mexicanus (Filippi, 1853). N= 3564

Nombre(s) Común(es): Sardina plateada, platija, mexican tetra.

Notas Ecológicas: Típica de habitats lóticos (rápidos y desniveles) en -- todo tipo de substrato (grava, conglomerado rocoso, arena y manto rocoso). Con amplia distribución local.

FAMILIA CYPRINIDAE

Cyprinus carpio (Linnaeus, 1758). N = 32

Nombre(s) Común(es): Carpa común, common carp.

Notas Ecológicas: Esta especie es comúnmente encontrada en zonas lénticas de fondo arena-cieno, grava-manto rocoso y arena-grava. Distribuída - en la parte alta y media del río.

Hybopsis aestivalis (Girard, 1857). N= 42

Nombre(s) Común(es): Sardina de lunares y bigotes, speckled chub.

Notas Ecológicas: Prefiere zonas de corriente de poca profundidad y de - fondo tipo grava. Limitada distribucionalmente a la parte baja del -- río.

Notropis amabilis (Girard, 1857). N= 898

Nombre(s) Común(es): Sardinita, Texas shiner.

Notas Ecológicas: Habita zonas lóticas (rápidos y desniveles) de poca -- profundidad, de substrato tipo conglomerado rocoso y grava. Distribuída en la porción alta y media del río. Sintópica de N. lutrensis en la parte media del río.

Notropis cf. buchanani. N= 14

Nombre(s) Común(es): Sardinita fantasma, ghost shiner.

Notas Ecológicas: Especie poco común colectada en una zona de remanso de fondo grava-cieno. Confinada a la parte alta del río, en la localidad de La Soledad, Vallecillo, N. L.

Notropis lutrensis (Baird y Girard, 1853). N= 6366

Nombre(s) Común(es): Sardinita, red shiner.

Notas Ecológicas: Frecuenta biotopos lóticos de fondo variable (manto rocoso, grava y arena). Distribución de la parte baja a la parte media del río.

Pimephales vigilax (Baird y Girard, 1853). N = 14

Nombre(s) Común(es): Sardinita cabeza de toro, bullhead minnow.

Notas Ecológicas: Especie comúnmente encontrada en remansos someros de - fondo arena-cieno. Su distribución está limitada a la parte baja del río.

FAMILIA CATOSTOMIDAE

Carpiodes carpio (Rafinesque, 1820). N= 33

Nombre(s) Común(es): Matalote, river carpsucker.

Notas Ecológicas: Típica de remansos profundos con fondo generalmente de arena-cieno. Se limita distribucionalmente de la parte baja a la parte media del río.

Moxostoma congestum (Baird y Girard, 1854). N= 3

Nombre(s) Común(es): Matalote blanco, Texas redhorse.

Notas Ecológicas: Frecuenta zonas de remansos de substrato arena-cieno y grava-manto rocoso. Colectada desde la desembocadura hasta *ca.* 4 km río arriba.

FAMILIA ICTALURIDAE

Ictalurus furcatus (Lesueur, 1840). N=1
Nombre(s) Común(es): Bagre, bagre azúl, blue catfish.
Notas Ecológicas: El único ejemplar fué capturado en una zona de remanso profundo con fondo arenoso-cenagoso, en la boca del río.

Ictalurus (=*Ameiurus*) *melas* (Rafinesque, 1820). N= 2
Nombre(s) Común(es): Bagre, puyón, black bullhead.
Notas Ecológicas: Característica de habitats lénticos (remansos profundos) con abundante vegetación (*Nuphar* sp.) y de fondo cenagoso. Con una distribución discontinua en la parte alta y media del río - (una población en la Presa Parás y otra en La Soledad).

Ictalurus punctatus (Rafinesque, 1818). N= 38
Nombre(s) Común(es): Bagre de canal, channel catfish.
Notas Ecológicas: Característico de habitats lénticos, aunque en ocasiones (juveniles) pueden encontrarse en la corriente. Habita en todo tipo de substrato. Especie de amplia distribución en el río.

Pylodictis olivaris (Rafinesque, 1818). N= 2.
Nombre(s) Común(es): Piltonte, flathead catfish.
Notas Ecológicas: Típico de remansos profundos y generalmente en cuevas ú oquedades que se forman entre las raíces sumergidas del Sauce (*Salix* sp.). Prefiere fondos cenagosos. Esta especie presenta distribución en la parte media del río.

FAMILIA CYPRINODONTIDAE

Cyprinodon variegatus (Lacépede, 1803). N = 36
Nombre(s) Común(es): Sardina perrito, sheephead pupfish.
Notas Ecológicas: Frecuenta zonas de remanso de poca profundidad y en -- charcas aisladas, principalmente en orillas; en substrato de arena

cieno. Confinada a la parte baja del río.

Fundulus grandis (Baird y Girard, 1853). N= 1
Nombre(s) Común(es): Sardinita, gulf killifish.
Notas Ecológicas: El único ejemplar colectado fué encontrado en la orilla de un remanso profundo de substrato arena-cieno en la parte baja del río (desembocadura).

FAMILIA POECILIIDAE

Gambusia affinis (Baird y Girard, 1853). N= 1692
Nombre(s) Común(es): Gambusia, guayacón, mosquito-fish.
Notas Ecológicas: Comúnmente encontrada en las orillas de remansos y entre la vegetación sumergida (e.g. Cyperáceas). Habita en todo tipo - de substrato, como grava, arena, cieno, manto y conglomerado rocoso. Especie ampliamente distribuída en todo el río.

Poecilia mexicana (Steindachner, 1863). N= 933
Nombre(s) Común(es): Moli, Atlantic molly.
Notas Ecológicas: Habita generalmente remansos someros y en corriente, - de substrato tipo grava. Se distribuye sólamente en la parte alta -- del río.

FAMILIA ATHERINIDAE

Menidia beryllina (Cope, 1869). N= 22
Nombre(s) Común(es): Charalito crema, tidewater silverside.
Notas Ecológicas: Se encuentra principalmente en zonas lénticas (orillas) de substrato de arena-cieno, manto rocoso y grava. Especie típica de la región baja del río.

FAMILIA PERCICHTHYIDAE

Morone chrysops (Rafinesque, 1820). N= 3
Nombre(s) Común(es): Robalo blanco, white bass.
Notas Ecológicas: Colectada en zonas de corriente de fondo arena-cieno.

La distribución de esta especie se confina a la región de la boca del río.

FAMILIA CENTRARCHIDAE

Chaenobryttus (= Lepomis) gulosus (Cuvier y Valenciennes, 1829). N= 2
Nombre(s) Común(es): Encontrada en remansos someros y aislados entre sí, de fondo rocoso (tipo "lajas").

Lepomis cyanellus (Rafinesque, 1819). N= 10
Nombre(s) Común(es): Mojarra verde, green sunfish.
Notas Ecológicas: Habita en zonas lénticas someras y con vegetación tipo Nitella sp. y Typha sp., en substratos de manto rocoso y grava-cieno. Distribuída a lo largo de todo el río.

Lepomis machochirus (Rafinesque, 1819). N= 1252
Nombre(s) Común(es): Mojarra azúl, mojarra de oreja azúl, blue-gill.
Notas Ecológicas: Típica de remansos de mediana a poca profundidad, como en orillas, recodos y áreas con vegetación de Nuphar sp., Nymphaea sp. y Nitella sp. El tipo de fondo donde se encontró varía de arena-cieno, manto rocoso y grava. Especie ampliamente distribuída en todo el río.

Micropterus salmoides (Lacépede, 1802). N= 218
Nombre(s) Común(es): Robalo, lobina negra, largemouth bass.
Notas Ecológicas: Se encuentra en zonas de remanso y corriente de todo tipo de substrato. De amplia distribución local en el río.

Pomoxis annularis (Rafinesque, 1818). N= 25
Nombre(s) Común(es): Robaleta, white crappie.
Notas Ecológicas: Habita en zonas lénticas de fondo arena-cieno, grava y manto rocoso. Esta especie es común encontrarla en la región cercana a la desembocadura, aunque un solo ejemplar fué colectado en la localidad de Parás, N. L.

FAMILIA SCIAENIDAE

Aplodinotus grunniens (Rafinesque, 1829). N= 6

Nombre(s) Común(es): Besugo, freshwater drum.

Notas Ecológicas: Característica de habitats lénticos (remansos profundos y abiertos) con fondo tipo arena-cieno y grava-cieno. Con distribución discontinua a lo largo del río.

FAMILIA CICHLIDAE

Cichlasoma cyanoguttatum (Baird y Girard, 1854). N= 417.

Nombre(s) Común(es): Mojarra copetona, mojarra tropical, Texas cichlid.

Notas Ecológicas: Habita generalmente en zonas de remanso de abundante -- vegetación (e.g. Nuphar, Chara, Nitella, Utricularia, Nymphaea), y de fondo tipo variable (arena, cieno, grava, manto y conglomerado rocoso). Con amplia distribución local en el río.

Tilapia sp. N =57

Nombre(s) Común(es): mojarra africana, tilapia.

Notas Ecológicas: Habita principalmente remansos con vegetación abundante y de fondo arena, grava, cieno y manto rocoso. Distribuída a lo largo de todo el río.

FAMILIA MUGILIDAE

Agonostomus monticola (Bancroft, 1836). N= 2

Nombre(s) Común(es): lisa, mountain mullet.

Notas Ecológicas: Colectada abajo de la cortina de la Presa Parás, en una zona de tipo léntico y somera, y en vegetación consistente de Nuphar, Nymphaea, Juncus, Eleocharis, Scirpus, Cyperus y Ultricularia. Esta especie ha sido encontrada sólamente en la parte media del río, en la localidad antes mencionada.

II. Distribución local

La distribución local de las especies ícticas en el canal principal -

TABLA I - DISTRIBUCION LOCAL DE LAS ESPECIES ICTICAS EN EL RIO ALAMO, SUB-CUENCA DEL RIO BRAVO, MEXICO.

ESPECIES	LOCALIDADES DE COLECTA														
	PARTE BAJA						PARTE MEDIA					PARTE ALTA			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
LEPISOSTEUS OCULATUS		X								X			X	X	
LEPISOSTEUS OSSEUS		X													
LEPISOSTEUS SPATULA		X													
ANGUILLA ROSTRATA												X			
DOROSOMA CEPEDIANUM		X	X	X	X	X	X	X	X	X				X	
DOROSOMA PETENENSE		X	X												
ASTYANAX MEXICANUS		X	X	X	X	X	X	X	X	X	X	X	X	X	X
CYPRINUS CARPIO		X	X		X		X		X	X					
HYBOPSIS AESTIVALIS			X	X											
NOTROPIS AMABILIS								X	X	X	X	X			
NOTROPIS CF. BUCHANANI														X	
NOTROPIS LUTRENSIS		X	X	X	X	X	X	X	X						
PIMEPHALES VIGILAX		X	X	X											
CARPIODES CARPIO		X		X	X					X					
MOXOSTOMA CONGESTUM		X	X												
ICTALURUS FURCATUS		X													
ICTALURUS MELAS										X				X	
ICTALURUS PUNCTATUS		X	X		X		X	X	X	X	X	X		X	
PYLODICTIS OLIVARIS							X			X					
CYPRINODON VARIEGATUS	X		X												
FUNDULUS GRANDIS		X													
GAMBUSIA AFFINIS	X	X	X	X	X	X	X	X	X		X	X		X	X
POECILIA MEXICANA														X	
MENIDIA BERYLLINA		X	X												
MORONE CHRYSOPS		X	X												
CHAENOBRYTTUS GULOSUS	X														
LEPOMIS CYANELLUS	X				X				X	X				X	
LEPOMIS MACROCHIRUS		X	X	X	X	X	X	X	X	X	X	X	X	X	X
MICROPTERUS SALMOIDES		X	X		X		X	X	X	X		X	X	X	
POMOXIS ANNULARIS		X	X		X				X						
APLODINOTUS GRUNNIENS		X	X							X					
CICHLASOMA CYANOGUTTATUM	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TILAPIA SP.		X	X		X				X			X		X	
AGONOSTOMUS MONTICOLA										X					

TABLA II.COMPOSICION ICTIOFAUNISTICA EN EL RIO ALAMO, SUBCUENCA DEL RIO BRAVO, NORESTE DE MEXICO.

FAMILIA	ZOOGEOGRAFIA				ECOLOGIA						DISTRIBUCION		
ESPECIE	NR	NA	NT	EX	Pr	S	D	V	C	E	PA	PM	PB
LEPISOSTEIDAE													
Lepisosteus oculatus		X				X					X	X	X
Lepisosteus osseus	X	X				X							X
Lepisosteus spatula	X	X				X							X
ANGUILLIDAE													
Anguilla rostrata	X	X					X				X		
CLUPEIDAE													
Dorosoma cepedianum		X						X			X	X	X
Dorosoma petenense	X	X						X					X
CHARACIDAE													
Astyanax mexicanus			X		X						X	X	X
CYPRINIDAE													
Cyprinus carpio				X	X							X	X
Hybopsis aestivalis	X	X			X								X
Notropis amabilis		X			X						X	X	
Notropis cf. *buchanani*	X	X			X						X		
Notropis lutrensis	X	X			X							X	X
Pimephales vigilax	X	X			X								X
CATOSTOMIDAE													
Carpiodes carpio		X			X							X	X
Moxostoma congestum	X	X			X								X
ICTALURIDAE													
Ictalurus furcatus	X	X			X								X

NR = NUEVO REGISTRO, NA = NEARTICA, NT = NEOTROPICAL, EX = EXOTICA, Pr = PRIMARIA, S = SECUNDARIA,
D = DIADROMA, V = VICARIA, C = COMPLEMENTARIA, E = ESPORADICA, PA = PARTE ALTA, PM = PARTE MEDIA, PB= PARTE BAJA

TABLA II (CONTINUACION). COMPOSICION ICTIOFAUNISTICA EN EL RIO ALAMO, SUBCUENCA DEL RIO BRAVO, NORESTE DE MEXICO.

FAMILIA	ZOOGEOGRAFIA				ECOLOGIA						DISTRIBUCION		
ESPECIE	NR	NA	NT	EX	Pr	S	D	V	C	E	PA	PM	PB
Ictalurus melas	X			X	X						X	X	
Ictalurus punctatus		X			X						X	X	X
Pylodictis olivaris		X			X							X	
CYPRINODONTIDAE													
Cyprinodon variegatus	X		X			X							X
Fundulus grandis	X		X			X							X
POECILIIDAE													
Gambusia affinis			X			X					X	X	X
Poecilia mexicana			X			X					X		
ATHERINIDAE													
Menidia beryllina	X		X					X					X
PERCICHTHYIDAE													
Morone chrysops	X			X				X					X
CENTRARCHIDAE													
Chaenobryttus gulosus	X			X	X								X
Lepomis cyanellus		X			X						X	X	X
Lepomis macrochirus		X			X						X	X	X
Micropterus salmoides		X			X						X	X	X
Pomoxis annularis	X			X	X							X	X
SCIAENIDAE													
Aplodinotus grunniens		X								X		X	X
CICHLIDAE													
Cichlasoma cyanoguttatum			X			X					X	X	X
Tilapia sp.	X			X		X					X	X	X
MUGILIDAE													
Agonostomus monticola			X						X				

de la cuenca del Río Alamo es presentada en la Tabla I. Aquí es evidente un marcado patrón de diferenciación distribucional de las especies a través del río. Esta zonación distribucional está representada por formas confinadas a la parte baja del río, tales como: L. osseus, L. spatula, D. petenense, H. aestivalis, P. vigilax, M. congestum, I. furcatus, C. variegatus, F. grandis, M. beryllina, M. chrysops y Ch. gulosus; formas con distribución limitada a la parte alta del río, como: A. rostrata, N. cf. buchanani y P. mexicana; otras especies como P. olivaris y A. monticola están limitadas a la porción media del río, y finalmente formas de amplia distribución local, tales como: L. oculatus, D. cepedianum, A. mexicanus, Cyprinus carpio, N. amabilis, N. lutrensis, I. punctatus, G. affinis, L. cyanellus, L. macrochirus, M. salmoides, P. annularis, A. grunniens, C. cyanoguttatum y Tilapia sp.

III. Ictiogeografía.

En la Tabla 2 se presenta la clasificación zoogeográfica de las especies ícticas del Río Alamo. Aquí es notable la gran dominancia de formas norteñas (neárticas) representada por 20 especies; en menor proporción se encuentran formas (8 especies) de afinidad neotropical, y un total de 6 especies exóticas al sistema.

Por otra parte, también en la Tabla 2 se incluye la clasificación ecológica de la fauna íctica del Río Alamo, donde se registró un total de 18 formas primarias, 9 secundarias, 4 vicarias, y un sólo caso para las categorías ecológicas de diadromas, complementarias y esporádicas; las primeras dos categorías son de estirpe dulceacuícola y el resto son de origen ó derivación marina.

DISCUSION Y CONCLUSIONES.

De las 34 especies de peces registradas para el Río Alamo, subcuenca del Río Bravo, México, 18 son nuevos registros para el área (13 nativas y 5 exóticas). La composición faunística del Río Alamo es muy similar a la reportada para los sistemas Río Salado (Guerra, 1952; Smith y Miller, 1986) y Río San Juan (Contreras, 1962, 1967).

Es evidente en la parte baja del río (desembocadura y áreas proximales) el gran número de especies características de la ictiofauna del Río

Bravo (Treviño-Robinson, 1959; Edwards y Contreras, 1982; Smith y Miller 1986); la presencia de estas formas dentro del Alamo se debe posiblemente a las características ecológicas de esta porción hidrológica (gran caudal) que favorece la entrada de especies típicas de "gran río".

Aunque es obvia la relación neártica de la ictiofauna del Río Alamo, dada por la gran representación de elementos de afinidad norteña (20 especies), algunas especies (8) son representantes neotropicales, siendo de interés notable el caso de *Poecilia mexicana*. Esta especie cuya población confinada a una localidad de la parte alta del río, representa el registro más norteño de la distribución de esta especie; ya que Miller (1983) marca el límite distribucional más norteño hasta el Río San Juan en Nuevo León. Aunque Contreras (1967) lo reportó en el Río Alamo.

Por otra parte de gran interés ecológico representa el hallazgo de una población aislada en la parte alta del río del ciprínido *Notropis* cf. *buchanani*, siendo esta especie característica de habitats de gran río (Trautman, 1957), y parte de la fauna característica del bajo Río Bravo (Smith y Miller, 1986).

De especial interés es la distribución de *Notropis amabilis* y *N. lutrensis* dentro del río Alamo, *N. amabilis* se distribuye de la parte alta a la parte media del río, en cambio *N. lutrensis* se distribuye de la parte baja a la parte media. Ambas especies se traslapan distribucionalmente en dos localidades de la parte media del río (El Barro y Parás), siendo dominante en El Barro *N. lutrensis* y en Parás *N. amabilis*, posiblemente representa un caso de exclusión competitiva.

Aunque ecológicamente la ictiofauna del Río Alamo está compuesta de especies propiamente de origen dulceacuícola en su mayor parte (18 primarias y 9 secundarias), una menor proporción corresponde a formas de derivación marina, de las cuales seis son de tipo vicaria y sólamente una especie para las categorías ecológicas de diadroma, complementaria y esporádica. Estas especies de estirpe marina son en su mayoría formas procedentes vía Río Bravo, las cuales han sido reportadas a penetrar gradualmente el bajo Río Bravo, debido al salamiento de esta región causado por las actividades antropogénicas (Rodríguez, 1976; Edwards y Contreras, 1982).

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LITERATURA CITADA.

Contreras-Balderas, S. 1962. Contribución al conocimiento de la ictiofauna del Río San Juan, Provincia del Río Bravo, México. Tesis Profesional, Universidad de Nuevo León, México.

_______. 1967. Lista de Peces del Estado de Nuevo León. Cuad. Inst. Invest. Cient., U.N.L., 11:1-12.

_______. 1972. *Agonostomus monticola* (Bancroft): Primer registro de la -- familia Mugilidae en Nuevo León, México. idem, 16:1-5.

_______, MS. La distribución de *Lepisosteus oculatus* Winchell en México (Pisces: Lepisosteidae).

_______ y M.A. Escalante-C. 1984. Distribution and known impacts of exotic fishes in Mexico. p. 102-130. In: Distribution, biology, and management of exotic fishes. (W.R. Courtenay, J. & J.R. Stauffer, Jr. eds.). The Johns Hopkins University Press, Baltimore.

Darlington, P.J., Jr. 1957. Zoogeography: The geographical distribution of animals. John Wiley & Sons, New York.

Edwards, R.J. y S. Contreras-B. 1982. Historical changes in the ichthyofauna of the Lower Rio Grande (Río Bravo Norte), Texas and México. Tamaulipan Biotic Province Symp.

Guerra, Luciano Val. 1952. Ichthyological survey of the Rio Salado, México. Univ. Texas, M. Sc. thesis (inédita).

Hall, E.R., *et al.* 1962. Collecting and preparing study specimens of vertebrates. Univ. Kansas Mus. Nat. Hist. Misc. Publ., 30:1-46.

Miller, R.R. 1983. Checklist and key to the mollies of México (Pisces: Poeciliidae: Subgenus *Mollienesia*). Copeia, 1983(3):817-822.

Myers, G.S. 1951. Fresh-water fishes and East Indian zoogeography. Stanford Ichthyol. Bull., 4:11-21.

Rodríguez-Olmos, G. 1976. Cambios en la composición de especies de peces en comunidades del Bajo Río Bravo, México-Estados Unidos. Tesis profesional, F.C.B., U.A.N.L.

Smith, M.L. y R.R. Miller. 1986. The evolution of the Rio Grande basin - as inferred from its Fish Fauna. p. 457-485. In: The Zoogeography of North American freshwater fishes. (Ch. H. Hocutt & E.O. Wiley, eds.) John Wiley & Sons, New York.

Trautman, M.B. 1957. The Fishes of Ohio. Ohio State University Press, Columbus.

Treviño-Robinson, D. 1959. The ichthyofauna of the Lower Rio Grande, Texas and México. Copeia, 1959(3):253-256.

Apéndice 1. Lista de localidades de colecta en el Río Alamo, subcuenca - del Río Bravo. México. Un asterisco (*) indica las localidades que fueron muestreadas bimestralmente durante Marzo 1981-Febrero 1982.

1.- El Saladito (arroyo), 4 km. SE Cd. Mier, Tamps. (N 26°24' y W 99° 07').

* 2.- Desembocadura, 5.2 km. E Cd. Mier, Tamps. (N 26°25'34'' y W 99°06' 41'').

* 3.- Ciudad Mier, 300 m. E Cd. Mier, Tamps. (N 26°25'32'' y W 99°08'33'')

4.- Paso del Cántaro, 3.9 km. N Cd. Mier, Tamps. (N 26°27'06'' y W 99° 09'10'').

* 5.- Las Blancas, 9.4 km. W Cd. Mier, Tamps. (N 26°25'58'' y W 99°10' 45'').

6.- Pasito Nuevo, 19.1 km. SW Cd. Mier, Tamps. (N 26°23'28'' y W 99°15' 37'').

* 7.- Las Anacuas, 26 km. W Cd. Mier, Tamps. (ca. Las Auras) (N 26°24' 17'' y W 99°19'37'').

* 8.- El Barro, 11.7 km. SE Parás, N.L. (N26°28'35'' y W 99°25'38'').

* 9.- Parás, N. L. 300 m. S Plaza municipal (N 26°29'45'' y W 99°31'34'').

10.- Presa Parás, 14 km. WSW Parás, N.L. (N 26°30' y W 99°34').

11.- Ejido El Tanque, Parás, N.L. 18.2 km. W Parás (N 26°29'11'' y W 99° 39'04'').

*12.- Palo Alto, 50.3 km. E Sabinas Hdo., N.L. (N26°29'42'' y W 99°45'13'')

13.- Rancho Cantarranas, 43.3 km. E Sabinas Hgo., N.L. (N 26°29'22'' y W 99°48'47'').

*14.- La Soledad (rancho), 39.5 km. E Sabinas Hgo., N.L. (N 26°28'38'' y W 99°50'40'').

15.- Las Adjuntas, Vallecillo, N.L. (confluencia de los arroyos del Macho y Las Nueces), 1.5 km. S del km. 39 de la carr. Sabinas Hgo.-Parás (N 26°28'38'' y W 99°51'16'').

Apéndice 2. Material examinado.

Lepisosteus oculatus N = 10

Desembocadura, UANL-4128; Presa Parás, UANL-1367; Rancho Cantarranas, UANL-3868; La Soledad, UANL 3533, 3857, 4070.

Lepisosteus osseus N = 1

Desembocadura, UANL-4178.

Lepisosteus spatula N = 1

Desembocadura, UANL-4179.

Anguilla rostrata N = 1

Palo alto, UANL 3988.

Dorosoma cepedianum N= 156

Desembocadura, UANL-4129; Ciudad Mier, UANL-3903, 3962, 4022, 4083, 4142, 4230; El Cántaro, UANL-3909; Las Blancas, UANL-3916, 3971, 4032, 4094, 4150, 4242; Pasito Nuevo, UANL-3926; Las Anacuas, UANL-3980, 4042, 4101, 4194, 4249; El Barro, UANL-4050; Parás, UANL-4057, 4108; Presa Parás, UANL-1409, 4222; La Soledad, UANL-4071, 4120, 4171, 4216, 4272.

Dorosoma petenense N=178

Desembocadura, UANL-3896, 3957, 4015, 4079, 4130; Ciudad Mier, UANL-4023.

Astyanax mexicanus N = 3564

Desembocadura, UANL-4016, 4080, 4131; Ciudad Mier, UANL-3963, 4024, 4084, 4143, 4184, 4231; El Cántaro, UANL-3910; Las Blancas, UANL-3917, 3972, -- 4033, 4095, 4151m 4190, 4243; Pasito Nuevo, UANL-3928; Las Anacuas, UANL-3932, 3981, 4043, 4102, 4195, 4250; El Barro, UANL-3938, 3989, 4051, 4200 4256; Parás, UANL-3945, 3995, 4058, 4109, 4157, 4205, 4260; Presa Parás, UANL-1410; El Tanque, UANL-3951; Palo Alto, UANL-3885, 4002, 4064, 4115, 4165, 4212, 4266; Rancho Cantarranas, UANL-3869; La Soledad, UANL-3858, 3878, 4009, 4072, 4121, 4170, 4217, 4273; Las Adjuntas, UANL-3874.

Cyprinus carpio N = 32

Desembocadura, UANL-4132; Ciudad Mier, UANL-4144; Las Blancas, UANL-3918, 4034, 4344; Las Anacuas, UANL-4044, 4251; Parás, UANL-4265; Presa Parás, UANL-1411.

Hybopsis aestivalis N = 42

Ciudad Mier, UANL-4232; El Cántaro, UANL-1758.

Notropis amabilis N = 898

El Barro, UANL-3939, 3990, 4052, 4201; Parás, UANL-3946, 3996, 4059, 4110, 4158, 4206, 4261; El Tanque, UANL-3952; Presa Parás, UANL-1412; Palo Alto, UANL-3886, 4003, 4065, 4267.

Apéndice 2 (Cont.) Notropis lutrensis N= 6366

Desembocadura, UANL-3898, 4133; Ciudad Mier, UANL-3904, 3964, 4025, 4085, 4145, 4185, 4233; El Cántaro, UANL-3911; Las Blancas, UANL-3919, 3973, 4035, 4096, 4152, 4191, 4245; Pasito Nuevo, UANL-3927; El Barro, UANL-3940, 3991, 4053, 4202, 4257; Las Anacuas, UANL-3933; 3982; 4045, 4103, 4196, 4252; Parás, UANL-3946, 3997, 4159, 4207, 4262.

Notropis cf. buchanani N= 14

La Soledad, UANL-3879.

Pimephales vigilax N= 14

Desembocadura, UANL-3899, 4134, 4224; Ciudad Mier, UANL-4234; El Cántaro, UANL-1759.

Carpiodes carpio N= 33

Desembocadura, UANL-4135; El Cántaro, UANL-3912; Las Blancas, UANL-3920, 3974, 4036, 4153, 4246; Presa Parás, UANL-1413.

Moxostoma congestum N= 3

Desembocadura, UANL-4225, Ciudad Mier, UANL-4026.

Ictalurus furcatus N= 1

Desembocadura, UANL-4180.

Ictalurus melas N= 2

Presa Parás, UANL-4223; La Soledad, UANL-4274.

Ictalurus punctatus N= 2

Desembocadura, UANL-4017; Ciudad Mier, UANL-4086, 4235; Las Blancas, UANL 3921, 4037; Las Anacuas, UANL-3934, 3983; El Barro, UANL-3941; Parás, UANL-4111, 4160; El Tanque, UANL-3953; Palo Alto, UANL-4116; La Soledad, UANL-3870; Presa Parás, UANL-1415.

Pylodictis olivaris N= 2

Presa Parás, UANL-1414; Las Anacuas, UANL-4104.

Cyprinodon variegatus N= 36

El Saladito, UANL-3891; Ciudad Mier, UANL-3905, 3965, 4236.

Fundulus grandis N= 1

Desembocadura, UANL-4181.

Gambusia affinis N-1692

Desembocadura, UANL-3897, 4081, 4136; Ciudad Mier, UANL-3906, 3966, 4027, 4087, 4146, 4186, 4237; El Cántaro, UANL-3913; Las Blancas, UANL-3922, 3975, 4038, 4098, 4154, 4192, 4247; Pasito Nuevo, UANL-3931; Las Anacuas, Apéndice 2 (Continuación).

UANL-3935, 3984, 4046, 4105, 4253; El Barro, UANL-3942, 3992, 4054, 4203, 4258; Parás, UANL-3948, 3998, 4112, 4161, 4208; Palo Alto, UANL-3887, 4004, 4066, 4166, 4268; El Tanque, UANL-3954; La Soledad, UANL-3859, 3880, 4010, 4073, 4122, 4172, 4218, 4275; Las Adjuntas, UANL-3875; El Saladito, UANL-3892.

Poecilia mexicana N= 933

La Soledad, UANL-3860, 3881, 4011, 4074, 4123, 4173, 4219, 4276, 4199.

Menidia beryllina N= 22

Desembocadura, UANL-3900, 4018, 4137, 4227; Ciudad Mier, UANL-3907.

Morone chrysops N=3

Desembocadura, UANL-4182, 4228; Ciudad Mier, UANL-4088.

Chaenobryttus gulosus N = 2

El Saladito, UANL-3894.

Lepomis cyanellus N= 10

El Saladito, UANL-3893; Las Blancas, UANL-3976, 4039; Parás, UANL-4209; Presa Parás, UANL-1419; La Soledad, UANL-3864.

Lepomis macrochirus N= 1252

Desembocadura, UANL-3901, 3958, 4019, 4183, 4229; Ciudad Mier, UANL-3967 4028, 4089, 4147, 4187, 4238; El Cántaro, UANL-3914; Las Blancas, UANL-3923, 3977, 4040, 4155; Pasito Nuevo, UANL-3929; Las Anacuas, UANL-3936, 3985, 4047, 4106, 4197, 4254; El Barro, UANL-3943, 3993, 4055, 4259; Parás, UANL-3949, 3999, 4060, 4113, 4162, 4210, 4263; Presa Parás, UANL-1418; El Tanque, UANL-3955; Palo Alto, UANL-3888, 4005, 4067, 4117, 4167 4213, 4269; Cantarranas, UANL-3871; La Soledad, UANL-3865, 3861, 3882, 4012, 4075, 4124, 4174, 4220, 4277; Las Adjuntas, UANL-3876.

Micropterus salmoides N= 218

Desembocadura, UANL-3959, 4020; Ciudad Mier, UANL-3968, 4029, 4090; Las Blancas, UANL-3924; Las Anacuas, UANL-3986, 4048; El Barro, UANL-3994; Parás, UANL-3950, 4000, 4061; Palo Alto, UANL-3889, 4006, 4068, 4118, 4168, 4214, 4270; Cantarranas, UANL-3872; La Soledad, UANL-3862, 3866, 3883, 4013, 4076, 4125, 4175, 4278; Presa Parás, UANL-1420.

Pomoxis annularis N= 25

Desembocadura, UANL-3902, 3960, 4021, 4082, 4139; Ciudad Mier, UANL-3969 4091, 4188; Las Blancas, UANL-3978; Parás, UANL-4163.

Aplodinatus grunniens N= 6

Desembocadura, UANL-4140, Ciudad Mier, UANL-4239; Presa Parás, UANL-1421

Apéndice 2 (Continuación).

Cichlasoma cyanoguttatum N= 417

Desembocadura, UANL-3961, 4141; Ciudad Mier, UANL-3908, 3970, 4030, 4092, 4148, 4240; El Cántaro, UANL-3915; Las Blancas, UANL-3925, 3979, 4100, 4156, 4193, 4248; Pasito Nuevo, UANL-3930; Las Anacuas, UANL-3937, 3987, 4049, 4107, 4198, 4255; El Barro, UANL-3944, 4056, 4204; Parás, UANL-4001 4062, 4114, 4164, 4211, 4264; Presa Parás, UANL-1417; El Tanque, UANL-3956; Palo Alto, UANL-3890, 4007, 4069, 4119, 4169, 4215, 4271; Cantarranas, UANL-3873; La Soledad, UANL-3863, 3884, 4014, 4077, 4126, 4177, - - 4221, 4279; Las Adjuntas, UANL-3877; El Saladito, UANL-3895.

Tilapia sp. N= 57

Desembocadura, UANL-4183; Ciudad Mier, UANL-4031, 4093, 4149, 4189, 4241; Las Blancas, UANL-4041; Parás, UANL-4063; Palo Alto, UANL-4008; La Soledad, UANL-3867, 4078, 4127, 4176.

Agonostomus monticola N= 2

Presa Parás, UANL-1416.

Update of Upper Rio Grande Fish Fauna, Colorado

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The non-harvested fishes of the Rio Grande Drainage (Rio Bravo del Norte) and the San Luis Closed Basin in Colorado are relatively unknown. In 1782, Reverend Preacher Fray Juan Agustin de Morfi under Governor Don Juan Bautista de Anza's 1779 expedition against the Comanches, described four types of fish from the Rio Grande near its confluence with the Rio Conejos. Jordan in 1889, followed by Ellis from 1912 to 1913, made the earliest fish surveys of the Rio Grande in Colorado. Previous to this study there were no systematic surveys for non-harvested fishes from the San Luis Closed Basin. From 1980-1984, 38 fish taxa including only ten natives were collected from the Rio Grande Drainage and San Luis Closed Basin on the Rio Grande Fishes Survey sponsored by the Colorado Division of Wildlife. Only seven of the 15 fish families are native; with two, Anguillidae and Acipenseridae, extirpated in Colorado.

Of the ten natives, only three are endemics. The endemic fishes apparently have Colorado River affinities. The other seven species have Mississippi-Missouri origins. In contrast to the Upper Basin, endemics and fishes with Gulf of Mexico distributions, many of which are secondarily freshwater species, are much more important in the Lower Rio Grande. The Rio Grande sucker (*Catostomus plebeius*), Rio Grande chub (*Gila pandora*), and Rio Grande cutthroat trout (*Salmo clarki virginalis*) have declined dramatically, with the trout protected as state threatened and the sucker proposed for protection by the Colorado Division of Wildlife. The endemics have been greatly impacted by habitat destruction, competition with non-native fishes, and hybridization. The Rio Grande sucker, only found in two isolated localities, hybridizes with introduced white sucker (*Catostomus commersoni*). In other parts of the San Luis Valley, the white sucker has apparently displaced the native sucker in less than 30 years.

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TEMPORAL CHANGES IN THE *GAMBUSIA HETEROCHIR* X *G. AFFINIS* HYBRID SWARM FOLLOWING DAM RECONSTRUCTION

The long occurring *Gambusia* hybrid swarm in Clear Creek, Menard County, Texas, involving the Endangered endemic *Gambusia heterochir* and *G. affinis* was monitored quarterly through 1983 following the repair and reconstruction of the uppermost dam on Clear Creek in 1979.

While the repaired dam now prevents the immigration by *G. affinis* into the upper spring pool inhabited by *G. heterochir*, the major result was a dramatic decrease in the incidence of hybridization in the upper spring pool and a moderate decrease in *G. affinis* abundance in this upstream environment.

Downstream populations of these two *Gambusia* species appear to be hybridizing with greater frequency than in the uppermost spring pool, although at levels considered less than in previous decades. The introduction of the coastal cyprinodontid, *Lucania parva*, in the portion of Clear Creek below the uppermost dam may be responsible for the observed increase in abundance of *G. heterochir* at downstream spring-fed stations, presumably by interference competition with *G. affinis*.

CAMBIOS TEMPORALES EN LA POBLACION HIBRIDA ENTRE *GAMBUSIA HETEROCHIR* X *G. AFFINIS* DESPUES DE LA RECONSTRUCCION DE UNA PRESA EN CLEAR CREEK, TEXAS

Híbridos entre las especies *Gambusia heterochir* (en vías de extinción) y *G. affinis* han ocurrido por largo tiempo en Clear Creek, un arroyo del condado de Menard, Texas. La población híbrida entre esas dos especies fue muestreada durante las cuatro estaciones de 1980 a 1983, después de la reconstrucción de la presa superior del arroyo, que tuvo lugar en 1979.

Mientras que la presa recientemente reconstruida evita la migración de *G. affinis* hacia las lagunas de la parte superior del arroyo habitadas por *G. heterochir*, el resultado más importante fué la dramática reducción de la hibridación entre ambas especies. Esta reducción en las hibridaciones se debe quizá, a la reducción moderada de *G. affinis* en este medio ambiente.

En la parte baja del arroyo, las dos especies de *Gambusia* parecen hibridizar con más frecuencia que en la parte superior, aunque a niveles más bajos que en décadas anteriores. La introducción del ciprinodontido de la costa, *Lucania parva*, en la parte del arroyo situada bajo la presa superior podría ser responsable del incremento de *G. heterochir* en lugares bajos del arroyo. Esto es debido probablemente a una interferencia competitiva entre *L. parva* y *G. affinis*.

Establishing Flow Requirements for the Fishes Of the Virgin River

by Terry J. Hickman
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In early 1984 a five-year study was initiated on the fishes of the Virgin River in Utah. One goal of this study was to establish flow requirements for the six native fish species found in the Virgin River. Of these six species, one, the woundfin (Plagopterus argentissimus), is listed as an endangered species, and two others, Virgin roundtail chub (Gila robusta seminuda) and Virgin spinedace (Lepidomeda mollispinis), are being considered for listing as endangered species. The Virgin River is a very harsh environment for fish, exhibiting extreme variations in flow, turbidity, salinity and temperature. From the 1850's (first white settlements) to approximately 1910, the Virgin River in Utah underwent a dramatic change as a result of water diversions and overgrazing by cattle and sheep. During the past 75 years there have only been slight modifications to the Virgin River in Utah and the fish present today appear to have adapted to the early environmental changes.

During periods of the year it is not uncommon to find portions of the river virtually dry, with disjunct pools scattered throughout. Often the temperatures in these pools approach 35°C. One 3 x 10 meter seine haul in these pools can produce 1,000-3,000 fish, representing all six native species. This "packing" of fish may last for a few weeks at a time. The fish exist under these conditions until a flushing flow (flooding or irrigation return) comes down the river and "cleans" out these pools. This is analogous, in some respects, to a goldfish bowl which requires periodic changing of the water to allow for survival. Survival of the native fish is tied very closely to these flushing flows, without which, reproduction is inhibited, mortalities occur and non-native species become established. Caution should be used so that one or two flow figures are not established for the fish. (i.e. the present flows established by the U.S. Fish and Wildlife Service are 80 cfs from July - October and 120 cfs for the remainder of the year) Should this be the case, water could be drawn down to these levels and the variability of the system would be lost. Establishing flow criteria for the fishes of the Virgin River should take into consideration measures needed to maintain some semblance of the natural flow regime. This includes gathering information on the timing, frequency and duration of the flushing flows.

It is anticipated that the results of this five-year study will provide adequate information to establish flow requirements for the fishes of the Virgin River.

Establecimiento de Requisitos de Flujo Por los Pescados del Rio Virgen

Al princípio de 1984, un estudio de cinco años de los pescados en el Río Virgen de Utah fué iniciado. Un objeto del estúdio era de establecer los requisitos de flujo por las seis especies de pescados nativos situados en el Rio Virgen. De las seis especies, solamente una, el woundfin (Plagopterus argentissimus),está registrado como un especie "puesto en peligro," y dos mas, el Virgin roundtail chub (Gila robusta seminuda) y Virgin spinedace (Lepidomeda mollispinis), están en consideración por estar "puesto en peligro." El Río Virgen tiene un ambiente áspero por pescado - lo cual exhibe variaciónes extremas en flujo, en contento de sal, en claro de agua, y en temperatura.

Desde los 1850 hasta aproximadamente 1910, el Río Virgen de Utah sufrió cambios dramáticos que resultaron por los diversiónes de agua y demasiado pastar de ganado y oveja. Durante los 75 años pasados, hay habido pequeño modificaciones al Río Virgen en Utah y el pescado que hay ahora aparece de haber adaptarizado a los cambios princípios del ambiente.

Durante períodos del año, no es difícil hallar partes del río casi seco, con charcos separados y dispersado en todas partes. Muchas veces la temperatura en estos charcos acerca 35 centígrado. Una redada de 3 x 10 en estos charcos pueden producir mil a trés mil (1,000 - 3,000) pescados, que representan todo los seis especies nativos. Este "empaqueteando" de pescado puede durar algunos semanas cada vez. Los pescados existen con estas condiciones hasta un flujo chorriando viene en el río y límpie los charcos. Es como una vasija de pescado que necesita un cambio de agua periódicamente para sobrevivir. Supervivencia del pescado natívo es dependiente sobre estos flujos chorriando, y sín lo cual reproducion está inhibido, mortalidades se occuren, y especies que no son nativos se establecen. Es necesário tener cautela que no se establecen por los pescados solamente una o dos figuras por flujo. (Tal como: los flujos de presente, establesado por el U.S. Fish and Wildlife Service, son 80 cfs por julio hasta octubre y 120 cfs por el resto del año.) Si éste fué el caso, agua podría estar sacado hasta estas llanuras y la habilidad por variación en el sistema se pierde. El establecimiento de criterio de flujo por los pescados del Río Virgen debe de considerár medidas necesário por mantener un poco de un regimen flujo natural. Éste incluye obteniendo información de tiempo, frecuencia y duración de los flujos chorriando.

Esperamos que los resultados de éste estudio de cinco anos nos proveemos con suficiente información por establecer los requisitos de flujo por los pescados del Río Virgen.

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DESCRIPTIONS OF SUBSPECIES OF CUTTHROAT TROUT FROM THE ALVORD AND WHITEHORSE BASINS, OREGON-NEVADA

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ABSTRACT

Cutthroat trout were first collected from the Alvord and Whitehorse basins by Carl Hubbs and family in 1934. These collections represent two distinct subspecies, indicating long isolation between the two contiguous basins. The cutthroat trout is the only species of fish native to the Whitehorse basin. The only non-trout species native to the Alvord basin is an endemic chub, *Gila alvordensis*. Obviously, these basins have experienced a long and virtually complete isolation from contiguous drainages. The Alvord trout is extinct but the Whitehorse trout persists in Willow and Whitehorse creeks, its original habitation, and has been introduced into other small streams in both the Whitehorse and Alvord basins. Formal descriptions of these two subspecies have been prepared for submission to Copeia for publication.

FISHES IN ARID LANDS - SUMMARY

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The fishes of the Sonoran Desert region comprise a diverse and highly adapted fauna. Because deserts are characterized by a lack of precipitation and water in general, it appears paradoxical to suggest fishes as a resource in these xeric areas. Except to the ichthyologist or fishery biologist, and then mostly on a local level, this resource is little-known and is unillustrated. To attempt to improve these shortcomings, the fishes of the Sonoran Desert regions (United States and Mexico) have been extensively photographed over the past six years within the region depicted by the map. Two trips into Sonora and Chihuahua were made in 1981 and 1982 to collect and photograph fishes. Permits were graciously granted by the Departamento de Pesca in Mexico City.

A manuscript is now under review that will accompany the photos. The text discusses deserts and their aquatic systems within geologic and recent time. The majority of the publication will discuss the fish species occupying respective habitats. In addition, the status of this remarkable fauna and reasons for its drastic decline in many areas are discussed. The planned publication will consist of more than 100 figures, half of which are color plates of fish species and habitats. Selected references are included, as are descriptive figure captions that supplement the text. Several outlets for publication have been identified, and a portion of the copies are planned for translation into Spanish. A 1986 publication date is likely.

LOS PECES IN LAS TIERRAS ARIDAS - RESUMEN

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Los peces de la region desiertica Sonorense se constan de una fauna diversa y muy adaptada. Ya que se caracterizan a los desiertos por la falta de precipitación y agua en general, parece ser paradójico sugerir que los peces son un recurso en estos areas xericos. Con excepción de los ictiólogos y los biólogos pesqueros, y ésto de nivel local, se sabe muy poco de estos recursos. Tambien se hace falta la ilustración del recurso.

Para mejorar estos defectos, los peces de la region del desierto Sonorense (de ambos México y los Estados Unidos) han sido ampliemente fotografiado a travez de los últimos seis años. La region del estudio se esté descrito en el mapa. Se hicieron dos viajos a Sonora y Chihuahua en 1.981 y 1.982 para colectar y fotografiar peces. El Departamento de Pesca de México fue muy amable en otorgar los permisos de colecta.

Un manuscrito que acompañará las fotografias ya está bajo de revisión. Ex texto se trata del desierto y las sistemas acuaticas en el aspecto de tiempo geológico y actual. La mayoría de la publicacion se tratará las especies de pez que ocupan los hábitats respectivas. Además, se discutirá la condición de esta fauna notable y los motivos trás su disminución en muchas áreas. La publicación se constará de mas de cien ílustraciones, la mitad de las cuales son placas de color de especies de pez y los hábitats. Se incluyen referencias además de leyendas descriptivas que completan el texto. Se han identificado varios posibilidades para publicarlo. Una porción de los ejemplares saldrán en español. Es posible que salga el libro en 1.986.

Food Partitioning Among Fishes of the Virgin River

James E. Deacon and Paul Greger

Food partitioning of one introduced and six native species of fish was investigated from two different sites in the Virgin River. Replicate benthic and drift samples from riffle areas indicated that chironomid and simuliid larvae comprised the major food base available to fish. Selectivity values suggest that chironomid larvae were selected over simuliid larvae.

Stomach analysis revealed seasonal inter and intra-specific differences in diets. Desert and flannelmouth suckers fed on a mixture of sediment, detritus, filamentous algae and invertebrates. Intra-specific differences in their diets suggest spatial separation of young and old suckers in the habitat. Roundtail chubs consumed largely Spirogyra spp. and diatoms. Speckled dace, were strictly insectivorous, consuming large numbers of small dipterans. Spinedace and red shiners also consumed mostly insects. Woundfin were omnivorous, consuming an array of benthic and drift animals and plant matter.

Food overlap among native fishes was often high and varied with season. Food overlap among woundfin and red shiner was much higher in disturbed parts of the river than in more undisturbed segments. Food partitioning among fishes is in part a reflection of habitat partitioning.

Distribución de alimentación entre los peces del Río Virgen en Nevada

James E. Deacon y Paul Greger

Se efectuó una investigación, en dos lugares del Río Virgen, de la distribución de alimentación de seis especies de peces nativos y una especie introducida. Muestras del bentos y de la superficie indican que la alimentación más común consistía en larvas de quironomid y simuliid, aquéllas las predominantes.

Análisis del contenido estomacal de varias especies revelan diferencias de dieta, entre las diferentes especies y dentro de una misma, que varían según la estación del año. *Desert suckers* y *flannelmouth suckers* (catostomos) comían una mezcla de sedimentos, detritos, invertebrados y algas filamentosas. Dentro de su propia especie, las diferencias de dieta sugieren separacíon espacial entre *suckers* jóvenes y maduros. Los *roundtail chubs* (cachos) comían en gran parte Spirogyra spp. y diatomeas. *Speckled Dace* (dardos), exclusivamente insectívoros, consumían grandes cantidades de dipteros. *Spinedace* y *red shiners* son también mayormente insectívoros. Los *woundfin* son omnívoros; consumían una variedad de animales del bentos y de la superficie, además de mateia vegetal.

Coincidencias de dieta, a veces numerosas y variables según la estacíon del año, se observaban entre las especies nativas. Dichas coincidencias entre los *woundfin* y *red shiner* se observaban más en lugares de corriente rápida que en aguas tranquilas. La distribucíon de alimentación entre los peces estudiados refleja, en parte, los variantes de habitación.

An experimental analysis of variation in the breeding system of pupfish (Cyprinodon)

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Abstract -- The breeding system of pupfish (Cyprinodon) is characterized by extreme variability in male breeding behavior. Experimental manipulations of three environmental parameters, size of habitat, population density, and availability of oviposition substrate, resulted in major changes in the breeding system. Experiments took place in outdoor cattle tanks. Manipulation of all three environmental variables resulted in both quantitative and qualitative changes in courtship, aggression and spawning behavior of males. An analysis of variance indicated significant direct effects as well as interaction effects among all three variables on the behavior of males, size of defended areas, and reproductive success. Large tanks with populations at both high and low densities and limited oviposition substrate supported a territorial breeding system. Reduction of the physical dimensions of the habitat and a decrease in population size resulted in a change from territoriality to a dominance hierarchy, with corresponding changes in behavior of breeding males. Variance in male reproductive success, duration of courtship and aggression increased. Alternate male breeding strategies, such as satellites and sneak spawning were observed in treatments with high population densities, and limited oviposition substrates.

Abstracto -- El sistema de reproduccion de Cyprinodon pecosensis se caracteriza por una extremada variabilidad de la conducta reproductiva de los machos. Manipulaciones experimentales de tres variables ambientales, tamano del habitat, densidad de poblacion y disponibilidad del sustrato para la oviposicion, resultaron en cambios profundos en el sistema de reproduccion. Los experimentos se llevaron a cabo en estanques a la intemperie, permitiendo mantener a los poblaciones en estado seminatural. Las manipulaciones de las tres variables provocaron cambios tanto cuantitativos como cualitativos en la conducta de fertilizacion, cortejo y agresividad de los machos. Un analisis de varianza de los resultados mostro que hubo efectos directos muy significativos asi como interacciones de los efectos de las tres variables en la conducta de los machos, tamano de las areas defendidas y variabilidad en el exito reproductivo. Estanques con poblaciones a altas y bajas densidades y sustratos para la oviposicion limitados, desarrollaron sistemas de reproduccion territoriales. Reducciones de las dimensiones fisicas del habitat (estanques pequenos) y decrementos en el tamano de las poblaciones resultaron en cabios de sistemas territoriales y jerarquias de dominancia, alterandose la conducta reproductiva de los machos. La variacion en le exito reproductivo, la duracion del cortejo y la agresividad de los machos se incremento. Estrategias reproductivas alternativas tales como individuos satelites e intruciones para la fertilizacion de los huevos fueron observadas en los tratamientos con densidades de poblaciones altas y sustratos de oviposicion limitados.

Proc. Desert Fishes Council
San Luis Potosí, México.

NEW RECORDS AND NOTES OF EXOTIC FISHES IN NORTHEASTERN MEXICO:

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Recently an annotated list of introduced exotic fishes in freshwater of México appeared (Contreras and Escalante, 1984:102-130), expanding the previously published list numbering 15 (Welcomme, 1981) to 54 (data to the end of 1982). Since that paper was published, some new records of introduced -- fishes are additions to the list or new localities for known or suspected exotics, in Chihuahua, Coahuila, Nuevo León, Tamaulipas, and San Luis Potosí.

CHIHUAHUA.
Río Bravo.- A survey of the Río Bravo, searching for Notropis orca, revealed the presence of the clupeid Dorosoma petenense at Ciudad Juárez, Isleta San Isidro and Millon. Formerly native in the area (Miller, 1982), it is - now exotic and common. Also present were the exotic catfish Ictalurus natalis at Ciudad Juárez and Isleta, Roccus sp. and the Eastern cyprinid form Pimephales vigilax perspicuus at Ciudad Juárez, Ysleta, and El Porvenir; Hubbs et al. (1977) reported the species, without mention of subspecies. Most authors do not recognize these subdivisions, but the specimens are sufficiently distinct from the native P. v. vigilax of the lower Río Bravo, so recognition of both forms might be useful. One new exotic.

Río Florido, Río Bravo Basin.- The interesting endemic poeciliid Gambusia hurtadoi of the Ojo Hacienda Dolores, Hubbs y Springer (1957) has escaped the spring via irrigation ditches, and now occurs in the Río Florido around Jiménez. One specimen was collected in 1968, 2 in 1984. Of concern is the possibility that the riverine fauna may also be reaching the spring rising the risk of damage to the endemic fishes. New exotic.

COAHUILA.
El Cariño de la Montaña.- Up to now, the poeciliid Xiphophorus gordoni was known only from the spring system of Tia Tecla, Valley of Cuatro Ciénegas Miller and Monckley (1963). It is considered an endangered endemic. X. gordoni has been collected twice at El Cariño, in 26-V-84 and 13-VI-84. Its presence seems due to the channelization of the springs, and it has been possibly established in the river. New exotic.

Cañón de Arteaga.- The characid Astyanax mexicanus, UANL 5699, and the poeciliid Xiphophorus helleri UANL 5700, were not reported by Rodríguez Gámez (1978) in his paper on the fishes of the valley of Saltillo, although the swordtail has been known there since 1977. These species may represent and added pressure on the endemic cyprinid Gila modesta and in all probability are introduced., the first of unknown procedence and purpose, the - second from aquarium fanciers. New exotic and new locality, respectivelly.

Río Salado at Don Martin Reservoir.- Numerous uncatalogued collections at Don Martin reservoir contain high number of the atherinid Menidia beryllina:

they may represent an introduction or a recent invader from the lower and saltier waters of the river. It was not reported from Río Salado by Val - Guerra (1952). New record.

NUEVO LEON.

Rodrigo Gámez Reservoir.- The fish community of this reservoir, also called La Boca, has been changing during the last 40 years as a result of impounding, fish planting, exotic weeds, and mismanagement. Out of 13 native species (Contreras, 1975), only 5 remain. The exotics, such as atherinids *Chirostoma* spp. were introduced for fish production, the poeciliid *Gambusia affinis* was probably accidentally released. The first from an unknown source but reported as Pátzcuaro, the second possibly in a black bass, *Micropterus salmoides*, shipment from Tampico. The presence of the Asiatic Cyprinid *Ctenopharyngodon idella* was recently reported (Contreras and Escalante, 1984); more recently the following species are recorded: The clupeid *Dorosoma petenense*, UANL 5691, *Poecilia reticulata*, *Xiphophorus helleri*, all tropical and the mainly marine atherinid *Membras martinica*, UANL 5694, plus an unidentified species of Tilapia or similar. It is surprising that *Membras* apparently is reproducing in the reservoir (the smallest specimen collected is 29.1 mm.). Its nearest natural occurrence is in the lower Río San Juan, nearly 120 km. NE-ward, where it seems to be a recent invader. *Membras* and *Dorosoma* are new exotics, the others represent new localities only.

Manantial Casa Blanca or La Soledad.- This is an isolated spring 100 km. NW of Monterrey, 0.5 km. SW of highway to Monclova. In 5-V-83 a collection produced the Poeciliids *Xiphophorus variatus* and *Poecilia reticulata* both exotic plus the Characid *Astyanax mexicanus*, and the Cyprinid *Dionda episcopa*, common nearby. Klaus Kallman addressed me to this new locality. The nearest river flowing is more than 20 km. E-ward.

TAMAULIPAS.

Río Purificación at La Cruz.- In spite of relative intense collecting in NE México, *Campostoma anomalum* has been known only as far south as the Río San Juan, Río Bravo. Hence its presence at La Cruz, on Río Purificación (SCB 84-10 20-VII-84) was a surprise. It was not reported by Meek (1904). A cursory examination does not allow to detect differences to the nearby San Juan populations. It may represent an accidental introduction of unknown date and purpose. New locality.

SAN LUIS POTOSI.

Mesquitic Reservoir.- Located along an interior basin, Mesquitic reservoir is 20 km. NW San Luis Potosí, on Hwy 49. No native fishes are known here. Collecting yielded only *Lepomis macrochirus* and *Micropterus salmoides*. New localities.

Ojo de Agua de Venado.- The spring contains the endangered goodeid *Xenoophorus exsul*; downstream is a dam, and *Micropterus salmoides* occurs below it, potentially endangering more the endemic. New locality.

La Media Luna.- This is a place of high endemism (Miller, 1943). I reported the presence of the endangered Tamesí endemic poeciliid *Poecilia latipunctata* as part of DFC Annual Meeting Area Coordinator Report (Contreras, 1983). Since the presence of *P. latipunctata*, the population of -

the endangered native goodeid Ataeniobius toweri has declined.

This report sustains the viewpoint that species kept within their original distributional area or when expanding by themselves out of it may be defined as native, and when outside its evolutionary range as a consequence of mankind action be termed exotic, be it purposefull or accidental introduction, or spontaneous expansion after it, or through channels, dams, and other human works. Also, stresses that natives including the so called endangered species may become pests when moved to other areas, and even endanger other fish species. Hence, some of the examples given here represent a live lesson of the natural meaning of native and exotic, as well of what is known as equilibrium of nature.

LITERATURE CITED

Contreras-Balderas, S. 1975. Impacto Ambiental de Obras Hidráulicas, Plan Nacional Hidráulico, Sría. de Recursos Hidráulicos. Informes Técnicos.

Contreras-Balderas, S., y M.A. Escalante. 1984. Distribution and Known Impacts of Exotic Fishes in México. In: W.R. Courtenay and J.M. Stauffer: Distribution, Biology, and Management of Exotic Fishes. Johns Hopkins Univ. Press.

Hubbs, C., y V.G. Springer. 1957. A revision of the Gambusia nobilis Species Group, with Descriptions of Three New Species, and Notes on Their Variation, Ecology and Evolution. Texas Journal Science, 9(3):279-327.

Hubbs, C., et al., 1977. Fishes Inhabiting the Río Grande, Texas and México, Between El Paso and the Pecos Confluence. Importance, Preservation -- and Management of Riparian Habitat A Symposium, U.S.D.A.

Meek, S.E., 1904. The Freshwater Fishes of México North of the Isthmus of Tehuantepec. Field. Col. Mus. Publ., 93, Zool. Ser., 5:1-252.

Miller, R.R., 1956. A New Genus and Species of Cyprinodontid Fish from San - Luis Potosí, México, with Remarks on the Subfamily Cyprinodontidae. Occ. Pap. Mus. Zool., Univ. Mich., 581:1-17.

Miller, R.R., 1982. First Fossil Record (Plio-Pleistocene) of Threadfin Shad, Dorosoma petenense, from the Gatuña Formation of Southeastern New - México. J. Paleontology, 56(2):423-425.

Miller, R.R., and W.L. Minckley, 1963. Xiphophorus gordoni, A New Species of Platyfish from Coahuila, México. Copeia, 1963(3):538-546.

Rodríguez-Gámez, Andrés. 1978. Los Peces del Valle de Saltillo. Segundo Congreso Nacional de Zoología, Monterrey (Resumen).

Val Guerra, L. 1952. Ichthyological Survey of the Río Salado, México. University of Texas Theses (M.Sc.). pp. 1-32.

Welcomme, R.L. 1981. Register of International Transfers of Inland Fish Species.
FAO Fisheries Technical Paper 213:1-120.

The Edwards Aquifer and Its Fauna.

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The Edwards Aquifer is located in south-central Texas. The aquifer contains a large, diverse and endemic fauna of 32 troglobites including four vertebrates. Much of the fauna was discovered by placing nets into outflows of artesian wells and spring orifices. The use of this technique has revealed the presence of a large fauna of snails of the family Hydrobiidae (Gastropoda: Prosobranchia) in the Edwards Aquifer. Based on material studied from 23 localities, three genera (all new) and nine species (seven new) are recognized. The snails are minute (maximum dimension less than 2.5 mm), unpigmented, and without eyespots. The Edwards Aquifer fauna is poorly known: widespread use of the above sampling technique may yield additional new species. The fauna will probably be negatively impacted by increasing mining and pollution of groundwater.

El Edwards Aquifer y Su Fauna

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El Edwards Aquifer está situado en la parte central del sur de Tejas. Este contiene una grande, diversa y endémica fauna de 32 troglobites incluyendo 4 vertebrados. El procedimiento empleado para descubrimiento de muchas de estas especies fue la toma de ejemplos colocando redes en los desagues de posos artesianos y los orificios de manantiales. El uso de ésta técnica ha revelado la presencia de una grande fauna de caracoles de la familia Hydrobiidae (Gastropoda: Prosobranchia) en el Edwards Aquifer. Basado en el material estudiado en 23 localidades, 3 genera (todas nuevas) y 9 especies (7 nuevas) son conocidas. Los caracoles son diminutos (dimension maxima 2.5 mm), sin pigmentación y sin ojos. La fauna del Edwards Aquifer es poco conocida: diversas aplicaciónes de la técnica de ejemplos mencionada producirá muchas especies nuevas. La fauna probablemente será amenazada por el incremento del saque de agua y la contaminación.

A Preliminary Report on Parental Care in Cuatro Ciénegas Cichlids

Marcie Friedman

Understanding the reproductive strategy of an organism is the key to understanding its behavior and ecology. Such knowledge is critical for protecting endangered species, for managing aquatic resources, and for answering basic questions in biological research. The cichlids of the Cuatro Ciénegas Basin in Coahuila, Mexico present an interesting problem for study. My research focuses upon the system of parental care used by Heroes minckleyi. Little is known about their life history and behavior. This summer I worked in the Cuatro Ciénegas Basin to analyze parent-offspring interactions and to evaluate the suitability of the area for a long term behavioral study. Observations were made with basic snorkeling equipment using an underwater slate. Preliminary findings suggest that H. minckleyi show female care for free swimming fry, an unusual behavior for New World cichlids.

There are three important aspects in the formation of a system of parental care. First is the mating system. In monogamous species, both parents are potentially available for care of the young. In a polygynous species, on the other hand, the males may not be able to devote the same amount of care to each brood. A second important factor involves the impact of the environment upon the system of parental care. Within the Cuatro Ciénegas Basin, there are a number of different types of lagoons. These lagoons vary in physical and biological factors such as water temperature, food availability, and predation pressure. In a lagoon with high predation pressure, for example, guarding by both parents may be necessary for the young to survive. Finally, evolutionary factors may play a role. The cichlids of Cuatro Ciénegas have different shapes and different types of dentition, yet they appear to be a single species. It will be interesting to determine if there are behavioral differences among the morphs with respect to parental care. To summarize, three important components which shape the system of parental care include the mating behavior, the ecological variables, and the evolutionary history of the organsim.

The region of Cuatro Ciénegas is a suitable site for behavioral research. The excellent water clarity provides a good environment for making detailed behavioral observations and for using underwater photography. The variety of lagoons makes it possible to perform comparative studies. The Cuatro Ciénegas Basin promises to be a productive area for research into the factors which form and influence parental care behavior.

Las Mojarras de Cuatro Ciénegas

Marcie Friedman

Las mojarras de el Bolsón del Valle de Cuatro Ciénegas son únicas. Tengo mucho interés en el comportamiento de las mojarras sobre cuando ellas cuidan de las crías. Estuve el verano pasado trabajando durante dos semanas con el fin de examinar el sistema de cuidado, y dedujé que éste proyecto de trabajo se realizará en un largo plazo. Las observaciones fueron hechas con el equipo de buseo. Utilizé una tabla y un lápiz graso, para hacer estas observaciones bajo el agua.

Hay tres aspectos importantes que forman un sistema de comportamiento de padres: primero, el sistema de reproducción. En especies monógamas ambos padres pueden ayudar a cuidar las crías. Pero en especies poligamas, algunos de los machos no pueden dar el mismo cuidado a todas las crías. Segundo, hay variación ecológica, como por ejemplo factores fisico-quimicos, temperatura, y alimentación. También hay factores biológicos tales como la presión de los predatores. Esta presión puede dar forma a el sistema de protección de ambos padres. Por ejemplo, en areas con pocos predatores solamente se necesita el cuidado de un padre. Tercero, de la historia evolutiva de Cuatro Ciénegas es importante. Nadie está seguro de cuantas especies hay de mojarras, porque las hay de muchas formas, tamaños, inclusive hay diferencias en dientes y posiblemente se trate de una misma especie. El comportamiento reproductivo sirve como un mecanismo de aislamiento entre especies o bien es fácil de distinguirse entre ellos. Sería interesante investigar las diferencias entre las areas de reproducción que existe entre las formas de estas mojarras.

Finalmente quiero mencionar que hay tres fuerzas selectivas que forman el sistema de cuidado que son:

(1) El sistema de reproduccíon
(2) Las variables ecológicas
(3) La historia evolutiva.

La región de Cuatro Ciénegas es un buen lugar para estudiar las actividades de cuidado. El agua es muy clara y es fácil hacer observaciones con detalles, se puede sacar fotos y peliculas bajo el agua. También es posible acercarse a las especies sin molestarlas. Voy a hacer más trabajo en Cuatro Ciénegas en el futuro.

Muchas gracias a las estudiantes de la Universidad de Nuevo Leon para su ayuda con este resumen.

BIOGEOGRAPHY OF REPTILES OCCUPYING HABITAT ISLANDS IN WESTERN ARIZONA: A DETERMINISTIC ASSEMBLAGE

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SUMMARY. Island size, habitat heterogeneity, and distance from major ("mainland") stands of habitat were examined relative to composition and number of coexisting reptile species dependent on upland habitats of 11 mountain and 4 riparian habitat islands. Species richness increased in a perfect step function with area on mountain islands, but area was unimportant in predicting species richness on riparian islands. Instead, isolation was of primary importance. Regardless of factors determining species richness, composition of species changed with species richness in a deterministic fashion; small assemblages were always totally-included subsets of larger assemblages. Furthermore, any species added in assemblages larger than 2 species were present in all assemblages of equal and larger size. This study is a clear case of determinism in island species distributions.

Observaciones Preliminares sobre Domesticación y Reproducción de Cyprinodon alvarezi y Megupsilon aporus.

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R E S U M E N

Estas dos especies han sido encontradas en un manantial en estado de desecación avanzado, localizado en el Ejido El Potosi, municipio de Galeana en el sur del estado de Nuevo León, México.

Esta región cuenta con un sistema de irrigación a base de bombeo de pozos profundos cerca de manantiales donde habitan estos peces, por lo que el futuro de estos manantiales y sus especies endémicas es incierto.

Mantenerlos en el laboratorio ha resultado un tanto problemático debido a que en su estado natural actual se encuentran altamente parasitados -- por Ichthyophthirius multifiliis, además de bacteriosis aguda y anemia avanzada.

Actualmente, tanto en Cyprinodon alvarezi como en Megupsilon aporus ha sido posible inducir su reproducción mediante manejos de alimentación y temperatura, obteniendose de esta manera datos importantes sobre los períodos de incubación y desarrollo temprano.

Se han obtenido alevines de Cyprinodon alvarezi, los cuales fué posible llevar hasta el estadio reproductor y obtenerse una segunda generación de laboratorio mucho mas numerosa, lograndose así determinar las técnicas apropiadas para su reproducción en cautiverio, esto da las bases suficientes para garantizar el manejo y supervivencia de esta especie en condiciones controladas, quedando pendiente un estudio especial para lograr resultados similares en Megupsilon aporus, y de este modo contribuir a evitar la extinción de estas dos especies endémicas de Nuevo León.

A B S T R A C T

Both species have been colected in a drying spring in Ejido El Potosi, Municipio de Galeana, Nuevo Leon, Mexico.

This southern region of Nuevo Leon now counts with an advanced irrigation complex with o deep well pomping system which sets these springs and its endemisms in a very uncertain future.

Keeping these species in the laboratory condition was troublesome at the begining since the fish were highly parasitized by Ichthyophthirius multifiliis and bacterias, besides an advanced state of anemia.

We have managed C. alvarezi and M. aporus to reproduce by food and temperature management, obtaining information about incubation requirements and early development.

C. alvarezi has been managed to produce a second generation at laboratory conditions, developing appropiate techniques for its culture providing enough basis to insure its survival under controled conditions, M. aporus remaines to be better understood in order to develop appropiate culturing techniques and on this way help these species which are endemic and only representatives of the native fish fauna of Nuevo Leon, in the area from become extinct.

Desert Fishes Council, 16a. Reunión Anual (1984), San Luis Potosí, S.L.P.

FISH SLOUGH AREA OF CRITICAL ENVIRONMENTAL CONCERN

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Fish Slough (Inyo and Mono counties, California) was identified as an Area of Critical Environmental Concern in 1982 by the BLM Benton/Owens Valley Management Framework Plan, Step 3 Decision. A unique desert wetland, Fish Slough provides critical habitat for the federally listed endangered Owens pupfish (*Cyprinodon radiosus*). It also provides protected habitat for three other species of fishes unique to the Owens Valley: Owens tui chub (*Gila bicolor snyderi*), Owens sucker (*Catostomus fumeiventris*), and the Owens form of speckled dace (*Rhinichthys osculus* ssp.). Unique plant species include the Fish Slough milkvetch (*Astragalus lentiginosus piscinensis*), *Astragalus argophyllus*, *Calochortus excavatus*, *Centaurium namophilum*, *Dodecatheon pulchellum*, *Fimbristylis thermalis*, and *Spartina gracilis*. An undescribed species of mollusc, the Fish Slough snail (*Fontelicella* sp.) is known to occur there. The abundance of wetland/riparian vegetation immediately adjacent fo rocky cliffs and the desert shadscale scrub community demonstrates the uniqueness of the area. Vehicle use, livestock grazing and exotic species management will be implemented to continue the basic ecological integrity of the area. Paleontological and archeological research will be encouraged within the area. Protective management of the Fish Slough watershed and aquifer are of fundamental importance to insure stability of natural resources dependent on continued water flow.

FISH SLOUGH: AREA DE PREOCUPACION CRITICO AMBIENTAL

por

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Una cenegal desiertico único, Fish Slough provee habitat crítico para arriesgado Owens pupfish (Cyprinodon radiosus) que se encuentra sobre la lista federal de especies arriesgados. Tambien provee hábitat protegido para tres otras especies de peces únicos al valle de Owens: Owens tui chub (Gila bicolor snyderi), Owens sucker (Catostomus fumeiventris), y Owens dace (Rhinichthys osculus ssp.); tambien Fish Slough milkvetch (Astragalus lentiginosus piscinensis), Astragalus argophyllus, Calochortus excavatus, Centaurium namophilum, Dodecatheon pulchellum, Fimbrystilis thermalis, and Spartina gracilis. Se sabe que una especies indescripto de moluscos, el Fish Slough snail (Fontelicella sp.) se encuentra alli.

La abundancia de la vegetación del cenegal y del ribereño que esta inmediatamente adjacente a los acantilados rocosos y la comunidad de desert shadscale (Atriplex) demuestran la unicidad del area.

Sé implementarán un programa de supervision en cuanto al uso vehicular, el apacento de ganado y la introducción de especies exóticas para continuar la integridad ecologica básico del area. Cuatro sitios arqueológicas de los indios norteamericanos se hallan dentro del area. Por lo tanto, se alentará investigaciones paleontológicas y arqueológicas en el area. El manejo protectiva de la cuenca colectora y la capa aquífera es de importancia fundamental para asegurar la estabilidad de los recursos naturales que dependen sobre el flujo continuo de agua.

Se ha delineado tres zonas de manejo dentro del area de preocupación crítico. Estos se basan sobre las características comunes de los recursos, la demanda para los recursos y las necesidades especiales de manejo.

Proc. Desert Fishes Council.
San Luis Potosí, México.

LISTA ANOTADA DE ESPECIES DE PECES MEXICANOS EN PELIGRO O AMENAZADOS DE EXTINCION.

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México es el único país de Norte América que no ha desarrollado una lista oficial de especies de peces (ú otros organismos) en peligro de extinción, a pesar de haberse publicado varios trabajos donde se demuestra que la ictiofauna está en malas condiciones. Por ésta razón se ha considerado conveniente recopilar la presente lista provisional, equivalente en su intención a las que se conocen para Estados Unidos, Canadá, o la Unión Internacional para la Conservación de la Naturaleza y sus Recursos.

Existen grandes dificultades para desarrollar una lista Oficial Mexicana que equivalga a las mencionadas arriba, por la insuficiencia de conocimientos faunísticos, ecológicos y de monitoreo adecuados, que arrojen luz sobre el tema, y por la falta de legislación específica. Hasta la fecha se conoce una relación de especies y áreas críticas en zonas áridas (Contreras, 1969), análisis cualitativos de la degeneración de la ictiofauna en zonas áridas (Contreras, 1974) y semiáridas (Contreras, 1975), y numerosas tablas de retrogresión cuantitativa de comunidades con intento de explicaciones causales de la pérdida de recursos (Contreras 1975; Contreras, Landa, Villegas y Rodríguez, 1976; Medina y Sanchez, 1977). La primera lista provisional fué muy extensa y está incluída en un informe de ecología e impacto ambiental de obras hidráulicas (Contreras, 1975), pero fuédepurada para un informe de la American Fisheries Society (Deacon, Kobetich, Williams y Contreras 1979), luego una lista presentada al VI Congreso Nacional de Zoología y ahora a la presente lista, la cual contiene:
a) Numerosas especies endémicas, con requerimientos ecológicos estrechos, y
b) algunas especies de amplia distribución o tolerancia. La declinación de las primeras es extendible como resultado de un cambio rápido aún ante alteraciones ambientales pequeñas, pero las segundas deben estar respondiendo a cambios masivos o a factores todavía no examinados.

Esta cuarta lista provisional cubre todo México, con ciento catorce (114) especies y subespecies; indica que se requiere con urgencia de datos detallados y abundantes de campo, investigados con planteamientos específicos derivados de la experiencia actual, que cuando se realicen podrán originar una lista firme, así como un mejor entendimiento de la realidad ambiental nacional.

LISTA DE ESPECIES

Familia SALMONIDAE

I	Salmo nelsoni (Evermann)	Sierra San Pedro Mártir, BCN.
V	Salmo chrysogaster Needham y Gard	Sierra Tarahumara, Dgo.

Familia CHARACIDAE

I	Astyanax mexicanus ssp.	Cuatro Ciénegas, Coah.
V	Astyanax sp. A. (Contreras y Aguilar)	Río Tamazulapan, Oax.
V	Astyanax sp. B. (Lozano y Contreras)	Pénjamo, Chis.

Familia CYPRINIDAE

E	Campostoma ornatum	Río Conchos, Río Yaqui.
V	Gila ditaenia Miller	Río Magdalena, Son.
E	Gila elegans Baird and Girard	Río Gila, Son.
V	Gila modesta (Garman)	Saltillo Valley, Coah.
I	Gila ca. modesta	Iturbide, N. L.
V	Gila nigrescens (Girard)	Río Casas Grandes, Río Santa María, Río Patos, Chih.
V	Gila purpurea (Girard)	Río Sonora, Río Yaqui, Son., Chih.
I	Gila ca. robusta	El Salto, Dgo.
E	Gila sp. A.	Parras, Coah.
E	Gila sp. B.	Parras, Coah.
V	Agosia chrysogaster Girard	N Son.
V	Rhinichthys osculus (Girard)	Río Gila, Son.
E	Tiaroga cobitis Girard	Río Gila, Son.
U	Notropis lutrensis formosus (Girard)	Río Casas Grandes, Río Patos, Chih.
U	Notropis l. santamariae Evermann y Goldsborough.	Río Santa María, Chih.
E	Notropis panarcys Hubbs y Miller	Río San Pedro, Chih.
E	Notropis sp. A.	Río Conchos, Chih.
	Notropis sp. B	Río Nazas y Aguanaval.
E	Notropis orca (Cope)	Río Bravo.
E	Notropis xanthicara Minckley y Little	Cuatro Ciénegas, Coah.
I	Notropis aguirrepequeñoi Contreras y Rivera.	Río Soto La Marina, Tamps.
E	Notropis bocagrande Hubbs y Miller	Ojo Solo, Chih.
V	Notropis imeldae Alvarez y Cortez.	Río Verde, Oax.
V	Notropis moralesi De Buen	Río Tepelmeme, Oax.

E	*Evarra tlahuacensis* Meek.	Tláhuac, Valle de México.
E	*Evarra eigenmanni* Woolman	Valle de México.
E	*Evarra bustamantei* Navarro	Valle de México.
E	*Dionda diaboli* Hubbs y Brown	NE Coah.
E	*Dionda episcopa* ssp.	Cuatro Ciénegas, Coah.
V	*Dionda episcopa* ssp.	Río Nazas, Dgo.
E	*Dionda episcopa punctifer* (Garman)	Saltillo valley, Parras, Coah.
E	*Dionda episcopa* ssp.	Río Mezquital, Dgo.
E	*Dionda mandibularis* Contreras y Verduzco.	Río Verde, S.L.P.(Media Luna, Cerritos)
V	*Dionda dichroma* Hubbs y Miller	Media Luna, Río Verde, S.L.P.

Familia CATOSTOMIDAE

E	*Catostomus insignis* (Baird y Girard)	Río Gila, Son.
E	*Catostomus wigginsi* Herre y Brock	Río San Miguel, Río Sonora, Son.
V	*Catostomus conchos* Meek	Río Conchos, Río Yaqui Alto
I	*Catostomus bernardini* Girard	Son.
I	*Catostomus* sp. (Miller)	Rio Tunal, Dgo.
V	*Catostomus* sp. (Miller)	Río Yaqui, Chih. Alto.
I	*Cycleptus elongatus* (Le Sueur)	Río Bravo.
V	*Xyrauchen texanus*	Río Colorado.

Familia ICTALURIDAE

E	*Prietella phreatophila* Carranza	Subsuelo, cerca de Múzquiz, Coah.
I	*Ictalurus australis* (Meek)	Río Pánuco Alto.
I	*Ictalurus mexicanus* (Meek)	Río Pánuco Alto.
I	*Ictalurus pricei* (Rutter)	Río Yaqui.

Familia PIMELODIDAE

I	*Rhamdia guatemalensis depressa* Barbour y Cole.	Cenotes, Yuc.
V	*Rh. g. decolor* Hubbs	Motul, Yuc.
V	*Rh. g. stygaea* Hubbs	San Isidro, Yuc.
V	*Rh. g. sacrificii* Barbour y Cole	Chihén Itzá, Yuc.
V	*Rh. reddelli* Miller	Cueva del Nacimiento, Río San Antonio Oax.

Familia BROTULIDAE.

E	*Typhliasina pearsei* (Hubbs)	Balaam Canché y Pochote, Yuc.

Familia CYPRINODONTIDAE

E	*Cyprinodon alvarezi* Miller	Potosí, N. L.
V	*Cyprinodon macrolepis* Miller	Ojo Hacienda Dolores, Chih.
E	*Cyprinodon verecundus* Humphries	Chichankanab, Q.R.
V	*Cyprinodon beltrani* Alvarez	Chichankanab, Q.R.
V	*Cyprinodon maya* Humphries y Miller	Chichankanab, Q.R.
V	*Cyprinodon labiosus* Humphries y Miller	Chichankanab, Q.R.
V	*Cyprinodon simus* Humphries y Miller	Chichankanab, Q.R.
E	*Cyprinodon m. macularius* Baird y Girard	NW Son., NE. B.C.N.
E*	*Cyprinodon* sp. (ca. *C. alvarezi*) Contreras y Lozano.	Valle de Sandia, N. L.
I	*Cyprinodon variegatus* ssp. (Contreras)	Islas Mujeres, Yuc.
V	*Cyprinodon* sp. ca. *C. variegatus*)	Cerca de Linares, N. L.
V	*Cyprinodon bifasciatus* Miller	Cuatro Ciénegas, Coah.
V	*Cyprinodon atrorus* Miller	Cuatro Ciénegas, Coah.
E	*Cyprinodon meeki* Miller	Río Mezquital, Dgo. Alto.
E	*Cyprinodon pachycephalus* Minckley y Minckley.	Ojo de San Diego, Chih.
E	*Cualac tessellatus* Miller	La Media Luna, S.L.P.
E	*Lucania interioris* Hubbs y Miller	Cuatro Ciénegas, Coah.
E	*Megupsilon aporus* Miller y Walters	Potosí, N. L.
E	*Rivulus robustus* Hubbs y Miller	Coatzacoalcos.
V	*Fundulus lima* Vaillant	Loreto, Baja California.

Familia GOODEIDAE

E	*Ataeniobius toweri* (Meek)	La Media Luna, S.L.P.
E	*Characodon lateralis* (Gunther).	Río Mesquital, Dgo. Alto.
V	*Xenoophorus captivus captivus* (Hubbs)	Jesús María, S.L.P.
V	*Xenoophorus c. erro* Hubbs y Turner.	Santa María, S.L.P.
V	*Xenoophorus c. exsul* Hubbs y Turner.	Venado y Moctezuma, S.L.P.
E	*Ameca splendens* Miller	Río Ameca, Jal.
E	*Girardinichthys viviparus* Bustamante	Valle de México.

* Se conocen tres poblaciones, posiblemente subespecies.

I	Skiffia francesae Kingston	Río Teuchitlán, Jal.
E	Hubbsina turneri De Buen	Río Grande de Morelia, Mich.
I	Goodea gracilis Meek	Río Pánuco, Qro. Alto.

Familia POECILIIDAE

V	Poecilia sulphuraria (Alvarez)	Baños de Azufre, Tab.
I	Poecilia latipunctata Meek	Río Tamesí, Tamps. Alto.
I	Poecilia velifera ssp. (Contreras)	Isla Mujeres, Yuc.
I	Gambusia puncticulata ssp. (Contreras).	Isla Mujeres, Yuc.
E	Gambusia alvarezi Hubbs y Springer	Ojo Dolores, Chih.
E	Gambusia hurtadoi Hubbs y Springer	Ojo San Gregorio, Chih.
E	Gambusia sp. (Contreras)	Ojo San Diego, Chih.
E	Gambusia longispinis Minckley	Cuatro Ciénegas, Coah.
V	Poeciliopsis occidentalis sonoriensis. (Girard)	Baird y Girard.
E	Xiphophorus couchianus (Girard)	Manantiales ca. Monterrey, N.L.
E	Xiphophorus gordoni Miller y Minckley	Cuatro Ciénegas, Coah.
E	Xiphophorus sp.	Múzquiz, Coah.
V	Xiphophorus clemenciae Alvarez	Alto Río Coatzacoalcos, Oax.

Familia ATHERINIDAE

E	Poblana a. alchichica De Buen	Lago Alchichica, Pue.
E	Poblana ferdebueni Solórzano y López.	Chignahuapan, Pue.
E	Chirostoma bartoni Jordan y Evermann	La Caldera, Gto.

Familia SYNBRANCHIDAE

E	Furmastix infernalis (Hubbs)	Holtún, Yuc.

Familia CENTRARCHIDAE

I	Lepomis megalotis ssp.	Cuatro Ciénegas, Coah.
I	Micropterus salmoides ssp.	Cuatro Ciénegas, Coah.

Familia PERCIDAE

E	Etheostoma australe Jordan	Rĩo Conchos.
R	Etheostoma pottsi (Girard)	Rĩo Conchos, Rĩo Nazas, Rĩo Aguanaval, Rĩo Mesquital.
E	Etheostoma sp. (Minckley)	Cuatro Ciénegas, Coah.

Familia CICHLIDAE

E	Cichlasoma labridens (Pellegrin)	La Media Luna, S.L.P.
E	Cichlasoma bartoni (Bean)	La Media Luna y Pánuco, SLP. Alto.
I	Cichlasoma sp.	La Media Luna, S.L.P.
I	Cichlasoma sp.	La Media Luna, S.L.P.
E	Cichlasoma minckleyi Kornfield y Taylor. **	Cuatro Ciénegas, Coah.

** Esto puede ser considerado como una sóla especie (Kornfield) o un completo de 4 especies crĩpticas. (Minckley/La Bounty).

E = En peligro; R= Rara; I= Insuficientemente conocida; U= Estatus desconocida.

LITERATURA CITADA:

CONTRERAS BALDERAS, SALVADOR.
1969. Perspectivas de la Ictiofauna en las Zonas Aridas del Norte de México. Mem. Primer Simp. Internal. Aumento Prod. Alim. Zonas Aridas. ICASALS, Texas Tech. Publ., 3:293-304.

1974. Speciation Aspects and Man Made Community Composition Changes in Chihuahuan Dessert Fishes. Mem. First Symp. Biol. Res. Chih. Des. (Alphine, Texas).

1975a. Cambios de Composición de Especies en Comunidades de Peces en Zonas Semiáridas de México. Publ. Biol. Inst. Invest. Cient., U.A.N.L., (Méx.), 1 (7):181-194.

1975b. Impacto Ambiental de las Obras Hidráulicas. Informe Técnico. Plan Nacional Hidráulico, México.

1982. Lista Anotada de Peces Mexicanos en Peligro ó Amenazados de - Extinción. Resumen. Sexto Congreso Nacional de Zoología, Mazatlán, México.

CONTRERAS, B., S., V.LANDA S., T. VILLEGAS Y G. RODRIGUEZ.
1976. Peces, Pisicultura, Presas, Polución, Planificación Pesquera y Monitoreo en México. ó la Danza de las P. Mem. Primer Simp. Pesq. Aguas Continentales, Méx., I:315-346.

MEDINA, GANDARA, JOSE A. Y RUBEN SANCHEZ SILVA.
1977. Impacto Ambiental de las Obras Hidráulicas. Doc. Com. Plan - Na. Hidráulico, 17:1-70; 29 cuadros.

APENDICE 1

Los criterios aplicados para determinar especies En Peligro, Vulnerables, - Raras, Insuficientemente Conocidas y de Estatus Desconocido, fueron los siguientes:

EN PELIGRO (E).

a). Cuando la población única o combinadas, no exceden de 1000 ejemplares

b). Cuando las poblaciones locales son 5 o menos.

c). Si la distribución conocida es menor de 10 km. de río, para cada población.

d) Conocerse que presenta reducción severa en distribución, número de poblaciones, o individuos, durante los últimos 10 años.

e). Tener escasa representación en colecciones científicas, generalmente para áreas bien exploradas.

VULNERABLE (V).

a). La que refleja adversamente cualquier cambio ambiental.

b). La que siendo localmente abundante, se conoce de pocas localidades.

c). La que siendo razonablemente abundante, ha mostrado reducción en su - distribución geográfica, poblaciones o individuos, particularmente en los últimos 10 años.

d). La conocida de biotopos pequeños, pero accesibles.

RARA (R).

a). La de escasa representación en colecciones de áreas bien exploradas.

b). La conocida de biotopos pequeños e inaccesibles.

c). La que siempre se ha conocido de pocos lugares, pequeñas poblaciones o escaso número de individuos.

INSUFICIENTEMENTE CONOCIDAS (I).

a). Aquella especie de la que se conocen datos que hacen sospechar que puede encontrarse en Peligro o Vulnerable.

ESTATUS DESCONOCIDA. (U).

a). Aquella especie de la cual no se tiene información, por lo menos reciente, subre sus condiciones de supervivencia.

Bonneville Basin Report to the Desert Fishes Council, 1984

by

Terry J. Hickman
Western Ecosystems
St. George, Utah

The Bonneville Basin comprises 34 million acres in portions of Utah, eastern Nevada, southeastern Idaho, and southwestern Wyoming. Major fisheries activities within the Basin during 1984 involved work with the following fish:

1. June sucker (*Chamistes liorus*):
   The proposed rule to list the June sucker as an endangered species with critical habitat was published in the Federal Register July 2, 1984. A public hearing was held on this proposed rule on Oct. 11, 1984, in Provo, Utah.

   The Utah Division of Wildlife Resources (UDWR) prepared a June sucker management plan and began implementing it in 1984. Adult suckers were trapped in the Provo River and spawned artificially. Larval suckers were reared at the experimental hatchery in Logan, Utah and stocked in three ponds near Utah Lake.

2. Least chub (*Iotichthys phlegethontis*):
   A site, in which least chub were stocked in an effort to expand their current range, was flooded by the rising waters of the Great Salt Lake. Two more sites have been identified by the UDWR and are currently being evaluated.

3. Bonneville cutthroat trout (*Salmo clarki utah*):
   The proposed rule to list the Bonneville cutthroat trout as a threatened species was submitted to the Denver regional office of the U.S. Fish and Wildlife Service (FWS) in May, 1984. The proposal was revised by the FWS Washington office and is currently under review by the FWS and UDWR. The UDWR has prepared a management plan for their native trouts including the Bonneville cutthroat trout. The trout taken to Logan, Utah, hatchery from Trout Creek appear to be doing fine and will be used in future propagation and introduction work.

4. Lahontan cutthroat trout (*Salmo clarki henshawi*):
   Bettridge Creek was sampled using electrofishing gear in September, 1984 by UDWR and BLM personnel. Seventeen fish were captured, including nine under 90mm total length; this is the first documented natural reproduction in Bettridge Creek. The UDWR is pursuing an agreement with a private land owner in Box Elder County, Utah, to utilize a 5-acre pond for raising Lahontans and taking eggs for a hatchery program.

North American Desert Aquatic Ecosystems

La Meda Luna, San Luis Potosi,

at Edge of Chihuahuan Desert, Mexico

La Media Luna (Seegers and Staeck 1984a) is the name given to an extensive series of warm-spring aquifers, marshes, and outflows that lie in a broad meadow about 10 airline km SSW of the town of Ríoverde, San Luis Potosí, at an elevation just over 1,000 meters.[1] The vegetation of the region is arid, with few trees on the valley floor and a close growth of xerophytic plants on the hills. Mesquite and creosote bush are characteristic, along with large acacias, yucca, and numerous cacti. (Miller 1956, 1978.)

A large, constant volume of exceptionally clear, blue water rises from six spring holes (one of them very deep, perhaps 40 m) in a crescent-shaped (half-moon) laguna that provides all the water for three municipios. According to SCUBA divers, the flow

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[1] The place is called Manantial de la Media Luna on the 1:50,000 topographic sheet "El Refugio", F-14-C-16, first published in 1973 by CETENAL, Mexico City.

[2] At RRM Sta. M78-3, at Puerta del Río, source of the Río Verde (20 km SE of Cerritos), water was 27°C, salinity 1.0 ppt., Umhos 1700, M74-2, II:5:1974. At a spring-fed marsh, 10 km S of Ríoverde, water was 25.5°C, salinity 1.2 ppt., Umhos 2,150, M74-52, III:21:1974.

from the laguna is 600 liters per second. Its area is aproximately 24,800 square meters. The water has a noticeable sulfurish odor, with temperatures varying from 29.5° to 30.3°C; pH values have ranged from 6.9 to 7.3 and hardness was 92 ppm. of CaCo3 (Umhos 1,930; salinity 1.3 ppt.).[2] Dissolved oxygen is high, 4.0 to 6.4 ppm. (Miller 1956). The area drains into the Río Verde which lies in the large Río Pánuco basin that flows into the Gulf of Mexico at Tampico. The upper Río Verde is isolated from its lower part by an 80-meter falls in the lava canyon near Pinihuán, 19 km S of Rayón on the road to Lagunillas. This barrier (age unknown) prevents the upstream movement of any lowland fishes.

The biota, yet imperfectly known, is noteworthy (Table I). Among the fishes are two endemic genera in two related families (Cyprinodontidae and Goodeidae), two endemic species of cyprinids, one endemic described cichlid (Taylor and Miller 1983) and another endemic undescribed cichlid. Among the invertebrates, the three that have been collected, studied, and described thus far comprise three endemic species of Crustacea — a crayfish, an ostracod, and a shrimp (Villalobos and Hobbs 1974).

To my knowledge, the aquatic and semiaquatic plants, the herpetology, snails and other invertebrates have yet to be studied; amongst these one might expect to find further examples of endemism. One hydrobiid has been identified by Robert Hershler (ANSP) as Cochliopina riograndensis, a widespread species. (Irv Kornfield, pers. comm. 1981.)

The earliest collections of fishes from La Media Luna were made during expeditions from Louisiana State University, 1951-54, culminating in the study by Gregg (1956) on the fishes of San Luis Potosí. I visited the area first in 1955, then again in 1970, 1971, 1972, 1974, and 1978. I also examined collections (deposited at UMMZ) made there in 1968 by Salvador Contreras-B. and party and by James and Martha Lackey, as well as specimens in FMNH collected by Tower. Although I could detect no obvious changes in habitat or species composition from 1955 through 1971, man-made modifications were present in 1972, which is also the year when the first exotic species (Gambusia panuco and Tilapia aurea) were noted in the outflow ditches south of Ríoverde. By 1978, two more exotics (Poecilia mexicana and Cichlasoma cyanoguttatum) had become established. By 1981, there was a population explosion amongst Tilapia such that it was difficult to find the native cichlids (Irv Kornfield, pers. comm. 1981).

In addition to the valuable and potentially important native biota discussed above, La Media Luna is of considerable anthropological interest, with the Upper Río Verde area being full of archeological sites (Beatriz Braniff, Inst. Nac. Antropol. e Historia, pers. comm. 1972). Figurines and pottery thrown into the main laguna during the approximate period from 600-900 A.D. involved ritual offerings for the purpose of obtaining rainfall to assist cultivation and the vigorous growth of crops.

La Media Luna is a unique aquatic ecosystem of great beauty and scientifc value. It should be set aside by the government of Mexico as a national treasure.

References

Contreras-B., S., and J. A. Verduzco M. 1977. *Dionda mandibularis* a new cyprinid fish endemic to the upper Rio Verde, San Luis Potosi, Mexico, with comments on related species. Trans. San Diego Soc. Nat. Hist. 18(16):259-266, figs. 1-3.

Gregg, R. T. 1956. A distributional survey of the fishes of San Luis Potosi, Mexico. PhD dissertation, Louisiana State University, 114 pp.

Hubbs, C. L., and R. R. Miller. 1977. Six distinctive cyprinid fish species referrable to *Dionda* inhabiting segments of the Tampico Embayment drainage of Mexico. Trans. San Diego Soc. Nat. Hist. 18(17):267-336, figs. 1-12.

Miller, R. R. 1956. A new genus and species of cyprinodontid fish from San Luis Potosi, Mexico, with remarks on the subfamily Cyprinodontinae. Occ. Pap. Mus. Zool. Univ. Michigan 581:1-17, figs. 1-2, pls. 1-2.

———— 1978. Composition and derivation of the native fish fauna of the Chihuahuan Desert region, pp. 365-381. Trans.-Symp. on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico, R. H. Wauer and D. H. Riskind, eds. U. S. Natl. Park Serv. Trans. Proc. Ser. No. 3 (1977).

Seegers, L., and W. Staeck. 1984a. Die Fische der Laguna Media Luna und der Laguna Los Anteojitos, Rio Verde, Mexiko. 1. Der Biotop Laguna Media Luna und seine Bedeutung. Aquarien- und Terrarien-Zeitschrift 37(4):128-131, illus.

------- & ------- 1984b. Die Fische der Laguna Media Luna und der Laguna Los Anteojitos, Rio Verde, Mexiko. 2. Die Nicht Cichliden. Ajquarien- und Terarien-Zeitschrift 37(5):164-168, illus.

Taylor, J. N., and R. R. Miller. 1983. Cichlid fishes (genus Cichlasoma) of the Rio Panuco basin, eastern Mexico, with description of a new species. Occ. Pap. Mus. Nat. Hist. Univ. Kansas 104:1-24, figs. 1-7.

Villalobos-F., A., and H. H. Hobbs, Jr. 1974. Three new crustaceans from La Media Luna, San Luis Potosi, Mexico. Smithsonian Contr. Zool. 174:1-18, figs. 1-8.

Prepared by Robert Rush Miller,
UMMZ XI:29:1982; modified V:1984.

Table I

KNOWN FISH AND CRUSTACEAN FAUNA OF LA MEDIA LUNA

Class	Scientific Name	Authority
Crustacea		
Cambaridae	*Procambarus roberti*	Villalobos & Hobbs 1974
Entocytheridae	*Ankylocythere barbouri*	Villalobos & Hobbs 1974
Palaemonidae	*Palaemonetes lindsayi*	Villalobos & Hobbs 1974
Pisces		
Characidae	*Astyanax mexicanus*	Hubbs & Miller 1977
Cyprinidae	*Dionda dichroma*	Hubbs & Miller 1977
	Dionda mandibularis	Contreras-B. & Verduzco-M. 1977
Ictaluridae	*Ictalurus mexicanus*	Miller 1956
Cyprinodontidae	*Cualac tesselatus*	Miller 1956
Goodeidae	*Ataeniobious toweri*	Miller 1956
Cichlidae	*Cichlasoma bartoni*	Miller 1956; Taylor & Miller 1983
	Cichlasoma labridens	Miller 1956
	Cichlasoma n. sp.	Hubbs & Miller 1977
Exotics:	*Gambusia panuco*	Hubbs & Miller 1977 (first noted in 1972)
	Poecilia mexicana	Miller, pers. obs. 1978
	Poecilia latipunctata	Seegars & Staeck 1984b
	Cichlasoma cyanoguttatum	Miller, pers. obs. 1978 (Sta. M78-3)
	Tilapia aurea	Hubbs & Miller 1977 (Sta. M78-3)

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"
407 West Line Street
Bishop, California 93514

November 28, 1984

RESOLUTION 84-1

RELATIVE TO THE COMPETENCE OF BIOL. NICOLAS VAZQUEZ-ROSILLO
AND THE HOSPITALITY OF THE STUDENTS, FACULTY, AND ADMINISTRATION
OF THE UNIVERSITY OF SAN LUIS POTOSI

WHEREAS the Sixteenth Annual Symposium of the Desert Fishes Council was held at the University of San Luis Potosí on 15-17 November, 1984, and

WHEREAS Biol. Nicolás Vázquez-Rosillo, Director of the Instituto de Investigación de Zonas Desérticas de la Universidad Autónoma de San Luis Potosí provided facilities and arrangements of superb quality, and

WHEREAS he was supported in his efforts by the students, faculty, and administration of the University of San Luis Potosí, and

WHEREAS said symposium was of enormous value in providing for improved communication and exchange between scientists from both México and the United States, and

WHEREAS the conservation of the desert resources of North America is of the highest importance in the long-term benefit and welfare of the citizens of both nations, and

WHEREAS the Sixteenth Annual Symposium of the Desert Fishes Council was of great value in the accomplishment of this long-term goal, now therefore be it

RESOLVED that the Desert Fishes Council, an organization numbering in excess of 400 persons and comprising an international representation of federal, state, and university scientists and resource specialists, members of conservation organizations, and individual citizens concerned with long-term environmental values, assembled at the Council's Sixteenth Annual Symposium on November 15 to 17, 1984 at the University of San Luis Potosí, S.L.P., México, does hereby express its profound and heartfelt thanks to Biol. Nicolás Vázquez-Rosillo, to the students and staff associated with the Instituto de Investigación de Zonas Desérticas, and to the administration of the University of San Luis Potosí for providing us with arrangements and facilities of such excellent quality, and be it further

RESOLVED that copies of this resolution be forwarded to Lic. J. de Jesús Rodríguez M., Rector de la Universidad Autónoma de San Luis Potosí.

PASSED UNANIMOUSLY

ATTEST:

Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514
November 28, 1984

RESOLUTION 84-2

HONORING DR. CARL E. BOND ON THE OCCASION OF HIS RETIREMENT

WHEREAS Dr. Carl E. Bond has taught at Oregon State University for nearly three decades, and

WHEREAS much of his time has been spent in teaching students and the public at large about the native fishes of Oregon and the surrounding region, and

WHEREAS this work has resulted in a better understanding and appreciation of the values inherent in undisturbed populations of native fishes and their habitats, and

WHEREAS the goals of this Council have benefited richly from this work, now therefore be it

RESOLVED that the Desert Fishes Council, meeting at its Sixteenth Annual Symposium at the Instituto de Investigación de Zonas Desérticas de la Universidad Autónoma de San Luis Potosí, México, does hereby acknowledge his many years of dedicated service in preserving western aquatic ecosystems, and be it further

RESOLVED that the Desert Fishes Council takes pleasure in anticipating continued dedication and productive effort from Dr. Bond in the future, and indeed will accept nothing less.

PASSED UNANIMOUSLY

ATTEST:

Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514
November 29, 1984

RESOLUTION 84-3

RELATIVE TO THE CHAIRMANSHIP OF DR. SALVADOR CONTRERAS-BALDERAS

WHEREAS Dr. Salvador Contreras-Balderas, of the Facultad de Ciéncias Biológicas at the University of Nuevo León, has served as Chairman-elect of the Council between the Twelfth and Fourteenth Annual Symposia, and as Chairman between the Fourteenth and Sixteenth Annual Symposia, and

WHEREAS Dr. Contreras will continue to serve the Council in an advisory capacity and as a member of the Executive Committee until the Eighteenth Annual Symposium, which will be held in 1986, and

WHEREAS since 1979 the Council has held two highly successful symposia within México, in 1980 at Nuevo León and in 1984 at San Luis Potosí, and

WHEREAS Dr. Contreras has played major roles in arranging and organizing said symposia, and

WHEREAS his effectiveness as a researcher and teacher have been manifested in the roles played by his students in the annual symposia and in the conservation of México's fish fauna, and

WHEREAS the symposia held in México have been of enormous value in extending the Council's programs and philosophies throughout North America and, in particular, in strengthening and cementing relationships between scientists, resource managers, and students from both México and the United States, and

WHEREAS such relationships will inevitably result in improved management and conservation of the desert resources and ecosystems of western North America, and

WHEREAS the improved management and conservation of said resources are of utmost importance to the well being of the citizens of both México and the United States, now therefore be it

RESOLVED that the Desert Fishes Council, an interagency and international group of more than 400 university and government scientists and resource managers, students, and private citizens concerned with long-term environmental values within North America and the world community generally, meeting at its Sixteenth Annual Symposium at the Instituto de Investigación de Zonas Desérticas de la Universidad Autónoma de San Luis Potosí on November 15-17, 1984, does hereby express its profound gratitude and admiration to Dr. Contreras for his efforts, which will benefit all future generations, and be it further

RESOLVED that copies of this resolution be forwarded to the Rector of the University of Nuevo León and to other parties as appropriate.

PASSED UNANIMOUSLY

ATTEST:

Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514

February 22, 1985

RESOLUTION 84-4

RELATIVE TO THE LISTING OF *MEDA FULGIDA* AS A THREATENED SPECIES

WHEREAS the spikedace (*Meda fulgida*) has been extirpated from more than 85 percent of its range in the Gila River basin because of dams, water diversions, habitat degradation, and competition from exotic species, and

WHEREAS the U.S. Bureau of Reclamation's Central Arizona Project is considering additional water diversions and dams within the remaining habitat of the species, and

WHEREAS the U.S. Fish and Wildlife Service has identified *Meda fulgida* as a Category 1 species in the 1982 Notice of Review of Vertebrate Species, indicating that there currently exists sufficient information to proceed with a listing as threatened or endangered, now therefore be it

RESOLVED that the Desert Fishes Council, an organization numbering in excess of 400 persons and comprising an international representation of federal, state, and university scientists and resource specialists, members of conservation organizations, and individual citizens concerned with long-term environmental values, assembled at the Council's Sixteenth Annual Symposium on November 15 to 17, 1984 at the University of San Luis Potosí, S.L.P., Mexico, does hereby express its profound and heartfelt concern over the well-being of *Meda fulgida* and urges the U.S. Fish and Wildlife Service to proceed immediately with the listing of *Meda fulgida* as a threatened species under the provisions of the Endangered Species Act of 1973, as amended, and be it further

RESOLVED that copies of this resolution be forwarded to the Director of the U.S. Fish and Wildlife Service in Washington, D.C., and to the Regional Director of the U.S. Fish and Wildlife Service in Albuquerque, New Mexico.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514
April 5, 1985

RESOLUTION 84-5

RELATIVE TO THE PRESERVATION OF THE BIOTIC INTEGRITY
OF THE YAMPA RIVER, COLORADO

WHEREAS the Yampa River is the last largely free-flowing river in western Colorado and has retained many of the natural features required for the continued existence of the native Colorado squawfish (Ptychocheilus lucius), humpback chub (Gila cypha), and the razorback sucker (Xyrauchen texanus), and

WHEREAS the lower Yampa River in Dinosaur National Monument contains critical natural habitat for spawning of Colorado squawfish, and

WHEREAS water development in other Colorado rivers continues to threaten the continued existence of the above-mentioned endangered fishes, now therefore be it

RESOLVED that the Desert Fishes Council, an organization numbering in excess of 400 persons and comprising a nationwide and international representation of federal, state, and university scientists and resource specialists, members of conservation organizations, and individuals concerned with long-term environmental values, assembled at the Council's Sixteenth Annual Symposium at the University of San Luis Potosí, San Luis Potosí, México, on 15-17 November, 1984, does hereby request that the Governor of Colorado and the Director of the Colorado Department of Natural Resources take appropriate action to secure policy designed to protect the biotic integrity of the Yampa River and the above-mentioned fishes, and be it further

RESOLVED that copies of this resolution be forwarded to the Governor of Colorado, the Director of the Colorado Department of Natural Resources, the Director of the Colorado Division of Wildlife, the Superintendent of Dinosaur National Monument, and members of the Colorado congressional delegation, as appropriate.

PASSED WITHOUT DISSENTING VOTE

ATTEST:
Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514
April 5, 1985

RESOLUTION 84-6

RELATIVE TO COLORADO DIVISION OF WILDLIFE REGULATION #103 PERMITTING THE USE, POSSESSION, AND EXPORTATION OF FISH, AMPHIBIANS, AND CRUSTACEANS IN: THE COLORADO RIVER (MESA COUNTY) FROM I-70 AT PALISADE DOWNSTREAM TO THE UTAH LINE; RIFLE GAP RESERVOIR (GARFIELD COUNTY); AND RIO BLANCO RESERVOIR (RIO BLANCO COUNTY).

WHEREAS the above areas include reaches critical to the survival and recovery of Colorado squawfish (Ptychocheilus lucius), and/or humpback chubs (Gila cypha), and/or bonytails (Gila elegans), and/or razorback suckers (Xyrauchen texanus) during one or more life history stages, and

WHEREAS the above species are recognized as rare or in imminent danger of extinction, and squawfish, humpback chubs, and bonytails are listed as endangered by the federal government and the State of Colorado, and

WHEREAS the use of live bait increases the probability of establishing nonnative fishes that may compete with or prey on early life history stages of the above-mentioned species, and

WHEREAS Permitting the collection and/or use of live bait in the above-mentioned areas can increase angling pressure by encouraging the development of commercial bait dealerships, and

WHEREAS the early life stages of the above-mentioned species require specialized scientific expertise to be distinguished from each other and from other common species, and

WHEREAS the early life stages of the above-mentioned species would be subjected to increased mortality if collected and/or used as bait, and

WHEREAS experimental stocks of young Colorado squawfish have been introduced into the mainstem Colorado River as part of research/recovery efforts by the U.S. Fish and Wildlife Service, and these stocks would be subjected to increased mortality through capture and/or use as bait fish, and

WHEREAS live bait angling will subject piscivorous stages of adult squawfish to increased mortality by hooking or removal from the water, and

Desert Fishes Council Resolution 84-6 April 5, 1985

WHEREAS other, more appropriate and less harmful types of angling techniques exist for the capture of channel catfish (Ictalurus punctatus), and

WHEREAS the regulation in question constitutes an unfortunate reversal of progressive regulations and policies by a wildlife agency acknowledged to be a national leader in nongame and endangered species management, now therefore be it

RESOLVED that the Desert Fishes Council, an organization numbering in excess of 400 persons and comprising a nationwide and international representation of federal, state, and university scientists and resource specialists, members of conservation organizations, and individuals concerned with long-term environmental values, assembled at the Council's Sixteenth Annual Symposium at the University of San Luis Potosí, San Luis Potosí, México, on 15-17 November, 1984, does hereby urge the Colorado Wildlife Commission to act at the earliest possible date to rescind the aforementioned regulation in the areas listed above in order to afford continued protection of the species of concern, and be it further

RESOLVED that copies of this resolution be forwarded to the members of the Colorado Wildlife Commission, to the Director of the Colorado Division of Wildlife, and to the Director of the Colorado Department of Natural Resources.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

Edwin P. Pister

Edwin P. Pister
Executive Secretary

ATTENDANCE LIST, SYMPOSIUM XVI, SAN LUIS POTOSI, S.L.P., MEXICO. NOV. 15-17, 1984.

Jack E. Williams	U.S. Fish & Wildlife Service	Sacramento, CA 95825
Beula Edmiston	Friends of Wildlife	Monterey Park, CA 91754
Tasker Edmiston	" " "	" " " "
Becky Hensley		Edinburg, TX 78539
Mareen Nichols		Phoenix, AZ 85004
Victor M. Martinez	Instituto de Zonas Deserticas	San Luis Potosi
G. Gary Scopp one	U.S. Fish & Wildlife Service	Reno, NV 89502
Paul Cuplin	B.L.M.	Denver, CO
Larry Zuckerman	Colorado State University	Fort Collins, CO 80523
Charlie Haynes	Colorado Division of Wildlife	" " " "
Marcie Friedman	U.C. Berkeley	Berkeley, CA 94720
Darrell Wong	Calif. Dept. Fish & Game	Bishop, CA 93514
Ann Wong	" " " "	" " "
David Rodriguez Baez	I.I.Z.D.	San Luis Potosi
Mary Dale Deacon	University of Nevada	Las Vegas, NV 89154
James E. Deacon	" " "	" " " "
Cindy Williams	Calif. State Legislature	Sacramento, CA 95814
Ma. de Lourdes Jiminez	I.I.Z.D.	San Luis Potosi
Victor Camacho Ibar	C.I.C.E.S.E.	Ensenada, B.C.N.
Arcadio Valdes G.	U.A.N.L.	Monterrey, N.L.
J. Refugio Ballin C.		San Luis Potosi
J.H. Guerrero Lopez		San Luis Potosi
Carlos Yruretagoyena	C.I.Q.R.O.	Cancun, Quintana Roo
Bob Ruesink	U.S. Fish & Wildlife Service	Salt Lake City, UT 84138
Neil Armantrout	B.L.M.&American Fish. Soc.	Eugene, OR 97440
Diana Evans	I.U.C.N.	Cambridge, U.K.
Lauren Kepner	Arizona Game & Fish Dept.	Phoenix, AZ 85029
Bill Kepner	U.S. Fish & Wildlife Svc.	Phoenix, AZ 85029
Ubana Ramirez C.	I.I.Z.D., U.A.S.L.P.	San Luis Potosi
Juan Tizcareno T.	" "	" " "
Jose Carmen Rodriguez G.	" "	" " "
Nicolas Vazquez R.	" "	" " "
Alicia Villalobos O.	" "	" " "
Ma. Carmen Vargas O.	" "	" " "
Rene Elizondo G.	" "	" " "
Karl Pister	Brigham Young University	Provo, UT 84601
Bob Love	The Nature Conservancy	Yorba Linda, CA 92686
Rosie Thompson		Santa Barbara, CA 93110
Virginia Ullman	Arizona Zoological Society	Phoenix, AZ 85018
Terry Hickman	Western Ecosystems	St. George, UT 84765
John Rinne	U.S. Forest Service, A.S.U.	Tempe, AZ 85282
Clark Hubbs	University of Texas	Austin, TX
Randy Benthin	Calif. Dept. Fish & Game	Bishop, CA 93514
Paul Turner	New Mexico State University	Las Cruces, NM 88005
Ellen Gleason	Calif.. Dept. Fish & Game	Sacramento, CA 95814
Arlis Fisk	" " " "	" " "
Patricia Palmer		Scottsdale, AZ 85253
Robert Behnke	Colorado State University	Fort Collins, CO80523
Juan Carlos Robles S.	I.I.Z.D.	San Luis Potosi
Hector Rivera M.	Secretaria de Pesca	Nuevo Leon
Gorgonio Ruiz Campos	C.I.C.E.S.E.	Ensenada, B.C.N.
Hector Espinosa Perez	Inst. de Biologia, U.N.A.M.	Mexico City
Salvador Contreras B.	Univ. Auton. de Nuevo Leon	Monterrey, N.L.

Yolanda Gallegos G.	I.I.Z.D.	San Luis Potosi
Astrid Kodric-Brown	University of Arizona	Tucson, AZ
Deborah Edwards	Pan American University	Edinburg, TX
Erica Hershler	Southwest Texas State U.	San Marcos, TX 78666
Phil Pister	Calif. Dept. F & G, D.F.C.	Bishop, CA 93514
Bob Hershler	Southwest Texas State U.	San Marcos, TX 78666
Bob Edwards	Pan American University	Edinburg, TX 78539
Carlos Chavez Toledo	Instituto Politec. Nacional	Mexico, D.F.
Teniente Nivon Edmundo	" " "	" "
Jerry Burton	U.S. Fish & Wildlife Svc.	Albuquerque, N.M. 87102
Terry Russi	B.L.M.	Bishop, CA 93514
K. Bruce Jones	B.L.M., Phoenix Trng. Center	Phoenix, AZ 85015
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Maria Elena Limon L.	Univ. Auton. Nuevo Leon	Monterrey, N.L.
Chavez Ortega J.	" " " "	" "
Reynaldo Perez Bernal	" " " "	" "
Sally Stefferud	U.S. Fish & Wildlife Svc.	Albuquerque, N.M. 87102
Jerry Stefferud	U.S. Forest Service	Albuquerque, N.M. 87102
Hectór Leal Sotelo	Univ. Auton. Nuevo Leon	Monterrey, N.L.
Lilia Mendoza Cuevas	" " " "	" "
Javier Flores Mtz.	" " " "	" "
Jose Luis Vallejo G.	S.E.D.U.E.	San Luis Potosi
Leonel Truegar Sanchez	"	" " "
Edmundo Diaz Pardo	Escuela Nacion. Cienc. Biol.	Mexico, D.F.
Carlos Palau Trujillo	I.I.Z.D.	San Luis Potosi

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

SEVENTEENTH ANNUAL SYMPOSIUM

Death Valley National Monument Headquarters

Furnace Creek, California

November 14-16, 1985

INTRODUCTION TO THE SYMPOSIUM: REHABILITATION OF ASH MEADOWS, NEVADA

Donald W. Sada
U.S. Fish and Wildlife Service
Reno, Nevada

The strong commitment toward desert fish conservation is being rewarded by actions that provide meaningful protection for these species. Public and private agencies have responded to the plight of these fishes by implementing a number of conservation programs. Many extinctions have been prevented and the program now has the luxury of expanding to include recovery. This new direction is not without challenge, and, in most cases, it is not likely to be successful without diligent care and proper direction.

The desert fishes conservation program has had little experience with recovery, and the experience we have has been oriented more toward preventing extinction than enhancing populations to secure levels within reconstructed habitats. In many cases "recovery" has relied heavily on our ability to effectively implement the Johnny Applefish management technique of introducing threatened taxa into more secure and hopefully unthreatened habitats. This management scheme has been reinforced since it prevented the extinction of many taxa. However, we fail to remember the many unsuccessful transplant attempts. These failures are reason for us to reconsider the importance of Johnny Applefish management to recovery.

Recent experience with several endangered fishes shows that careful planning and the accumulation of detailed biological information is required to successfully maintain and/or reestablish species within perturbed habitats. Recovery of the Devils Hole pupfish (Cyprinodon diabolis) and Moapa dace (Moapa coriacea) in southern Nevada exemplify the merits of using this approach to guide recovery. Initial management of the Devils Hole pupfish necessarily required establishing laboratory and refugium populations. All attempts at laboratory breeding failed, and two attempts at refugium propagation are minimally successful. Although this program provides important insurance against extinction, progress toward protection of the native population and recovery occured only after research showed the relationship between habitat quality and population size. This information was important to protect its habitat and it furthermore provided strong justification for recovery tasks designed to protect the enhanced status. Moapa dace recovery presents a similar situation. Recovery efforts conducted intuitively, but without information about dace life history and habitat preferences, failed when dace did not remain in habitat reclaimed for its benefit. Recently collected habitat preference and life history data has provided information used to rework the formerly manipulated habitats and establish a breeding proulation of at least 200 dace.

This symposium is organized to consider the recovery process required to for success in Ash Meadows. This area presents an unusual challenge because of the diversity and number of intimately associated endemic species (including plants, fishes, a mammal, and invertebrates). The relationship of these taxa makes single-species management impractical since any single activity designed solely for the conservation of one rare species may eliminate habitat and/or a population of another. Therefore, each recovery action requires consideration of the entire ecosystem. To do differently is contrary to the goals and purposes of recovery objectives. Presentations made by particpants in this symposium will first show how Ash Meadows appeared before perturbation by mining and agriculture over the past 25 years, and then show how recovery is being successfully planned then implemented for other desert ecosystems.

INTRODUCTION AL SIMPOSIO: REHABILITATCION DE ASH MEADOWS, NEVADA

Donald W. Sada
U.S. Fish and Wildlife Service
Reno, Nevada

El esfuerzo a la conservación de los peces del desierto se está recompensando con acciónes que proveen protección para estos especies en una manera significativa. Agencias públicas y privadas han respondido al apuro de estos peces con implemintación de varios programas conservativos. Muchas extinciónes se han prevenido y el programa ahoy tiene lujo de extenderse para incluir recobro. Esta dirección nueva no es sin demanda, y, en la majoría de casos, probablemente no sucede sin diligencia y propia dirección.

El programa de conservación de los peces del desierto ha tenido poca experencia con recobro, y la experencia que hemos tenido ha sido orientada más a preveniendo extinción que a realizando poblaciones a niveles seguros entre habitaciones reconstruidos. En muchos casos, "recobro" ha contado mucho en nuestra capacidad para implementar efectivamente la técnica de manejo Johnny Applefish, de introducir formas amenazadas entre habitaciones más seguras y, con esperanza, sin amenazación. Este esquema de manejo se ha reforzado porque ha prevenido la extinción de muchas formas de vida. Sin enbargo, se nos falla recordar los muchos esfuerzos de trasplante que no sucedieron. Estas faltas son razon para reconsiderar la importancia del manejo Johnny Applefish para recobro.

Experencia reciente con algunos peces empeligrados enseña que planeación cuidadosa y la acumulación de información biológica en detalle se requiere para mantener y/o restablecer prósperamente especies entre habitaciones perturbadas. Recobro del Devils Hole pupfish (<u>Cyprinodon diabolis</u>) y Moapa dace (<u>Moapa coriacea</u>) en el sur del estado de Nevada ejemplifica los méritos de usar esta técnica para guiar recobro. Manejo inicial del Devils Hole pupfih requerió necesariamente establecer poblaciones en el laboratorio y en refugios. Todos esfuerzos parna criar estos peces en el laboratorio failaron, y dos esfuerzos para propagacion en refugios tuvieron minimo exito. Aúnque este programa proviene importante aseguranza contra extinción, progreso a rumbo de proteción de las poblacione nativas y recobro ocurrieron solamente despues de que investigaciones enseñaron la relación entre habitación de calidad y el tamaño de la población. Esta información fue importante para protejer su habitación y además proveyó fuerte justificación para faenas de recobro diseñadas para protejer la condición de realizamiento. Recobro de Moapa dace presenta una situación semejante. Esfuerzos de recobro conducido intuitivamente, pero sin información en la vida y preferencia de habitación, fallaron porqué los dace no quedaron en habitacion recobrada para su beneficio. Datos collectados recientemente sobre la preferencia de habitación y su vida han provenido información usada para reconstruir las habitaciones que fueron manipuladas y para establecer una población de a lo menos 200 dace, con capacidad de crianza.

Este simposio es organizado para considerar el proceso de recobro requerido para éxito en Ash Meadows. Este area presenta un desafío raro para la diversidad y numeros de especies con asociaciones íntimas (incluyendo plantas, peces, un mamifero, y invertebrados). Las relaciones de estas formas de vida hace manejo de especies singular impracticable porque como cualquiera activadad singular designada solamente para la conservación de un expecie raro probablemente puede eliminar habitación y/o una población de otro especie. Talvez, cada acción de rocobro requiere consideración del ecosistema entero. De hacer diferente es contrario a las metas y propósitos de los objectivos de recobro. Presentaciones por los participantes en este simposio enseñaron, al principio, como aparecía Ash Meadows antes de perturbación por las industrias de minería y agricultura sobre los pasados 25 años, y entonces enseñarán como el recobro se esta planeando prosperamente y luego implementado en otros ecosistemas del desierto.

PERSPECTIVES ON AN INTEGRATED APPROACH TO RECOVER ASH MEADOWS, NEVADA

Donald W. Sada
U.S. Fish and Wildlife Service
Reno, Nevada

Natural resource management in Ash Meadows has long been oriented toward protecting local biotic communities to prevent extinction. Recent establishment of Ash Meadows National Wildlife Refuge provides the necessary mechanism to change this toward management that enhances wildlife populations and increases their distribution.

Recovery of Ash Meadows requires implementing a number of integrated programs. The close proximity of habitats occupied by various endemic species requires these programs to consider the entire ecosystem and not only individual species. To do otherwise will result in enhancement of one species at the expense of cohabitating species or other species occupying immediately adjacent habitats. Ecosystem management is a popular topic for resource managers; however, there is little understanding of requirements for its success. For this management to occur in Ash Meadows, substantial new information must be gathered to create a solid foundation of ecological knowledge. Considerable planning will be required to determine what information is necessary and the best methods for its accumulation.

The amount of existing life history and habitat requirements information varies for endemic species. The fishes, for instance have been much more thoroughly studied than the endemic plant or invertebrate species.

Setting criteria to quantify progress toward recovery goals will be difficult because there is little known about the distribution of endemic species and characteristics of their associated communities prior to perturbation. Although it is impossible to determine these factors in many instances, striving toward reestablishing these species throughout their historic range is the most effective guide for orienting recovery actions. There are several means of gathering information characterizing pristine vegetation and animal communities. A search to compile field notes and photographs taken by naturalist visiting the area prior to 1963 will provide valuable information. Also, the military took aerial photographs of the area in 1948 which show the courses of spring outflows and the distribution of vegetation communities. Lastly, 10,000 acres of the 50,000 acres within Ash Meadows were altered by development. The remaining natural areas are valuable sites where research may gather data required to indicate the characteriestics of pristine communities. Properly designed research conducted in these areas will direct implementing tasks required to reconstruct disturbed sites and reestablish populations of endemic species.

ABSTRACTO
PERSPECTIVAS A UN METODO INTEGRADO PARA RECOBRAR ASH MEADOWS, NEVADA

Donald W. Sada
U.S. Fish and Wildlife Service
Reno, Nevada

El manejo de recursos naturales en Ash Meadows por mucho tiempo se ha orientado a protejiendo comunidades biológicas locales para prevenir extinción. Establecimiento reciente de Ash Meadows National Wildlife Refuge provene el mecanismo necesario para cambiar esta dirección a manejo que realiza poblaciones silvestres y aumenta su distribución.

El recobro de Ash Meadows requiere implemintando varios programas integrados. La proximidad de habitaciones ocupadas por varios especies endémicos requiere que estos progamas consideren el ecosistema entero y no solamento especies individuos. Para proceder diferentemente se resultará en realización de un especie al sacrificio de otros especies en la misma habitación o otros especies ocupando habitaciones immediatamente adyacente. El manejo de ecosistemas es tema popular con manejadores de recursos; sin embargo, hay poca comprensión de los requerimientos para su éxito. Para que este manejo ocurre en Ash Meadows, considerable información nueva se tiene que recojer para crear una fundación sólida de información ecologica. Considerable planeación sera requirida para determinar qual información es necesaria y los mejores métodos para su acumulación.

El total de información que existe en la vida y requerimientos de habitación es vario para especies endémicos. Los peces, por ejemplo, han sido estudiados mas completamente que los especies de plantas endémicas o invertebrados.

Estableciendo criterio para medir el progreso a metas de recobro será dificil porque hay poca información sobre la distribución de especies endémicos y las características de sus comunidades asociadas antes de la perturbación. Aunque es imposible para determinar estos factores en muchos casos, esforzando a restablecer estos especies en todos areas históricos es el guia más efectivo para orientar acciones de recobro. Hay algunos métodos para recoger información que caracteriza la vegetación pristina y comunidades de animales. Una investigación para compilar notas de campo y fotografías por naturalistas visitando el area antes de 1963 se provene información valiosa. Tambien, los militares tomaron fotografias aereas del area en 1948 que enseñan los canales de manantiales y la distribución de comunidades de vegetación. Últimamente, 10,000 acres de los 50,000 acres entre Ash Meadows fueron cambiados por el desarollo. Los restos de los areas naturales son sitios valuosos donde investigaciones pueden recoger datos requeridos para indicar las caracteristicas de comunidades pristinas. Investigaciones que sean designadas propiamente y conducidas en estos areas servirán a dirigir implemintación

de tareas requeridas para reconstruir sitios perturbados y restablecer poblaciones de especies endémicos.

Autecological Monitoring of Endangered Plants and Damaged Communities

Bruce M. Pavlik
Department of Biology
Mills College
Oakland, California 94613

Abstract

The management of endangered plant populations and the recovery of damaged plant communities require quantitative, autecological data. Among the most important and appropriate fields of investigation are demography and physiological ecology. Of primary concern in the maintenance of endangered species are the demographic factors that lead to stability in population size. Demography includes descriptive and small-scale manipulative studies of seed production, dispersal, recruitment, establishment, predation and mortality. Derived from such studies is information regarding the reproductive limitations on species in a particular environment, delineation of actual and potential habitat, population cycles and half-lives and the probability of survival. This information can enter directly into management decisions regarding the perpetuation of endangered species that cannot be subjected to widescale manipulation or physiological experimentation. Physiological ecology, on the other hand, is best applied to communities in which change (the establishment and recovery of dominant species) is the major goal of the manager. Of critical importance here are identifying patterns and intensity of resource use, characterizing physiological responses in relation to recovery treatments, and developing physiological schedules of manipulation to favor the performance of desirable species.

Objectives of Restoration at Ash Meadows

Restoration of the native plant communities at Ash Meadows has two major objectives:

1) Slow and eventually reverse the rate of decline of endangered, threatened and otherwise unique elements of the local flora (Table 1), and

2) Initiate and facilitate the return of native vegetation in areas that have been most disturbed by development in the past.

Regarding the first objective, there are approximately 14 species of vascular plants that should receive immediate attention. Populations of these species may be comprised of as few as 100 individuals at present (e.g. Mentzelia leucophylla) or more than 10,000 (Grindelia fraxino-pratensis). Although the distribution and general ecological characteristics of the species have been described, we have no quantitative data on the dynamics of their populations upon which to base management decisions. In order to meet the second objective, we will need to determine the pre-disturbance characteristics of Ash Meadows vegetation and develop a plan for landscape restoration. Among the primary types of pristine vegetation that may have to be reconstructed are bulrush-cattail marsh (Scirpus-Typha), riparian thicket (Prosopis), saltgrass meadows (Distichlis), spring mound scrub and upland Atriplex scrub.

The techniques used to conserve endangered species and restore communities will be based on studies from other regions and ecosystems (e.g. Dr. Romney at the Nevada Test Site, Dr. Smith at Mono Lake and Dr. Ohmart along the Colorado River) and many new techniques will undoubtedly evolve at Ash Meadows. Regardless of which techniques are used, the practice of ecosystem restoration is time-consuming, labor intensive, expensive and often frustrating. My purpose here is to show how autecological monitoring can contribute to the restoration process by providing essential, quantitative data for:

1) assessing the current status of endangered plant populations,

2) determining the effect of an experimental manipulation on a re-established plot of vegetation, and

3) developing management plans for endangered plants and restored plant communities.

The monitoring program should include short-term ecophysiological and long-term demographic analyses.

Recovery of Endangered Plant Populations (Types I+II Monitoring)

Human disturbance has probably been the greatest threat to rare and unusual plants at Ash Meadows. Activities such as road construction, altering drainage patterns, plowing, introducing exotic plants and animals and mining have directly or indirectly affected the size and/or vigor of the populations. Therefore, the first step in the recovery of these species is to discourage any further change in the habitat by minimizing the probability of future disturbance (Table 2). Unnecessary roads that come near important populations should be closed and all access to these areas regulated by permit. In some cases it may be helpful to designate the patterns of access to a particular site if scientists and managers use it frequently over long periods of time.

During this initial phase of minimal disturbance, each species population can be monitored using standard demographic methods (Type I monitoring). The goal is to use survivorship, age structure, and reproductive output parameters for determining populations trends over relatively long periods of time (perhaps 2-5 years depending on the life form and status of particular species). The essential features of a Type I monitoring program are its demographic basis and long-term time framework. Type I monitoring could indicate the appropriateness of performing experimental manipulations to increase the size and extent of certain populations. Resource supplementation (e.g. water and nitrogen), artificial germination and establishment, and the management of predators and competitors would be implemented, if the populations were relatively stable in the absence of other forms of human disturbance. These manipulations would be conducted in a controlled, scientific manner so as to be of some use in future management of these species. During this experimental phase, the populations could be monitored physiologically (Type II monitoring) as well as demographically in order to determine the best combination of manipulations to successfully increase the number of established, reproductive individuals. The essential features of Type II monitoring are its ecophysiological basis and short-term time framework. I will discuss this monitoring in relation to the recovery of damaged communities (below).

As a sequence of logical program steps, the recovery of endangered plants would incorporate Types I and II monitoring within three major routines (Figure 1):

1) stabilization routine - acts to minimize the probability of extinction caused by future disturbance or premature and/or deleterious manipulation

2) amplification routine - experimental manipulations to increase the number of established, reproductive individuals

3) evaluation routine - evaluates the methods being employed in case of a negative evaluation of the population or to determine if drastic manipulations are warrented in case of an extreme decline in the size and/or vigor of the population

These approaches to the recovery of endangered plants, including Types I and II monitoring have been developed from my own research on the endemic species of Eureka Dunes, Inyo County, California (Pavlik 1979, Pavlik and Barbour 1985).

Recovery of Native Plant Communities (Type II Monitoring)

In contrast to the recovery of endangered plant populations, the recovery of native communities requires the initiation and facilitation of changes in the plant cover of an area (Table 3). This process of change may be quite radical and incorporate drastic methods for re-establishing dominant, native species. Weed control, resurfacing and re-vegetation are among the most important methods to be implemented. Because the species to be used for revegetation are usually widespread and abundant, demographic monitoring is inappropriate and unnecessary. Instead, it is important to know if the re-established individuals are likely to survive and reproduce under conditions of the reconstructed habitat. It is also essential to determine which manipulations could better insure their productivity and success. In this case, resource supplementation and the management of competitors and predators would be routinely applied along with a program of short-term ecophysiological (i.e. Type II) monitoring (Figure 2).

The goal of Type II monitoring is to use in situ measurements to determine if:

1) favorable conditions for establishment and reproduction exist at the moment (i.e. are the plants stressed ?)

2) a given manipulation has been effectively applied in terms of amount, timing and duration, and

3) alternative manipulations should be applied to insure success of the desired species.

Among the most critical measurements for species at Ash Meadows would be plant water status, leaf gas exchange (including photosynthesis), mineral nutrition and whole plant growth and phenology. The principle advantage of implementing a Type II monitoring program is that the status of the recovering community can be assessed prior to the death of individual plants and the extirpation of the re-established populations. Other important advantages include:

1) immediate feedback regarding the effects of manipulation on plant performance

2) the development of schedules of critical resource use, thus avoiding shortages and accesses in availability

3) low expense, especially when compared to repeated attempts at revegetation, and

4) methods that are currently available and readily learned by technicians.

Relationship Between Types I and II Monitoring

These two types of monitoring, when used together, take advantage of the important relationship that exists between short-term ecophysiological processes and long-term demographic trends within populations (Figure 3). As plant water status (Ψ) declines in the absence of precipitation or moisture supplementation, the stomates will close and create a high resistance (R_s) to water vapor loss. As stomatal resistance increases, CO_2 uptake is impeded and photosynthesis declines. The relationship between total plant photosynthesis integrated over time and whole plant growth is approximately exponential in the absence of stress. Finally, as plant size increases so does reproductive output. Greater reproductive output results in more seeds in the seed bank or more ramets established so that the probability of population growth is increased. Therefore, it is possible to infer long-term success of species conservation or revegetation from a detailed series of short-term, ecophysiological measurements. Combining these types of autecological monitoring into a coherent recovery program can reduce the probability of extinction and increase the probability that efforts to restore native vegetation will be successful.

Literature Cited

Pavlik, B.M. 1979. The biology of endemic psammophytes, Eureka Valley, California and its relation to off-road vehicle impact. U.S.D.I. Bureau of Land Management, California Desert Plan contract report, Riverside, Ca.

Pavlik, B.M. and M. G. Barbour. 1985. The demography of sand dune endemics, Eureka Valley, California I. Seed production, dispersal and herbivory. California Department of Fish and Game Endangered Plant Program contract report, Sacramento, Ca.

Table 1. Endangered, threatened and otherwise rare or unusual plants of Ash Meadows. E = endemic to Ash Meadows, DVR = found only in the Death Valley region, DU = dry upland, DL = dry lowland, SP = spring mound or wetland, Ann = annual, Per = perennial. Federally listed species are indicated with an asterisk.

species	distribution	habitat	life form
Mentzelia leucophylla*	E	DU	Per
Grindelia fraxino-pratensis*	E	SP	Per
Nitrophila mohavensis*	E	DL	Per
Astragalus phoenix*	E	SP	Per
Enceliopsis nudicaulis var. corrugata*	E	DU	Per
Ivesia eremica*	E	SP	Per
Centaurium namophilum*	E	SP	Ann
Cordylanthus tecopensis	DVR	SP	Ann
Arctomecon merriamii	DVR	DU	Per
Calochortus striatus	DVR	DU	Per
Oxystylis lutea	DVR	DL	Ann
Ephedra funerea	DVR	DU	Per
Solidago spectabilis	DVR	DU	Per
Fraxinus velutina var. coriacea	DVR	SP	Per

Table 2. Approaches and methods for recovering endangered plant populations.

approach	method
discourage change	road closure regulate all access designate access patterns minimize disturbance
Type I monitoring	survivorship age structure reproductive output effects of predators
manipulate	resource supplementation artificial germination artificial establishment manage predators manage competitors
Type II monitoring	ecophysiological parameters (see Table 3)

Table 3. Approaches and methods for recovering or reconstructing native vegetation.

approaches	methods
initiate change	weed control resurface the substrate re-establish drainage patterns re-establish dominant native plants
manipulate	resource supplementation manage predators manage competitors
Type II monitoring	phenology of growth and reproduction plant water status leaf resistance and gas exchange plant mineral nutrition

Figure 1. Flow diagram for the recovery of endangered plant populations.

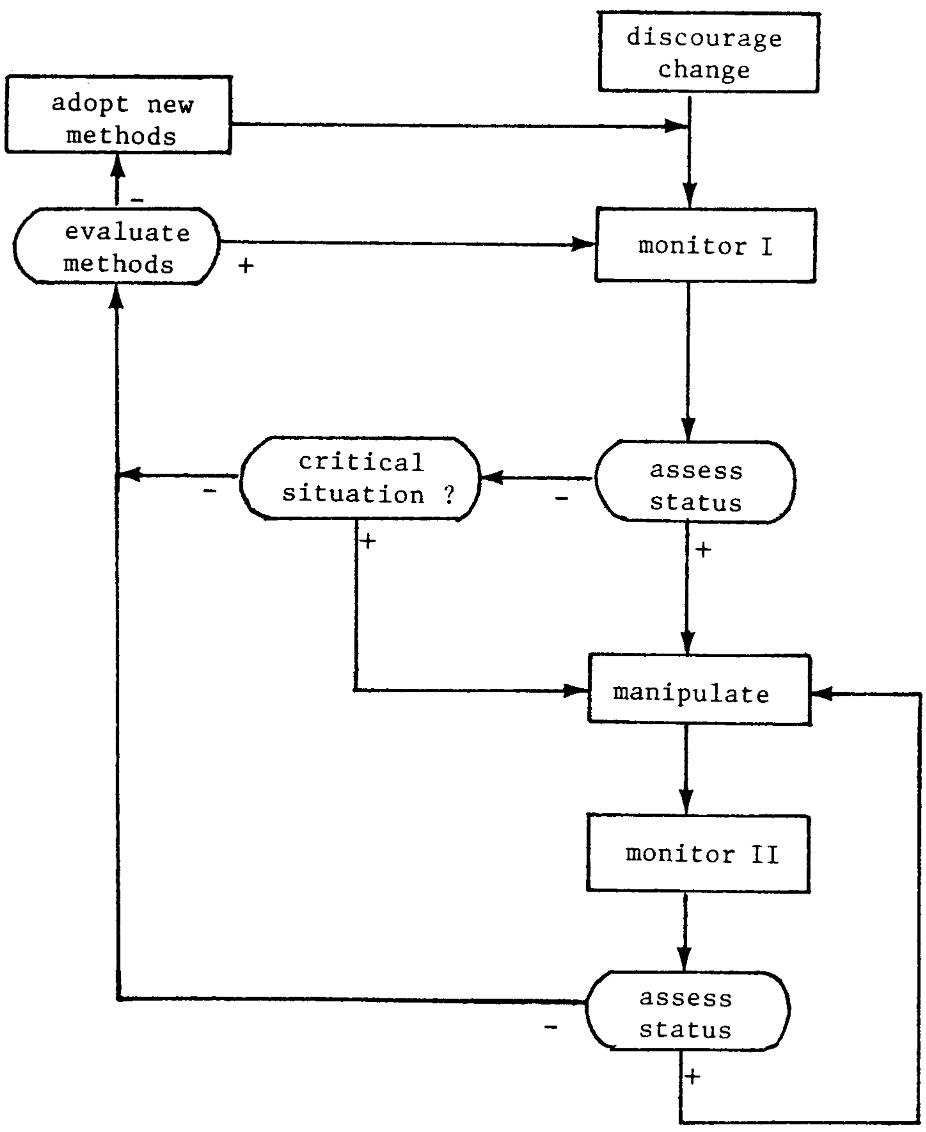
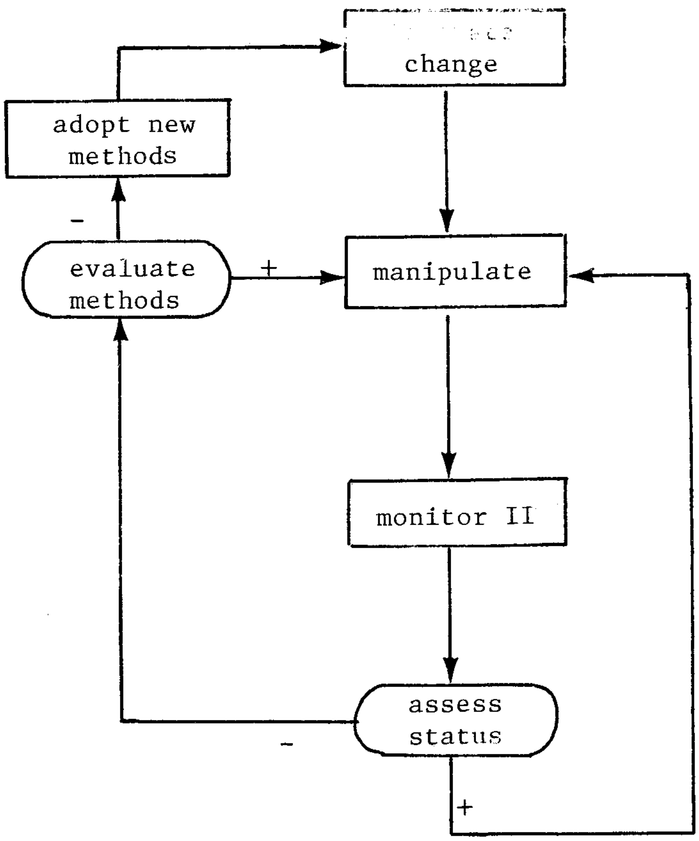
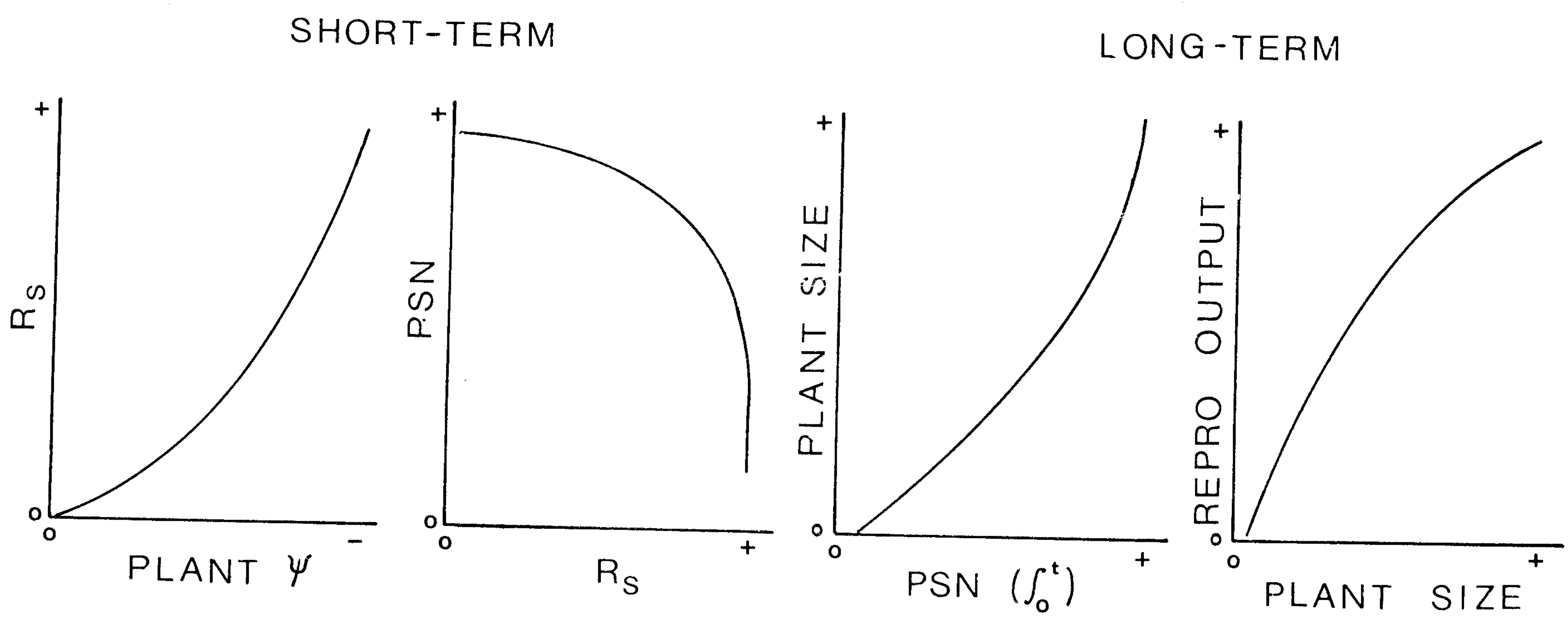


Figure 2. Flow diagram for the recovery of native vegetation.





[illegible] term ecophysiological processes and long-term demographic parameters. ψ = plant water potential, R_S = stomatal resistance [illegible]

ABSTRACT

REVEGETATION OF DESERT HABITATS: EXAMPLE FROM THE NEVADA TEST SITE, NEVADA AND MONO LAKE, CALIFORNIA

Evan M. Romney, University of California, Los Angeles;
and Stanley D. Smith, University of Nevada, Las Vegas

Self-revegetation of shrubs and grasses on disturbed land in the Mojave and Great Basin Deserts is a very slow and variable process. Contributing to the problem is the lack of water at times necessary to ensure seed germination and seedling survival, consumption of seedlings by grazing animals, impaired soil fertility, salt imbalance, and alkaline soils.

Through the use of horticultural management procedures we have developed methods for restoring native shrub cover onto disturbed land at the Nevada Test Site. This, however, involves the costs of producing and transplanting shrub specimens, protecting them from grazing animals, and providing them with supplemental water to ensure their survival and establishment. Artificial seeding and supplemental irrigation may be required with this method, depending upon the nature of the site and type of disturbance. The infrequency of sufficient rainfall to germinate seeds and competition from grazing animals for new seedlings are inherent problems with this methods; however, it's use can result in restoration of significant shrub cover within a 10-year period.

The recent dewatering of Mono Lake has exposed large areas of former lake bottom as saline/alkaline beaches which are presently creating a substantial dust problem in the area. We have initiated pilot studies to assess the Feasibility of stabilizing these shorelines with native vegetation. Soil sampling and early revegetation trials indicate that shrub species may not be successful due to highly alkaling soils (pH = 11) and subsurface anoxic conditions. Early tests indicate that native rhizomatous grasses, such as saltgrass and alkali bullrush, any be a more realistic alternative. Through this study, we hope to identify some of the constraints limiting the natural establishment of vegetation on alkali bottomlands in the Great Basin.

ABSTRACTO

LA REVEGETACIÓN DE LAS REGIONES DEL DESIERTO: EJEMPLARES DEL SITIO DE PRUEBA EN EL ESTADO DE NEVADA Y EL LAGO MONO EN EL ESTADO DE CALIFORNIA

Evan H. Romney, Universidad de California, Los Angeles y
Stanley D. Smith, Universidad de Nevada, Las Vegas

Revegetación de si mismo de arbustos y hierbas en terreno perturbado en los Desiertos Mohave y Great Basin es un proceso muy despacio y variable. Contribuyendo al problema es falta de aqua que es, a veces, necesaria para asegurar germinación de la semilla y supervivencia de las plantas de semillero, consunción de las plantas de semillero por animals rozadores, empeorar fertilidad de la tierra, el imbaláñce de sal, y terreno alkalino.

Mediante el uso de procedimientos del manejo de hortícola, hemos desarrollado métodos para restituir arbustos nativos en terreno perturbado en el Sito de Prueba en el estado de Nevada. Esto, sin embargo, se envuelve en cuestos de producir y transplantar arbustos, protejerlos de animales rozardores, y proveerles con aqua suplementaria para asegurar su supervivencia y establecimiento. Sembradera artifical y riego suplementario tal vez se requieren con este metodo, pendiente en las características del sitio y el tipo de perturbación. Falta de lluvia suficiente para brotar semillas y competición de animales rozardores para los semilleros nuevos son problemas inherente a este método; sin embrago, su uso puede resultar en restauración de significante cubierto de arbustos entre un período de 10 años.

Reciente reducción del nivel de aqua del Lago Mono, ha manifestado áreas grandes de lo que era el fondo del lago como playas salinas/álcalis que al presente estan produciendo un problema substancial de polvo en el área. Hemos iniciado estudios preliminarios para amillorar la posibilidad de estabilizar estos costos con vegetación nativa. Muestras de terreno y ensayos con la vegetacion indican que especies de arbustos probablemente no prosperan por el álcalis elevado en los terrenos (pH = 11) y condiciones anoxias bajo de superficie. Pruebas al principio indican que las hierbas nativas con rizomas, como hierbas de sal y hierba de álcalis, pueda que séan alternativas más realistas. Por medio de este estudio, tenemos esperanza de identificar algunos de los constreñimientos que limitan el estableciemiento natural de la vegetación en los fondos álcalis en el Great Basin.

Population Changes in Devil's Hole Pupfish Populations 1972-1984

James E. Deacon[1]

Abstract - Population estimates of the pupfish population in Devil's Hole were made at nearly monthly intervals from June, 1974, through September, 1981. Frequent estimates extend from April, 1972, through September, 1985.

Surface area of the pool decreases rapidly as water levels drop below 2.7 feet below a reference marker. Under those conditions, surface area or water level appears to have a dominating influence on population size. Surface area of the pool increases very slowly as water levels increase above 2.7 feet.

At the lower water levels (below 2.7), management activities included installation of artificial lighting to stimulate algae growth and enlarging the surface area of the shallow shelf area by removing substrate. These actions apparently caused population increases. In addition, natural catastrophies such as distant earthquakes and local floods caused disturbances in the pool that appear to be reflected by population declines. At both higher (above 2.7) and lower water levels, allochthonous nutrient input appears to influence population size.

All of the above factors were superimposed on a fundamental annual fluctuation in population size that resulted in an annual high population in the fall and an annual low in the spring. In general, the population of Devil's Hole pupfish in Devil's Hole varied from a minimum of about 150 to a maximum of nearly 600 adults.

Cambios de población de los pupfish de Devil's Hole, Nevada 1972-1984

Resumen - Proyectos mensuales de la población de pupfish en Devil's Hole, Nevada, se realizaron entre junio de 1974 y septiembre de 1981, con censos menos frecuentes hasta septiembre de 1985.

El área de la superficie del agua se se disminuye rápidamente cuando el agua retrocede más de 2.7 pies debajo de un punto de referencia instalado hace varios años lo cual parece influir la extensión de la población. El área de la superficie se extiende muy lentamente con la subida del agua.

Al bajarse el agua, se ha instalado iluminación artificial para estimular la reproducción de algas y se ha aumentado a mano el tamaño de un estante natural de piedra. Éstas acciones parecen haber causado un aumento de población. Catástrofes naturales como, terremotos lejanos e inundaciones parecen disminuir la población, la cual varía también según los cambios de nutrimento alóctono.

Todo lo citado tiene como resultado un cambio de población que varía desde un máximo en otoño hasta un mínimo en la primavera: una cantidad entre 150 y 600 adultos.

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ECOLOGICAL AND ZOOGEOGRAPHICAL CHECK-LIST OF THE CONTINENTAL FISHES OF THE BAJA CALIFORNIA PENINSULA, MEXICO

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ABSTRACT

The inland fish fauna from the Baja California Peninsula, Mexico, is reviewed up to 1985, from the ecological and zoogeographical points of view. According to the literature references and specimens available at the ichthyological collection from the School of Biological Sciences, University of Nuevo Leon, the check-list now includes 26 families, 44 genera, and 59 species (38 native and 21 exotic) registered for the Baja California inland fish fauna. Four species are new records for the Peninsula.

Most of the native fishes are ecologically of marine origin (89%), the remaining are of freshwater origin (11%). Those of marine origin fall into the following categories: species of Panamanian affinities (53%), amphi-American (10%), Californian (10%), circumtropical and circumpolar-holartic (3% each). The fish of freshwater origin are comprised of: nearctic affinities (10%), neotropical (8%), and endemic (3%).

INTRODUCTION

The inland fish fauna native to Baja California, Mexico, were first categorized by Follett (1960), into 17 families, 25 genera, and 29 species. Since then, a great number of new species have been collected in new localities. Consequently new records of species have been added to the freshwater ichthyofauna of the Baja California peninsula.

Several ichthyologists have studied the inland fish fauna of the Baja California peninsula. Most of them make only limited reference to their geographical distribution (e.g. Evermann, 1908; Snyder, 1926; Myers, 1930; Miller, 1943, 1968; Dill, 1944; Hubbs, 1954; Follett, 1960; Castro-Aguirre, 1978; Contreras and Escalante, 1984).

The fact that there is no systematic and ecological-zoogeographical check-list of the inland fish fauna for the Baja California peninsula is the motivating force behind this work. Our new list is based on literature records and specimens available at the Ichthyological Collection from the School of Biological Sciences, University of Nuevo Leon, Monterrey, Mexico (UANL).

DISTRIBUTIONAL ANALYSIS OF NATIVE SPECIES

We have listed a total of 22 families, 31 genera, and 38 native species to the Baja California peninsula, Mexico.

The local records for the species of Baja California Norte

(BCN) and Baja California Sur (BCS) are listed as follows:

FAMILY ELOPIDAE

Elops affinis (Regan). Machete
Local Records: BCN. Rio Colorado in the Mexican section (Follett, 1960: 214-15): Laguna Salada (Maquata of Mexicali: (Compean & Baylon, 1983: 208)

FAMILY ENGRAULIDAE

Anchoviella sp.
Local Records: BCN. El Estero *ca.* San Felipe (UANL-2540)

FAMILTY CLUPEIDAE

Harengula thrissina (Jordan & Gilbert). Flatiron herring.
Local Records: BCS. "Ojo de Agua" in Mulege (UANL-2515)

FAMILY SALMONIDAE

Salmo nelsoni (Evermann). San Pedro Martir trout.
Local Records: BCN. Arroyo San Antonio (Follett, 1960:215, as S. gairdneri); arroyo "La Grulla", tributary of the arroyo Santo Domingo (UANL-5679, as S. *nelsoni*). Transplanted to the arroyos San Jacinto (tributary of the San Vicente) and San Rafael (tributary of the Santo Domingo (Needham & Gard, 1959:46).

FAMILY CYPRINIDAE

Gila robusta (Baird & Girard). Roundtail chub.
Local Records: BCN. Rio Colorado south of the boundaries with U.S.A., in Horseshoe Bend and Rio Salton (Follett, 1960:216, as G. *robusta elegans*).

Ptychocheilus lucius (Girard). Colorado squawfish.
Local Records: BCN. idem. (Follett, 1960:217).

FAMILY CATOSTOMIDAE

Xyrauchen texanus (Abbott). Razorback sucker.
Local Records: BCN. Rio Hardy, tributary of lower Rio Colorado, (Follett, 1960:216).

FAMILY CYPRINODONTIDAE

Fundulus sp.
Local Records: BCS. Dam of San Francisco Javier in Loreto (UANL-2571).

Fundulus _lima_ (Vaillant). San Ignacio killifish.
Local Records: BCS. San Ignacio, Comondu and arroyo La Purisima (Follett, 1960:217); and "La Presa" in San Ignacio (UANL-2527).

Fundulus _parvipinnis_ (Girard). California killifish.
Local Records: BCN. Arroyos Medano, San Miguel and Carmen (Follett, 1960:217); San Quintin (UANL-2536); arroyo El Descanso, 55.8 km. NW of Ensenada (UANL-not cataloged).

Cyprinodon _macularius_ (Baird & Girard). Desert pupfish.
Local Records: BCN. Pozo del Tule; the NW margin of Laguna Salada; Pozo Cerro Prieto and Rancho Agua Caliente in Mexicali (Miller, 1943:17-18)

FAMILY GASTEROSTEIDAE

Gasterosteus _aculeatus_ (Linnaeus). Three Spined Stickleback.
Local Records: BCN. Rio Tijuana: arroyo del Rosario; and likely in streams of the Sierra San Pedro Martir (Follett, 1960:223m as G.a. _microcephalus_; and Castro-Aguirre, 1978, as G. _aculeatus_).

FAMILY SYNGNATHIDAE

Psuedophallus _starksii_ (Jordan & Culver).
Local Records: BCS. Streams near San Jose del Cabo (Castro-Aguirre, _op._ _cit._; Follett, 1960:224.

FAMILY MUGILIDAE

Agonostomus _monticola_ (Bancroft). Mountain mullet.
Local Records: BCS. Arroyo Santa Cruz; Sierra de las Cacachilas; South of La Paz; and San Jose del Cabo (Follett, 1960:220).

Mugil _cephalus_ (Linnaeus). Striped mullet.
Local Records: BCN. Laguna Maquata (=Salada) in Mexicali (Follett, 1960:219); Laguna Salada in "La Playita" place (Compean & Baylon, 1983:207); San Quintin (UANL-2542); mouth of Rio Colorado and tributaies (Castro-Aguirre, 1978:144); Arroyo San Miguel in Ensenada (Follett, 1960:219); "La Salina" _ca._ La Mision in Ensenada (G.R.C., obs. pers., 1985); San Quintin (UANL-2538). BCS. Arroyo La Purisima and San Jose del Cabo (Follett, 1960:219); "Ojo de Agua" of Mulege (UANL-2520).

Mugil _curema_ (Valenciennes). White mullet.
Local Records: BCS. Arroyo San Jose del Cabo (Follett, 1960:220); and Laguna de Cortez in San Jose del Cabo

(UANL-2531).

FAMILY ATHERINIDAE

Atherinops sp. (cf. analis)
Local Records: BCN. El Estero ca. San Felipe (UANL-2541).

Atherinops affinis (Ayres). Top smelt.
Local Records: BCN. San Quintin (UANL-2537).

FAMILY CENTROPOMIDAE

Centropomus nigrescens (Gunther). "Robalo Prieto".
Local Records: BCS. Mouth of Arroyo Mulege (Follett, 1960:219); and "Ojo de Agua" of Mulege (UANL-2516).

FAMILY LUTJANIDAE

Lutjanus argentiventris (Peters). "Pargo amarillo".
Local Records: BCS. Mouth of Arroyo Mulege (Follett, 1960:222); "Ojo de Agua de Mulege" (UANL-2518).

Lutjanus novemfasciatus (Gill). "Pargo Prieto".
Local Records: BCS. San Jose del Cabo (Follett, 1960:221); "Ojo de Agua" of Mulege (UANL-2517); and Laguna de Cortez in San Jose del Cabo (UANL_2529).

FAMILY GERREIDAE

Eucinostomus sp.
Local Records: BCS. "Ojo de Agua" of Mulege (UANL-2519).

Eucinostomus gracilis (Gill). Pacific flagfin mojarra.
Local Records: BCS. San jose del Cabo (Follett, 1960:221); and Laguna de Cortez in San Jose del Cabo (UANL-2530).

Gerres cinereus (Walbaum). Yellowfin mojarra.
Local Records: BCS. Arroyo San Jose del Cabo (Castro-Aguirre, 1978:107; Follett, 1960:221).

FAMILY POMADASYIDAE

Pomadasys bayanus (Jordan & Evermann)
Local Records: BCS. San Jose del Cabo (Follett, 1960:222)

FAMILY SCIAENIDAE

Cynoscion macdonaldi (Gilbert). "Totoaba".
Local Records: BCN. Mouth of Rio Colorado (Castro-Aguirre, 1978:130).

Cynoscion xanthulus (Jordan & Gilbert). Orange Mouth Corvina.
Local Records: BCN. Mouth of Rio Colorado (Castro-Aguirre, 1978:131; Follett, 1960:222).

Micropogon megalops (Gilbert).
Local Records: BCN. Rio Colorado (Castro-Aguirre,1978:133); and mouth of Rio Colorado (Follett, 1960:222).

FAMILY ELEOTRIDAE

Dormitator latifrons (Richardson). Pacific Fat Sleeper.
Local Records: BCS. Arroyo San Jose at San Jose del Cabo; Rio Mulege; Bahia Agua Verde; and Playa E San Jose del Cabo (Follett, 1960:224); "Ojo de Agua" of Mulege (UANL-2521); Laguna de Cortez in San Jose del Cabo (UANL-2532); Rio Mulege immediately below dam (UANL-not catalogued).

Gobiomorus maculatus (Gunther).
Local Records: BCS. San Jose del Cabo (Follett, 1960:224); and Laguna de Cortez at San Jose del Cabo (UANL-2534).

Eleotris picta (Kner & Steindachner). Spotted Sleeper.
Local Records: BCS. Rio San Jose del Cabo and Rio Mulege (Castro-Aguirre, 1978:155); and Laguna de Cortez in San Jose del Cabo (UANL-2533).

FAMILY GOBIIDAE

Awaous transandeanus (Gunther)
Local Records: BCS. San Jose del Cabo; La Purisima; and "Pozas Boca de la Sierra" in Santiago (Follett, 1960:225).

Gillichthys mirabilis (Cooper). Longjaw mudsucker.
Local Records: BCN. Localities near the mouth of Rio Colorado and Rio Hardy at Mexicali (Follett, 1960:225).

Gobionellus sp.
Local Records: BCS. "Ojo de Agua" if Mulege (UANL-2522); and Laguna de Cortez in San Jose del Cabo (UANL-2535).

FAMILY BOTHIDAE

Citharichthys gilberti (Jenkins & Evermann).
Local Records: BCS. San Jose Del Cabo (Follett, 1960:218; Castro-Aguirre, 1978:184); "Ojo de Agua" of Mulege (UANL-2524). BCN. Laguna Santa Maria (Castro-Aguirre, op. cit.).

FAMILY PLEURONECTIDAE

Hypsopsetta guttulata (Girard). Diamond turbot.
Local Records: BCS. "Ojo de Agua" of Mulege (UANL-2525).

FAMILY ACHIRIDAE

Achirus mazatlanus (Steindachner).
Local Records: BCS. "Ojo de Agua" of Mulege (UANL-2526).

FAMILY COTTIDAE

Leptocottus armatus (Girard). Pacific Staghorn sculpin.
Local Records: BCN. Arroyo Rosarito and San Miguel (Follett, 1960:223).

ECOLOGICAL AND ZOOGEOGRAPHICAL STATUS OF NATIVE ICHTHYOFAUNA

We analyzed the inland native fish fauna of the Baja California Peninsula, Mexico, according to an ecological classification described by Myers (1951). According to this classification the inland fauna is composed of species of sporadic status (63%), vicarious (13%), complementary (8%), primary (8%), diadromus (5%), and secondary status (3%) as depicted in table 1. Of these fish fauna, 89% are of marine derivation and 11 % are of freshwater origin.

We also analyzed the fish fauna from a zoogeographical point of view according to Briggs (1974). We found that the native fish fauna of marine derivation is composed of species with Panamanian affinity (53%), Amphiamerican (10%), Californian (10%), and circumtropical and circumpolar holarctic affinity (3% each). The native ichthyofauna of freshwater origin is comprised of spcies of nearctic affinity (10%), neotropical (8%), and endemic affinity (3%) as depicted in table 1.

DISTRIBUTIONAL RECORDS OF EXOTIC SPECIES

Our list comprises a total of 21 exotic fishes which have been introduced to the freshwaters of the Baja California Peninsula. The local records of each species are as follows:

FAMILY CLUPEIDAE

Dorosoma petenense (Gunther). Threadfin shad.
Local Records: BCN. Rio Colorado near the delta (Burgess 1980, Contreras & Escalante, 1984); tributary channel to Laguna Salada at Mexicali (Compean & Baylon, 1984:219).

FAMILY CYPRINIDAE

Cyprinus carpio (Linnaeus). Common carp.
Local Records: BCN. Lower Rio Colorado and tributaries (Follett, 1960:227; Contreras & Escalante, 1984:108); Laguna Salada in "La Playita" place, Mexicali (collected by G. Ruiz C., May 6, 1985).

Gila (Siphateles) mohavensis (Synder). Mohave chub.
Local Records: BCN. Arroyo Santo Tomas (Miller, 1968:171).

Gila orcutti (Eigenmann & Eigenmann). Arroyo chub.
Local Records: BCN. Arroyo Santo Tomas (Miller, 1968:171).

TABLE I

ECOLOGICAL AND ZOOGEOGRAPHICAL CLASSIFICATION OF THE INLAND NATIVE ICHTHYOFAUNA FROM THE BAJA CALIFORNIA PENINSULA, MEXICO.

SPECIES	STATUS													
	ECOLOGICAL						ZOOGEOGRAPHICAL							
	P	S	V	D	C	SP	NA	NT	EN	PA	AA	CT	CA	CH
Elops affinis						X					X			
Anchoviella sp.			X							X				
Harengula thrissina *						X				X				
Salmo nelsoni				X			X							
Gila robusta	X						X							
Ptychocheilus lucius	X						X							
Xyrauchen texanus	X						X							
Cyprinodon macularius		X						X						
Fundulus sp.						X		X						
F. lima			X						X					
F. parvipinnis						X		X						
Gasterosteus aculeatus			X											X
Pseudophallus starksii			X							X				
Agonostomus monticola					X						X			
Mugil cephalus				X								X		
M. curema						X					X			
Atherinops sp.						X				X				
A. affinis *						X							X	
Centropomus nigrescens						X				X				
Lutjanus argentiventris						X				X				
L. novemfasciatus						X				X				
Eucinostomus sp.						X				X				
E. gracilis						X				X				
Gerres cinereus						X					X			
Pomadasys bayanus			X							X				
Cynoscion macdonaldi						X				X				
C. xanthulus						X				X				
Micropogon megalops						X				X				
Dormitator latifrons						X				X				
Gobiomorus maculatus						X				X				
Eleotris picta						X				X				
Awaous transandeanus					X					X				
Gillichthys mirabilis						X							X	
Gobionellus sp.					X					X				
Citharichthys gilberti						X				X				
Hypsopsetta guttulata *						X							X	
Achirus mazatlanus *						X				X				
Leptocottus armatus						X							X	
TOTAL	3	1	5	2	3	24	4	3	1	20	4	1	4	1
PERCENT (%)	8	3	13	5	8	63	10	8	3	53	10	3	10	3

ABBREVATION: P = Primary, S = Secondary, V = Vicarious, D = Diadromus, C = Complementary, SP = Sporadic
NA = Neartic, NT = Neotropical, EN = Endemic, PA = Panamian, AA = Amphiamerican,
CT = Circumtropical, CA = Californian, CH = Circumpolar-Holartic, * = New record

Notropis lutrensis (Baird & Girard). Red Shiner.
Local Records: BCN. Lower Rio Colorado and tributaries (Hubbs, 1954:289).

FAMILY ICTALURIDAE

Ictalurus punctatus (Rafinesque). Channel catfish.
Local Records: BCN. Rio Hardy at Mexicali (Follett, 1960:227); tributary channel to Laguna Salada (Compean & Baylon, 1983:219).

Pylodictis olivaris (Rafinesque). Flathead catfish.
Local Records: BCN. Laguna Salada in "La Playita" place (collected by G. Ruiz C., May 6, 1985); tributary channel to Laguna Salada (Compean & Baylon, 1983:219).

FAMILY POECILIIDAE

Gambusia affinis (Baird & Girard). Mosquitofish.
Local Records: BCN. Arroyo San Jose; Rio Tijuana; arryo ca. Santa Rosa at Ensenada; Arroyo San Miguel; Laguna Santa Maria south of San Quintin; and tributaries of Rio Hardy (Follett, 1960:227); Rio Colorado near San Luis Rio Colorado (UANL-2550); Rio Guadalupe ca. La Mision in Ensenada (UANL-not catalogued); Laguna Hanson in Sierra Juarez (UANL-not catalogued); Arroyo El Descanso, 55.8 km NW of Ensenada (UANL-not catalogued);Dam in Rancho Tierra Santa, 30.5 km NE of Ensenada (UANL-not catalogued).

Poecilia reticulata (Peters). Guppy.
Local Records: BCS. Laguna Cortez in San Jose del Cabo (UANL-2528); Presa Juarez at Todos Santos (UANL-2569).

Poecilia latipinna (Le Sueur). Sailfin molly.
Local Records: BCN. Rio Colorado at San Luis Rio Colorado country (UANL-2490).

Xiphophorus maculatus (Gunther). Southern platyfish.
Local Records: BCS. "Ojo de Agua La Rosita" near San Antonio (UANL-2544); Presa Juarez at Todos Santos (UANL-2570).

Xiphophorus variatus (Meek). Variable platyfish.
Local Records: BCN. Rio Colorado at San Luis Rio Colorado country (Contreras & Escalante, 1984:114).

FAMILY CENTRARCHIDAE

Micropterus salmoides (Lacepede). Largemouth bass.
Local Records: BCN. Rio Tijuana near San Quintin; Rio Hardy, tributary to Rio Colorado (Follett, 1960:228); Rio Colorado at San Luis Rio Colorado country (UANL-2552); Laguna Salada in "La Playita" place (collected by G. Ruiz C., May

6,1985); tributary channel to Laguna Salada (Compean & Baylon,1983:219); Emilio Lopez Zamora Dam in Ensenada (G. Ruiz C., obs. pers.).

Lepomis cyanellus (Rafinesque). Green sunfish.
Local Records: BCN. Rio Tijuana; arroyo near Valle Santa Rosa and Arroyo San Miguel, both in Ensenada; tributaries of the Rio Colorado (Follett, 1960:228).

Lepomis gulosus (Cuvier). Warmouth.
Local Records: BCN. Rancho "Tierra Santa", 30.5 km NE of Ensenada (UANL-not catalogued); Arroyo Santo Tomas in Ejido Ajusco (UANL-not catalogued).

Lepomis macrochirus (Rafinesque). Bluegill.
Local Records: BCN. Rio Colorado (Rio Hardy) in Mexicali (Follett, 1960:228);tributary channel to Laguna Salada in Mexicali (Compean & Baylon, 1983:219).

Lepomis megalotis (Rafinesque). Longear sunfish.
Local Records: BCN. Laguna Hanson in the Sierra Juarez National Park (UANL-not catalogued).

Pomoxis annularis (Rafinesque). White crappie.
Local Records: BCN. Rio Colorado and tributaries (Follett, 1960:228); Laguna Salada in "La Playita" place (UANL-not catalogued).

Pomoxis nigromaculatus (Lesueur). Black crappie.
Local Records: BCN. Tributaries of the Rio Colorado (Follett, 1960:228).

FAMILY CICHLIDAE

Tilapia cf. aurea (Steindachner). Blue tilapia.
Local Records: BCN. Lower Rio Colorado (Contreras & Escalante, 1984:122); Laguna Salada in "La Playita" place (UANL-not catalogued).

Tilapia cf.zilli (Gervais). Redbelly tilapia.
Local Records: BCN. Lower Rio Colorado (Contreras & Escalante, 1984:122); tributary channel to Laguna Salada (Compean & Baylon, 1983:219).

DISCUSSION AND CONCLUSIONS

With the species listed in this paper, we have increased the number of fish species known until 1985 to the waters of the Baja California Peninsula from 40 species (29 native and 11 exotic species) which were earlier documented by Follett, (1960), to a total of 59 species (38 native and 21 exotic). The following four native species are new records to the Baja California Peninsula: Harengula thrissina, Atherinops affinis, Hysopsetta guttulata, and Achirus mazaltanus.

Most of the inland native ichthyofauna is ecologically composed of species of marine derivation, representing about 89 % of the total fish fauna. The "sporadic" and "vicarious" ecological groups are evidently the dominant ecological groups. Eleven percent of the total fish fauna belong to species of freshwater origin; most of these are distributed throughout the lower Rio Colorado system (see Follett, 1960:222). These fauna are represented by one sucker (Xyrauchen texanus), two cyprinids (Gila robusta and Ptychocheilus lucius) and only one endemic species represented by the killifish (Fundulus lima Vaillant) from San Ignacio, BCS.

With the exception of the Rio Colorado and Rio Mulege the Baja California Peninsula is characterized by having very few intermittent and shallow streams. Due to their physiographic and bioclimatological relationships, the indigenous fish of the Baja California Peninsula do not constitute a sufficiently discrete assemblage of species as to be designated as the "inland native ichthyofauna of Baja California Peninsula (according to criteria of Follett, 1960:212). Four biogeographic reasons for the absence of such fauna has been proposed by Follett (op. cit.): 1) a hydrologic discontinuity between certain coastal streams of southern California, U.S.A. and Rio Tijuana, Mexico has prevented the dispersal of freshwater species of the Santa Ana basin further south than the Rio San Luis Rey in San Diego County, California; 2) long term aridity has prevented the coastal dispersal of fish by way of estuaries; 3) the abrupt escarpment along much of the eastern shore precludes the formation of lagoons which might have facilitated dispersal; and 4) the Gulf of California is a barrier to entry of freshwater fish from the continent. For these reasons, the known ichthyofauna of the Baja California Peninsula is dominated by groups of marine derivation (e.g. sporadic species- 63%, vicarious species- 13%, and complementary species- 8%)

From a zoogeographical point of view, the inland native fish fauna of Baja California is dominated by species of Panamanian affinity (53%). Of this group, the genera Agonostomus, Pomadsys, Gobiomorus, Dormitator, and Awaous, have reached their northwesterly limit near Cabo San Lucas, BCS (Follett. 1960:214).

With regard to introduced or exotic species reported for the Baja California Peninsula, Follett (1960) earlier documented only eleven exotic species, and subsequently Contreras and Escalante (1984) increased this list to seventeen exotic species. In our new 1985 list we reported a total of twenty-one known exotic fish in the Baja California Peninsula. These new records of exotic species are a result of recent introductions made by several public agencies and private groups for various purposes (e.g. sport fishery, aquaculture, forage species, etc.).

It is important to recognize that this paper does not discuss the historic changes in space and time of the native fish communities of the Baja California Peninsula, or the anthropogenic impact on them. Our major goal is to provide a reference checklist for use in future monitoring of the populations and future ecological studies, which in turn will aid in better management and conservation of the inland native ichthyofauna.

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LITERATURE CITED

Briggs, J. S. 1974. Marine Zoogeography. McGraw Hill Book Company, New York.

Castro-Aguirre, J. L. 1978. Catalog Sistematico de los Peces Marinos que penetran a las Aguas Continentales de Mexico. Direccion General del Instituto Nacional de Pesca, Mexico. Serie Cientifica Num. 19.

Compean-J., G., and O. Baylon-G. 1983. Estudio preliminar de la pesquiria de la Laguna Salada Baja California. Proceed. Desert Fishes Council vols. XIII-XV-B:201-221.

Contreras-B.,S., and M. A. Escalante-C. 1984. Distribution and known impacts of exotic fishes in Mexico, p. 102-130. In: Distribution, biology, and management of exotic fishes, (W. R. Courtenay, J. & J. R. Stauffer, Jr., eds.). The Johns Hopkins University Press.

Dill, W. A. 1944. The fishery of the lower Colorado River. California Fish and Game, 30:109-211.

Evermann, B. W. 1908. Descriptions of a new species of trout (Salmo nelsoni) and a new cyprinodont (Fundulus meeki) with notes on other fishes from Lower California. Proc. Biol. Soc. Washington, 21:19-30.

Follett, W. I. 1960. The freshwater fishes-their origins and affinities. In: Symposium on the biogeography of Baja California and adjacent seas. Syst. Zool., 9(3-4): 212-294.

Hubbs, C. L. 1954. Establisment of a forage fish, the red shiner (Notropis lutrensis), in the lower Colorado River system. California Fish and Game, 40 (3):287-294.

Miller, R. R. 1943. The status of Cyprinodon macularius and Cyprinodon nevadensis, two desert fishes of western North America. Occas. Papers Mus. Zool., Univ. Michigan, No. 473:1-25.

Miller, R. R. 1968. Records of some native freshwater fishes transplanted into various waters of California, Baja California, and Nevada. Calif. Fish and Game, 54 (3): 170-179.

Myers, G. S. 1930. The Killifish of San Ignacio and the stickleback of San Ramon, Lower California. Proc. California Acad. Sci., Ser. 4, Vol 19:95-104.

Myers, G. S. 1951. Fresh water fishes and East Indian zoogeography. Stanford Ichthyol. Bull., 4:11-21.

Needham, P. R., and R. Gard. 1959. Rainbow trout in Mexico and California, with notes on the cutthroat series. Univ. California Publ. Zool., 67:1-124.

Snyder, J. O. 1926. The trout of the Sierra San Pedro Martir, Lower California. Univ. California Publ. Zool., 21:419-426.

REINTRODUCING THE NATIVES: COLORADO SQUAWFISH AND WOUNDFIN

by

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ABSTRACT

Reintroduction efforts for several native southwestern fishes are reviewed, as are the historic and present distributions of Colorado squawfish and woundfin. The new experimental category under the Endangered Species Act is discussed. Under that classification, over 117,000 squawfish have been stocked into the Salt and Verde rivers in Arizona during 1985 from Dexter National Fish Hatchery. Reintroduction of woundfin is slowed due to propagation problems, but will start with wild captured fish in 1986.

ABSTRACTO

La introdución de esfuersos de varias peces nativas del suroeste será repasado igualmente como el aspecto histórico y distribución presente de "squawfish" de Colorado y "woundfin". La nueva categoría experimental del acto de especies en peligro tambien sera discutido. Incluyido en esa clasificación hay sobre 117,000 "squawfish" de Colorado que se han puesto en los rios Salt y Verde en Arizona durante el año 1985, del "Dexter National Fish Hatchery." La reintrodución de "woundfin" se ha despaciado por que hay problems de propagación pero esto comensará con peces capturadas en 1986.

Introduction

Native southwestern fishes have undergone drastic declines in numbers and distributions during the latter part of the Twentieth Century, as cited in numerous scientific papers and articles (see Johnson and Rinne 1982, Ono, et al. 1983 for reviews). The amplitude of this problem has been most recently demonstrated in the listing of endangered fishes compiled by Deacon, et al.(1979), in which 46% of the 203 U.S. and Canadian species were found in the Southwest. It has been estimated that 81% of Arizona's native fishes and 42% of New Mexico's native fishes are now protected under State or Federal "endangered species" legisation (Johnson and Rinne 1982). In order to reverse this decline, the U.S. Fish and Wildlife Service has developed recovery plans for many of the southwestern fish species listed on the Federal Endangered Species Act (Table 1), and has begun their implementation. Several management plans for individual recovery actions have also been written by State, Federal and private agencies. These documents are produced to coordinate the recovery actions of the various agencies charged with the protections and recovery of these fishes.

Table 1. Recovery plans for southwestern fishes.

COMMON NAME	SCIENTIFIC NAME	DATE SIGNED
Apache trout	Salmo apache	8/20/79 & 9/22/83
Gila trout	Salmo gilae	1/12/79 & 1/3/84
Mohave tui chub	Gila bicolor mohavensis	9/12/84
Humpback chub	Gila cypha	8/22/79
Bonytail chub	Gila elegans	5/16/84
Chihuahua chub	Gila nigrescens	draft
Moapa dace	Moapa coriacea	2/14/83
Woundfin	Plagopterus argentissimus	7/ 9/79 & 3/1/85
Colorado squawfish	Ptychocheilus lucius	3/16/78
Cui-ui	Chasmistes cujus	1/23/78
Leon Springs pupfish	Cyprinodon bovinus	8/14/85
Devils Hole pupfish	Cyprinodon diabolis	7/15/80
Comanche Springs pupfish	Cyprinodon elegans	9/ 2/81
Warm Springs pupfish	Cyprinodon nevadensis pectoralis	11/10/76
Owens pupfish	Cyprinodon radiosus	9/17/84
Pahrump killifish	Empetrichthys latos	3/17/80
Big Bend gambusia	Gambusia gaigei	9/19/84
Clear Creek gambusia	Gambusia heterochir	1/14/82
Pecos gambusia	Gambusia nobilis	5/ 9/83
Gila topminnow	Poeciliopsis occidentalis	3/15/84
Unarmored threespine stickleback	Gasterosteus aculeatus williamsoni	12/27/77

Most southwestern fish recovery plans produced to date have several common action items, including protection of existing habitats, protection of genetic stock in refugia like Dexter National Fish Hatchery in New Mexico, reintroduction of the species back into waters from which they have been extirpated, and dissemination of public information. Region 2 (Albuquerque) of the U.S. Fish and Wildlife Service has been especially active in implementing the reintroduction sections of several of these recovery plans (Johnson 1980, 1985). This paper reports on efforts to reintroduce Colorado squawfish (Ptychocheilus lucius) and woundfin (Plagotperus argentissimus) into tributaries of the Gila River in central Arizona. Squawfish have been extirpated from the Gila River basin since 1950 (Miller 1961) and woundfin since prior to the turn of the century (Minckley 1973). Recovery plans for both species recommend reintroductions in the Gila River basin (USFWS 1978,1985). Additional reintroductions of native fishes into southwestern waters have been reported by Kepner and Brooks (1983) for Gila topminnows (Poeciliopsis occidentalis), Johnson (1985) for razorback suckers (Xyrauchen texanus), Rinne, et al. (1981) for Apache trout (Salmo apache), and Hubbs (1963, 1980) for Big Bend gambusia (Gambusia gaigei) and Leon Springs pupfish (Cyprinodon bovinus).

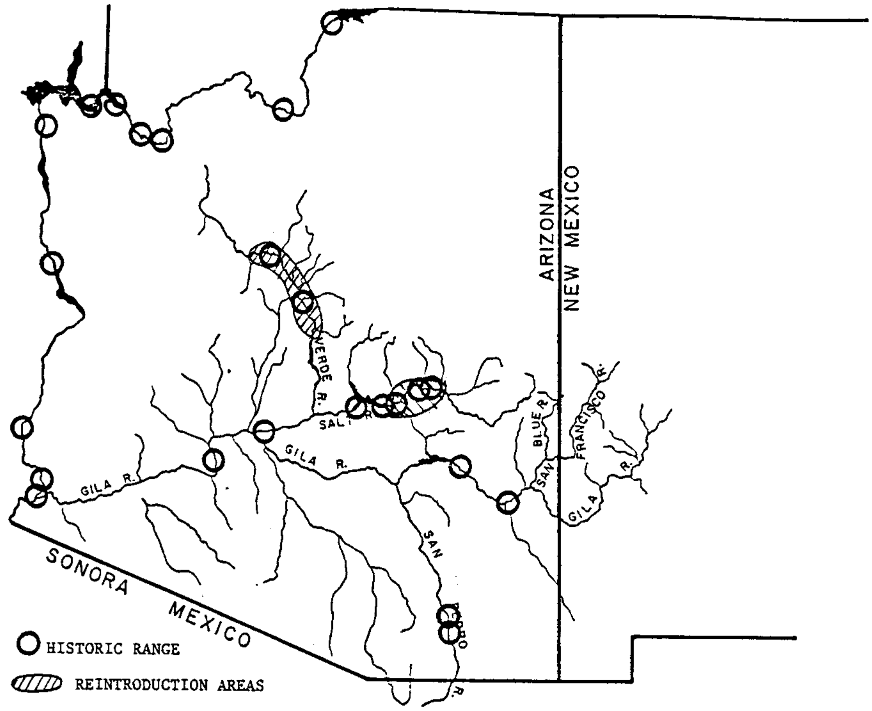

FIGURE 1. Historic range of Colorado squawfish in the lower basin of the Colorado River and areas selected for reintroduction.

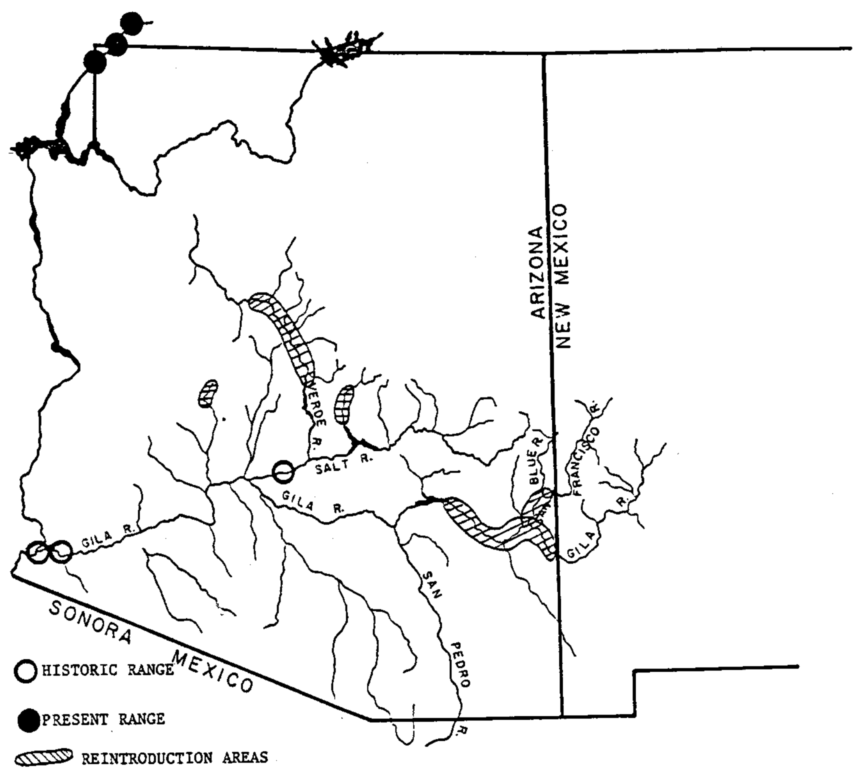

FIGURE 2. Historic and present range of the woundfin and areas selected for reintroduction.

Discussion

Decline of the Colorado squawfish in the lower basin of the Colorado River has been well documented by Minckley (1973). Once widespread in in the lower Colorado River basin (Fig. 1), little habitat remains for this species because of physical changes in habitats both above and below mainstream impoundments. No spawning has been reported from reservoirs or the cold, hypolimnetic waters below dams. Exotic fish species may also affect squawfish survival (USFWS 1978). Squawfish were last reported in the lower basin of the Colorado River in the early 1970's, at the base of Glen Canyon Dam. The last squawfish collected from the Gila River in Arizona was by R.R. Miller and party in 1950 (Miller 1961). In spite of repeated collecting efforts throughout the period 1965-1985, in what appears to be suitable habitat in the Salt, Verde and Gila rifers, no squawfish have been found. Colorado squawfish still maintain spawing populations in the upper Colorado and lower Green rivers of Colorado and Utah. The reasons for the exterpation of Colorado squawfish from the mainstream Gila, Salt and Verde rivers above the uppermost dams is not known, although recent studies in the upper Colorado River basin (Tyus, et al. 1981) indicate long distance spawning movements may be more important than was earlier believed.

Woundfin were once found throughout the lower reaches of the Gila River, the mainstream Colorado River at Yuma and likely upstream to the Virgin River, and the Virgin River and its tributaries upstream to LaVerkin Spring (Fig. 2)(Minckley 1973). Since the turn of the century the species has been restricted to the Virgin River and a single tributary, LaVerkin Creek (USFWS 1985). Even though the historic range of the woundfin in the Gila River basin included only the mainstream Gila River and the Salt River below Tempe, the species was probably also found in the upper Gila and Salt rivers and their tributaries, the Agua Fria and Hassayampa rivers and perhaps even the San Pedro and Santa Cruz rivers. While woundfin were never taken from these reaches, this can partially be explained by a lack of early collections. No known barriers, including elevation, prevented the fish from reaching or occupying these localities. It is believed that habitat in these streams was suitable for woundfin and that at least periodically, the species was found there. These habitats are included in the probable historic range of the woundfin.

Reintroduction efforts for Colorado squawfish and woundfin were proposed in Arizona during 1976-1979 by the U.S. Fish and Wildlife Service. No fish of either species was introduced during that period because of the apprehension of several public and private agencies. These agencies believed that once the fish were re-established, the Endangered Species Act (Act) would prevent ongoing and planned actions within the streams as well as the surrounding watersheds (Johnson 1980, 1985; Johnson and Rinne 1982). At its meeting in Las Cruces, NM in 1978, the Desert Fishes Council passed a resolution recommending the addition of a new listing catagory to the Act, called experimental, that would eliminate many of the staunch protective regulations for reintroduced populations and thus reduce opposition to those reintroductions. That resolution was supported by many agencies, and was eventually acted upon by Congress during the 1982 reauthorization of the Act, resulting in the new experimental category. Final regulations for the experimental category were published in the Federal Register on August 27, 1984.

Under the 1982 ammendment, two subcategories, essential and non-essential, were created for the experimental listings. These provided approximately threatened and candidate degrees of protection, respectively, for the reintroduced populations, and are determined by the importance of the reintroduced populations to the survival of the species. Other pertinent criteria for the new experimental listings include: reintroductions are to be within the probable historic range of the species, no critical habitat can be declared for nonessential populations, the public must be allowed to comment on the action before retintroductions take place, and the experimental populations must be geographically isolated from threatened or endangered populations of the same species.

During the period when Washington was developing the regulations for the experimental populations, Arizona Department of Game and Fish personnel were locating streams suitable for squawfish and woundfin reintroductions. Their surveys determined two streams, the Salt River above Lake Roosevelt and the Verde River above Horseshoe Reservoir, still retained enough of their natural characteristics to be considered suitable habitat for squawfish (Fig. 1). Five potentially suitable woundfin streams were also located: the Verde River above Horseshoe Reservoir, the Gila River above San Carlos Reservoir, the San Francisco River above its confluence with the Gila River, Tonto Creek above Lake Roosevelt, and the Hassayampa River above Red Cliff (Fig. 2).

During this same time period, the Fish and Wildlife Service initiated the extensive documentation for listing Colorado squawfish and woundfin under the experimental nonessential category, and began producing fish at Dexter NFH for the reintroductions. The proposal to reintroduce squawfish and woundfin into Arizona was published on April 10, 1984 and the final regulation on July 27, 1985; the listings took affect 30 days later.

Thirty three days after the final publication, on August 26, 1985, 296 Colorado squawfish were transported from Dexter NFH and stocked into the Verde River near Perkinsville, Arizona. The fish were over 4 years old and ranged from 12-16 inches, total length. Two days later (August 28, 1985), 113 I+ squawfish and 30,000 fry were stocked into the Salt River above Lake Roosevelt. By the end of September, 1985, over 117,000 squawfish had been reintroduced into Arizona waters. After nearly 35 years, Colorado squawfish again swim in the Gila River basin, and after many years of paperwork and effort they are doing so under the new experimental nonessential classification. Stocking of squawfish will continue in the Salt and Vedre rivers for up to the next 10 years in an attempt to reestablish a self sustaining population; monitoring will be conducted jointly by the Service and Arizona Department of Game and Fish.

Woundfin propagation has not been very successful at Dexter NFH when compared to the other species being reared there. While spawning has taken place and several thousand fish produced, these numbers are insufficient to restock the selected habitats. Efforts will continue at Dexter to produce sufficient numbers of woundfin for restocking, but next spring wild fish will be moved from the Virgin River into at least three of the selected streams. Stocking of the Gila and San Francisco rivers will be delayed at the request of New Mexico Department of Game and Fish until the impact on two other native minnows, the spikedace (Meda fulgida) and loach minnow (Tiaroga cobitis) can be more fully evaluated. Although woundfin were collected together with Meda and Tiaroga in the Salt River at Tempe (Minckley and Deacon 1968; Minckley 1973), these two latter species are suffering the same declines experienced by other southwestern fish, and have recently been proposed as threatened species under the Act. Stocking of woundfin in the Verde River below a population of Meda will occur as scheduled.

Summary

As an informational sidelight to the reintroduction efforts in the lower basin, 3,151,708 young razorback suckers were stocked in the Salt, Verde and Gila rivers in 1985. This brings the total number of razorback suckers stocked in the first five years of this effort to more than 9,400,000. The majority of the suckers stocked have been fry, but each year 100,000 or more fingerling fish (4-8 inches) are also stocked. Two recaptures from this effort were made in 1985; the first by a fisherman in the upper Verde River who caught a razorback sucker on hook and line and returned it to the water, and the second by Fish and Wildlife Service employee Bill Kepner, who captured a specimen in a gravel pit in the Salt River below Phoenix. A concerted effort by Service and State employees during spring, 1985, failed to locate any razorback suckers in the Salt, Verde or Gila rivers. Stocking of razorback suckers will continue through 1990 before success is determined, and depending upon that outcome, the species will be reevaluated for listing under the Act. The razorback sucker reintroduction effort initiated interest in additional stockings of native fish. To date the following species have been reintroduced into the wild from stocks at Dexter NFH: Colorado squawfish, razorback sucker, Gila topminnow, bonytail chub (Gila elegans), Yaqui chub (Gila purpurea), Big Bend gambusia and desert pupfish (Cyprinodon macularius).

Additional reintroductions of other species are planned, but it must be remembered that these efforts are only one phase of recovery. Long-term survival of southwestern native fishes depends primarily upon the protection of existing habitats; reintroduction programs add to the recovery effort but cannot assure its success.

LITERATURE CITED

Hubbs, C. 1963. Current abundance of Gambusia gaigei, an endangered fish species. Southwest. Nat. 8(1): 46-48.

________. 1980. The solution to the Cyprinodon bovinus problem: Eradication of a pupfish genome. Proc. Desert Fishes Council 10:9-18.

Deacon, J.E., G. Kobetich, J.D. Williams and S. Contreras. 1979. Fishes of North America endangered, threatened or of special concern. Fisheries 4(2):29-44.

Johnson, J.E. 1980. Reintroduction of endangered fish species into historic habitats. Asbtract. Proc. Desert Fishes Council 11:92.

____________. 1985. Reintroducing the natives: razorback sucker. Proc. Desert Fishes Council 13:73-79.

__________ and J.N. Rinne. 1982. The Endangered Species Act and Southwest fishes. Fisheries 7(3):2-8.

Kepner, W.G. and J.E. Brooks. 1985. Introduction of Gila topminnow and desert pupfish on public lands in Arizona. Abstract. Proc. Desert Fishes Council 13:294.

Miller, R.R. 1961. Man and the changing fish fauna of the American Southwest. Pap. Michigan Acad. of Sci., Arts, Lett. 46:365-404.

Minckley, W.L. 1973. Fishes of Arizona. Arizona Dept. Game and Fish, Phoenix. 293 pp.

Ono, R.D., J.D. Williams and A. Wagner. 1983. Vanishing Fishes of North America. Stone Wall Press, Washington. 257 pp.

Rinne, J.N., W.L. Minckley and J.N. Hanson. 1981. Chemical treatment of Ord Creek, Apache County, Arizona, to re-establish Arizona trout. J. Arizona-Nevada Acad. Sci. 16:74-78.

Tyus, H.M., E.J. Wick and D.L. Skates. 1985. A spawning migration of Colorado squawfish (Ptychocheilus lucius) in the Yampa and Green rivers, Colorado and Utah, 1981. Proc. Desert Fishes Council 13:102-108.

USFWS. 1978. Colorado Squawfish Recovery Plan. U.S. Fish and Wildl. Serv., Denver, Colorado. 65 pp.

USFWS. 1985. Woundfin Recovery Plan. U.S. Fish and Wildl. Serv., Albuquerque, New Mexico. 74 pp.

LIFE HISTORY PATTERNS OF *GAMBUSIA MARSHI* FROM CUATRO CIENEGAS, MEXICO

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The life history and ecology of *Gambusia marshi*, a poeciliid fish endemic to the Cuatro Ciénegas basin and Río Salado drainage of Coahuila, Mexico, is virtually unknown. Fishes collected in different seasons from natural lakes, rivers and an artificial canal were analyzed for reproductive patterns, food choice and parasitism. *G. marshi* reproduce seasonally, with fecundity increasing as a function of female size. Reproduction is not strongly habitat dependent, although reduced reproductive activity was noted in the canal. Superfetation is infrequent. Major food items of *G. marshi* are detritus and insects, with other invertebrates, plant material and juvenile fish also represented. Somatic condition was little affected by habitat or season and most individuals were robust. Parasites included two nematodes, a trematode and an acanthocephalan. *G. marshi* is a habitat and food generalist, which perhaps accounts for its local abundance and success within its limited range.

RESULTADOS PRELIMINARES DEL ESTUDIO ICTIOFAUNISTICO DE LA CUENCA LERMA-CHAPALA, MEXICO.

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La ictiofauna de las aguas continentales de México se compone de aproximadamente 460 especies. Es indudable que esta diversidad resulta del hecho de que en México se delimitan dos regiones zoogeográficas, la Neartica y la Neotropical, cada una con su propio modelo distribucional. La primera comprende una zona denominada Subregión del Lerma o Mexicana con características ictiofaunísticas muy peculiares, que la definen como una comunidad compuesta casi exclusivamente por peces mexicanos.

En el sistema Lerma-Chapala-Santiago habitan 49 especies nativas de peces, (55 si incluímos a las introducidas), lo que representa aproximadamente el 10.6% de la ictiofauna nacional; lo caracteriza también el hecho de que esta fauna está representada por pocos grupos pero con gran diversidad a nivel específico. Algunos de ellos son no sólo endémicos de México, sino que solo viven en esta subregión, como es el caso de la familia Goodeidae, y del género *Chirostoma*. Así, de las 49 especies nativas, 44 tienen como localidad típica diversas porciones de la cuenca del Río Lerma y Laguna de Chapala y 41 sólo habitan en ella.

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Aunque esta fauna se empezó a estudiar, desde el punto de - vista taxonómico a fines del siglo pasado y en el transcurso del tiempo han aparecido numerosos estudios, todos ellos son fragmentarios y ninguno contempla un análisis integral desde el punto - de vista sistemático y mucho menos ecológico o zoogeográfico. - La excepción es el trabajo de Romero (1967), aunque sólo comprende la revisión taxonómica de las especies del Alto Lerma.

Se sabe que la alteración ecológica provocada por la urbanización, contaminación, sobreexplotación del agua, construcción - de presas, introducción de especies exóticas, entre otras causas, determinan en el mejor de los casos la migración o desaparición local de las poblaciones de peces y en caso extremo la desaparición total de una especie, estos efectos se ven aumentados cuando las poblaciones tienen una distribución geográfica restringida, como en el caso del sistema Lerma-Chapala. Por ejemplo, Contreras, et.al. (1976) hacen notar que algunas comunidades ícticas en los estados fronterizos del norte se han reducido de tal manera que aproximadamente 36 especies se consideran como amenazadas o en peligro de extinción. En 1979, Deacon, et.al. incluyen, entre las especies cuya distribución comprende ocho estados del extremo norte de nuestro país, a 31 taxa en la categoría en peligro, 10 como amenazados y 13 de interés especial. Se ha considerado también que una especie de pescado blanco (Chirostoma - compressum) está muy probablemente extinto y que tal vez desapareció a causa de la prolongada sequía del Lago Cuitzeo en el invierno de 1941 (Barbour, 1973). En un trabajo posterior sobre - la fauna íctica del mismo lago, se hace notar la desaparición local de cinco especies y la aparición de otras tantas no registradas para el sitio (Aguirre, 1975).

Resulta indispensable entonces, el estudio integral de nuestra ictiofauna, contemplando no sólo como la actualización de un censo taxonómico y distribucional, sino analizando las causas y efectos de los cambios, conociendo las costumbres y requerimientos ecológicos de los peces nativos y proporcionando en fin, datos básicos que serán útiles para un mejor manejo de estos recursos. Es este el objetivo del presente estudio.

LOCALIZACION GEOGRAFICA Y METODOLOGICA.

La Cuenca Lerma-Chapala se origina aproximadamente a los 3,000 m.s.n.m. en los Manantiales de Almoloya del Río en el Estado de México e incluyendo la Laguna de Chapala tiene una extensión de 40,550 Km^2 (Tamayo,op.cit). Inicialmente tiene orientación hacia el NW, para terminar en dirección E-W. Dicha cuenca está dividida en 5 subcuencas: Bajo Lerma, Turbio-Silao-Guanajuato, Medio Lerma, Río Laja-Laguna Seca y Alto Lerma. (Sría. Rec. Hidráulicos, 1960); comprende cinco entidades estatales: México, Querétaro, Guanajuato, Michocán y Jalisco.(Fig.1)

Las consideraciones, resultados y conclusiones preliminares que hoy presentamos corresponden exclusivamente a la Subcuenca Alto Lerma.

Esta subcuenca queda comprendida entre los paralelos 19°00' y 20° 30' , y los meridianos 19°00' y 100°30'; tiene una superficie aproximada de 8,152 Km^2, que representa casi el 20% del total de la cuenca Lerma-Chapala.

La altitud va desde más o menos 3,000 y desciende, hasta los 1,990m. Sus lím on los manantiales de Almoloya del Río, México hasta la Presa Solís. Gto. La primera localidad es la de mayor altitud, si bien no es la que aporta el mayor volúmen de agua a la subcuenca.

A la fecha se han llevado a cabo colectas en 35 puntos de muestreo, poniendo énfasis en las localidades típicas. (Fig.2) En cada una de ellas se realizaron determinaciones ecológicas como: tipo de sustrato, vegetación, temperatura, oxígeno disuel to, pH y se tomaron muestras de agua para la determinación en el laboratorio de diversos nutrientes como nitratos, sulfatos, fosfatos, carbonatos, etc. Asimismo, se realizaron colectas de peces que han sido analizadas taxonómicamente, en principio con -- los procedimientos matemáticos convencionales; además con el mismo material se llevarán a cabo observaciones biológicas generales (alimentación, reproducción, etc).

Paralelamente se ha efectuado la recopilación bibliográfica y la revisión del material íctico depositado en la Colección del Laboratorio de Cordados de la Escuela Nacional de Ciencias Biológicas; los datos obtenidos en estas revisiones han sido comparados con los procedentes de este estudio a fin de establecer los cambios en la composición y distribución de las comunidades de - peces, así como sus probables causas.

RESULTADOS Y DISCUSION.

La figura 3 indica que las especies nativas son 49, pertenecientes a 7 familias distintas. Los Goodeidae representan el -- 32.6%, Atherinidae el 38.7 y Cyprinidae con 16.32; las restantes 4 familias comprenden de 2 a 4%. Si comparamos esto, con lo que se menciona para la subcuenca Alto Lerma, notamos tan sólo la -- presencia de 4 familias y 15 especies que da un total del 30.6% para toda la cuenca, porcentaje que puede considerarse alto si - tomamos en cuenta que el Alto Lerma tan sólo representa el 20% - de la superficie total. Las familias Cyprinidae, Goodeidae y -- Atherinidae siguen siendo las más representativas.

En la figura 4, se establece de manera comparativa, las especies registradas para la subcuenca Alto Lerma, de acuerdo con la recopilación bibliográfica, revisión de colección y las colectas en mayo-junio 1985, en las 35 localidades fijadas. De esas 15 especies, sólo se capturaron diez.

En esta misma figura aparece Poecilia reticulata, que es de reciente introducción a la subcuenca. Además de las 15 especies registradas para esta subcuenca, tres no pertenecen a la ictio-- fauna autóctona, la antes citada, Carassius auratus y Cyprinus - carpio.

Como se observa muchas de las localidades mencionadas por - la bibliografía y colección han sido excluídas (desaparecidas), principalmente por el crecimiento de las ciudades; por citar tan sólo un ejemplo, diremos que las localidades 1, 2, 3 han desaparecido para formar parte de la ciudad de Toluca, así mismo en -- las localidades 4, 19, 26, 30, también sitios periféricos de varias ciudades, se presentó un aumento en la mancha urbana. Muchas otras localidades, por donde pasa el Río Lerma o algunos afluentes, denotan una alteración del equilibrio ecológico, por - ejemplo la concetración de oxígeno que va de 0.1 p.p.m.- 2 p.p.m

ANALISIS DE LA DISTRIBUCION DE LAS ESPECIES COLECTADAS EN MAYO-JUNIO 1985.

Al realizar el análisis integral de los sitios de colecta - se observaron cambios en la distribución de algunas especies - - (Figs. 5 y 6), por ejemplo:

Lermichthys multiradiatus.- Que presentaba una distribución en toda la subcuenca, ahora se encuentra en la parte más alta, - desde su nacimiento hasta las localidades 17 y 24 entre los 2520 hasta los 2690 m.s.n.m.

Chirostoma riojai.- Sigue presentándose en las partes altas de la subcuenca por encima de los 2550 m.s.n.m.

Chirostoma jordani.- La bibliografía menciona que ha sido - capturado sólo en los extremos de la subcuenca, desde los 2000 a los 2700 m.s.n.m.; nosotros lo localizamos sólo en la parte alta (2700m) de la porción media.

<u>Notropis</u> <u>sallei</u>.- Anteriormente tenía una distribución amplia, ahora lo encontramos restringido a las partes altas de la subcuenca, desde los 2552m hasta los 2700 m.s.n.m.

<u>Chirostoma</u> <u>humboldtianum</u>.- Ha ampliado su distribución, hacia el extremo sur de la subcuenca pero ocupando las porciones altas hasta los 2552 m.s.n.m.

<u>Goodea</u> <u>atripinnis</u> y <u>Xenotoca</u> <u>variata</u>.- Estos goodeidos siguen manteniendo su distribución en la porción más baja de la subcuenca por debajo de los 2345m.

<u>Poecilia</u> <u>reticulata</u>.- Lo encontramos en canales próximos a la Presa Solís, pero no había sido registrado para la cuenca Lerma-Chapala, muy probablemente fué introducido recientemente, pues se trata de peces de uso muy común por los acuaristas.

Si observamos el cuadro de la figura 7, se nota que en términos generales, las especies que requieren una mayor demanda en oxígeno (6.0-10.3 p.p.m), son aquellas que se sitúan en la parte alta de la subcuenca (fig.5), tales son los casos de: <u>Lermichthys</u> <u>multiradiatus</u>, <u>Chirostoma</u> <u>riojai</u>, <u>Notropis</u> <u>sallei</u> y <u>Chirostoma</u> <u>jordani</u>, los cuales se ubican por arriba de los 2550m; a pesar de ésto la temperatura no parece ser un factor determinante ya que se les encontró desde los 19 hasta los 26°C, valor mínimo y máximo determinado para la subcuenca en mayo-junio de 1985. El análisis de los restantes valores no muestra alguna información sólida para otras inferencias, excepto la turbiedad y por ende los sólidos suspendidos, pues el primero registra un valor máximo de 135 UFT y el segundo de 140 p.p.m. respectivamente. Parece ser que la presencia de éstas cuatro especies en algunas localidades muestra que estos sitios no presentan perturbación, recordemos que los Atherinidos son un grupo caracterizado por ser muy selectivos en cuanto a sitios de desove además, en su --

trabajo de los peces del Alto Lerma, Romero (1967) considera a *Lermichthys multiradiatus* como una especie indicadora de todo el Alto Lerma, su restricción en la distribución actual pudiera indicar también una alteración ecológica, aunque cabe señalar que existe la posibilidad que muchos sitios de muestreo resientan la temporada de sequía.

En las otras especies: *Goodea atripinnis*, *Xenotoca variata* y *Poecilia reticulata* el oxígeno no parece ser el factor limitante (4.2-7.5 p.p.m), quizás el factor que determina su distribución, sea el de la temperatura de 22°C a 26°C. *G. atripinnis* y *X. variata* han mantenido su distribución en la parte baja de la subcuenca, parecen ser especies menos restrictivas en cuanto a la calidad del agua, ya que a diferencia de las especies anteriores habitan aguas donde la turbiedad y sólidos suspendidos registraron los valores más altos 600 UFT y 140 p.p.m. respectivamente.

Chirostoma humboldtianum, queda en forma intermedia entre los dos grupos, si bien al observar la figura 7 se nota que existe un área carente de sitios de muestreo entre los 2350 y 2550m. s.n.m., estos 200m pueden ser importantes e indican la necesidad de colectar en dicha área, ya que precisamente es esta la que delimita a los dos grupos de especies y quizá también explicara el porqué *C. humboldtianum* se halla entre esos dos grupos.

BIBLIOGRAFIA.

AGUIRRE, J.M. 1975. Contribución al conocimiento de la fauna íctica del Lago de Cuitzeo, Michoacán. Tesis Profesional Bió logo, I.P.N., México: 119 pp.

ALVAREZ, J. 1970. Peces Mexicanos (claves). Serie Invest.Pesq. N°1. INIBP, México: 166pp.

ALVAREZ, J. y M.T.CORTES. 1962. Ictiología Michoacana I. Claves y - Catálogo de las especies conocidas. An. Esc.Nac.Cienc Biol. Méx. XI (1-4):79-142.

BARBOUR, C.D. 1973. The systematics and evolution of the genus - - Chirostoma, Swainson (Pisces,Atherinidae). Tulane - - Stud. Zool. Bot. 18(3):97-141.

CONTRERAS, S., V.LANDA., T.VILLEGAS y G.RODRIGUEZ. 1976. Peces, Pi scicultura, Presas, Polución, Planificación Pesquera y Monitoreo en México. Mems. Simp.Pesq.Aguas Cont. - México. I:315-346.

DEACON, J.E., G.KOBETICH, J.D.WILLIAMS, S.CONTRERAS. 1979. Fishes of North America endangered, threatened, on of spe-- cial concern: 1979. Fisheries 4(2):29-44.

ROMERO, H. 1967. Catálogo Sistemático de los peces del Alto Lerma con descripción de una nueva especie. An.Esc. Nac. - Cienc.Biól. Méx. 14:47-80.

TAMAYO, J.L. 1946. Datos para la Hidrología de la República Mexica na, Inst.Panam.Geog. Hist.84:448pp.

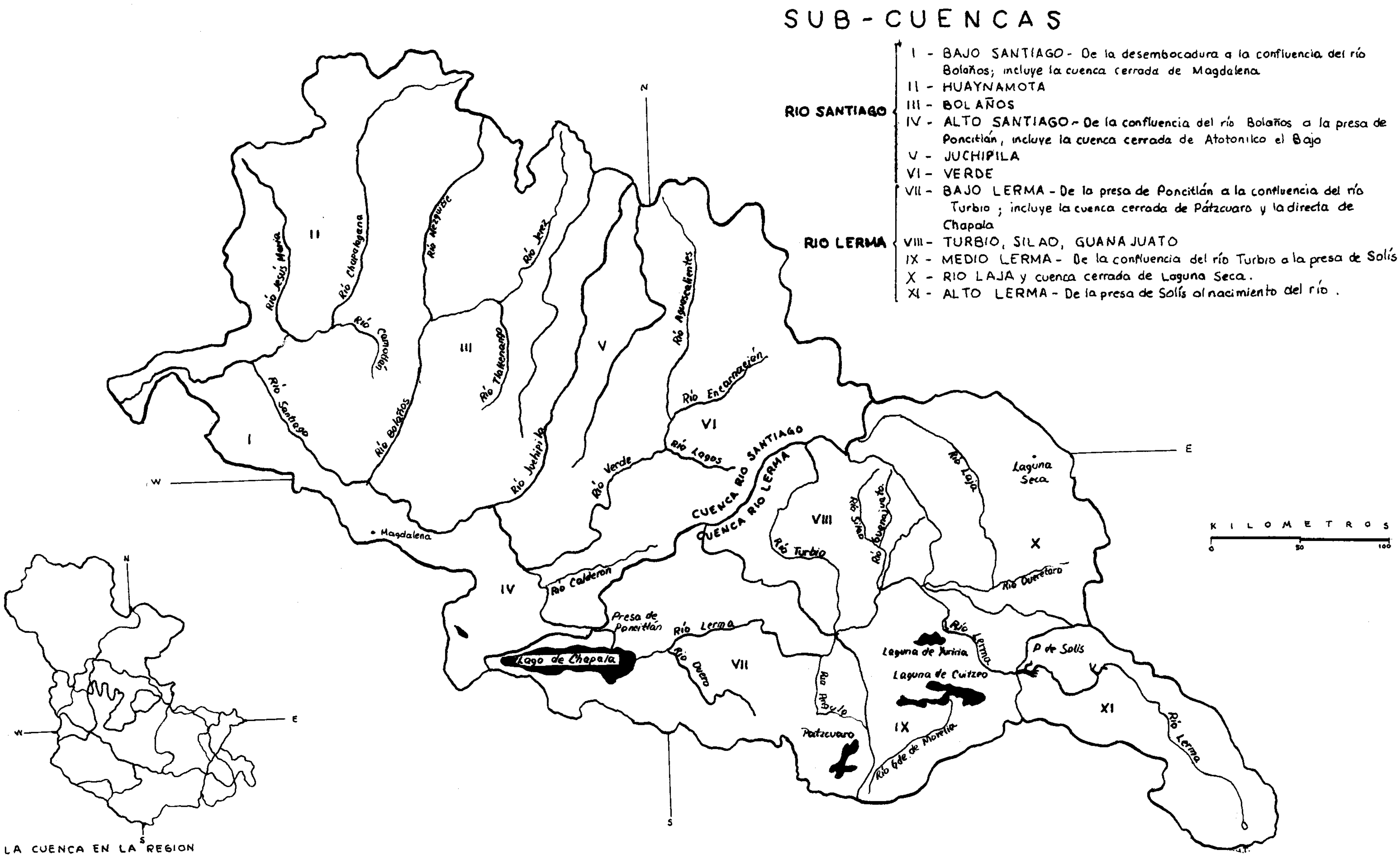

Fig. I .- SUBCUENCAS DEL SISTEMA LERMA-CHAPALA, MEXICO

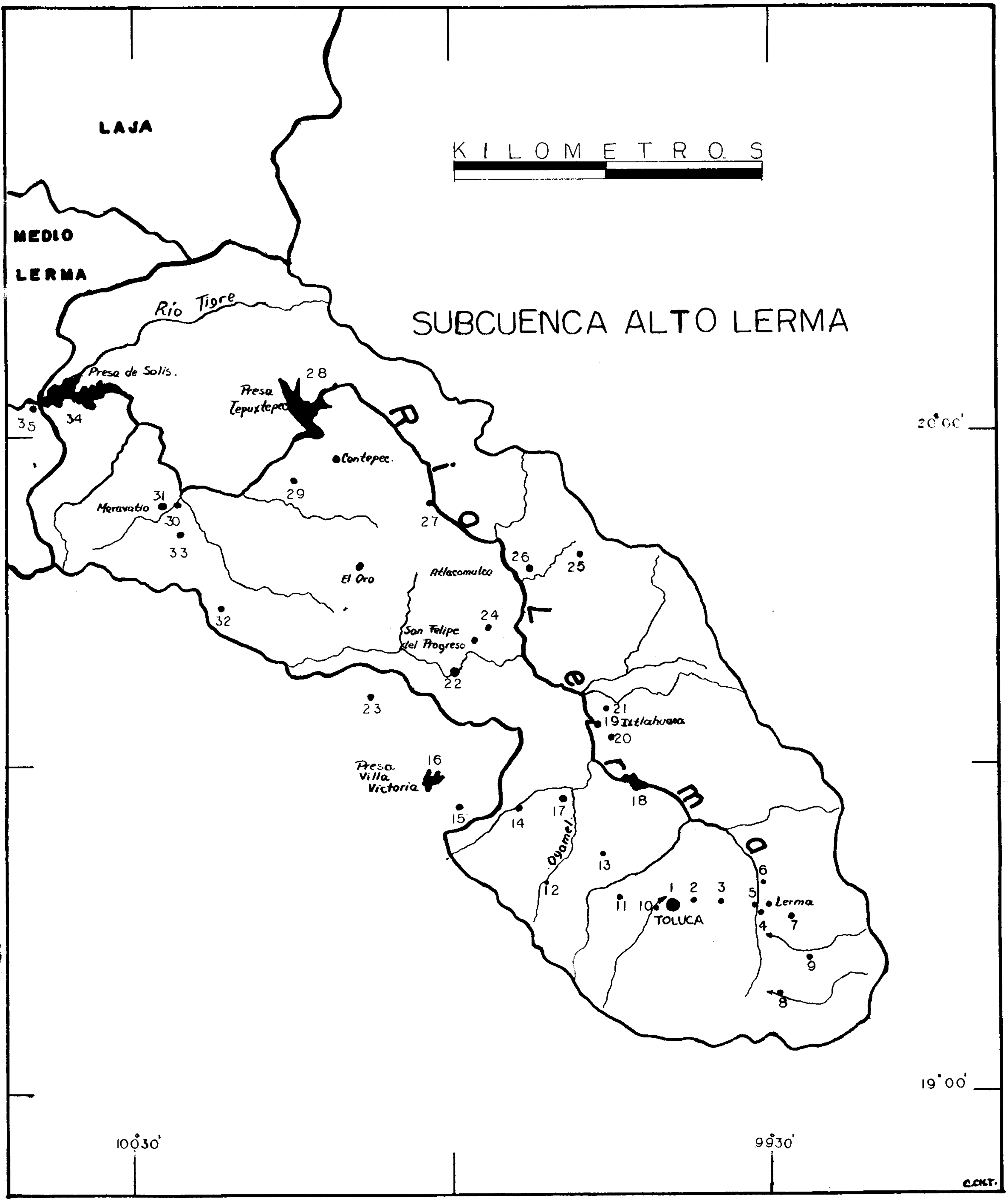

FIG. 2.- SUBCUENCA ALTO LERMA, LOCALIDADES ESTUDIADAS.

	CUENCA LERMA - CHAPALA		SUBCUENCA ALTO - LERMA	
	N°. ESPECIES	%	N°. ESPECIES	%
PETROMYZONTIDAE	2	4.08		
CATOSTOMIDAE	1	2.04		
CYPRINIDAE	8	16.32	7	14.28
ICTALURIDAE	2	4.08		
GOODEIDAE	16	32.65	4	8.16
POECILIIDAE	1	2.04	1	2.04
ATHERINIDAE	19	38.77	3	6.12
	49	99.9	15	30.6

FIG. 3.- Número de especies nativas en la Cuenca Lerma-Chapala, en comparación con las presentes en la Subcuenca Alto Lerma. (Alvarez y Cortés, 1962; Romero, 1967; Alvarez, 1970; Barbour, 1973; Aguirre, 1975).

FIG. 4.- Especies registradas para la Subcuenca Alto Lerma, en comparación con las encontradas en mayo-junio 1985.

E S P E C I E S	RECOPILACION BIBLIOGRAFICA	COLECCION E.N.C.B.	COLECTA MAYO-JUNIO-1985
Algansea tincella	+	+	
Algansea barbata	+	+	
Carassius auratus*	+	+	+
Cyprinus carpio*	+	+	+
Notropis calientis	+	+	
Notropis sallei	+	+	+
Yuriria alta		+	
Allophorus robustus		+	
Goodea atripinnis	+	+	+
Lermichthys multiradiatus	+	+	+
Xenotoca variata	+	+	+
Poecilia reticulata*			+
Poeciliopsis infans		+	
Chirostoma humboldtanum	+	+	+
Chirostoma jordani		+	+
Chirostoma riojai	+	+	+
TAL:	11	15	10

* Exótica = Introducida.

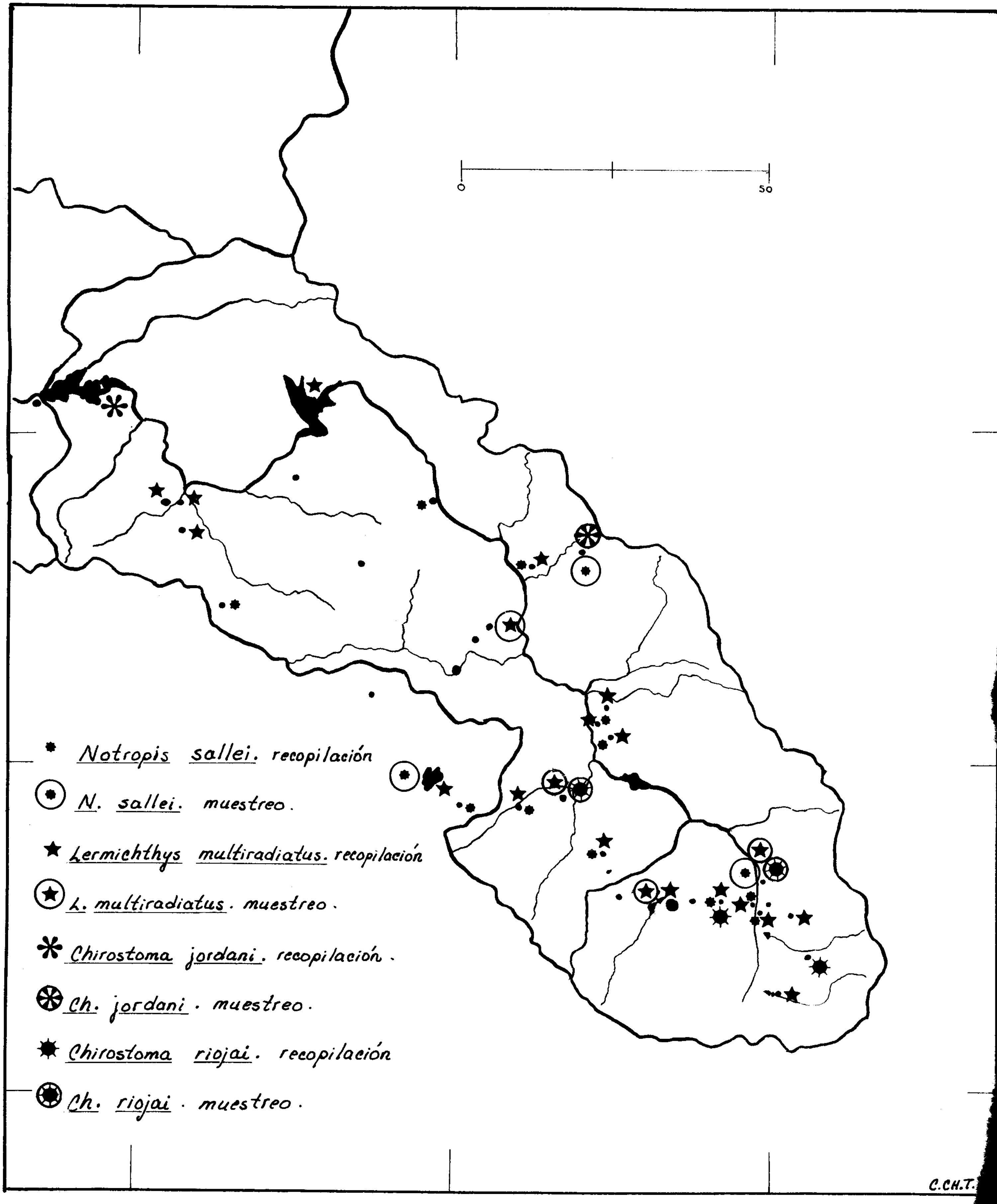

FIG. 5. - DISTRIBUCION GEOGRAFICA DE CUATRO ESPECIES DE PECES EN EL ALTO LERMA.

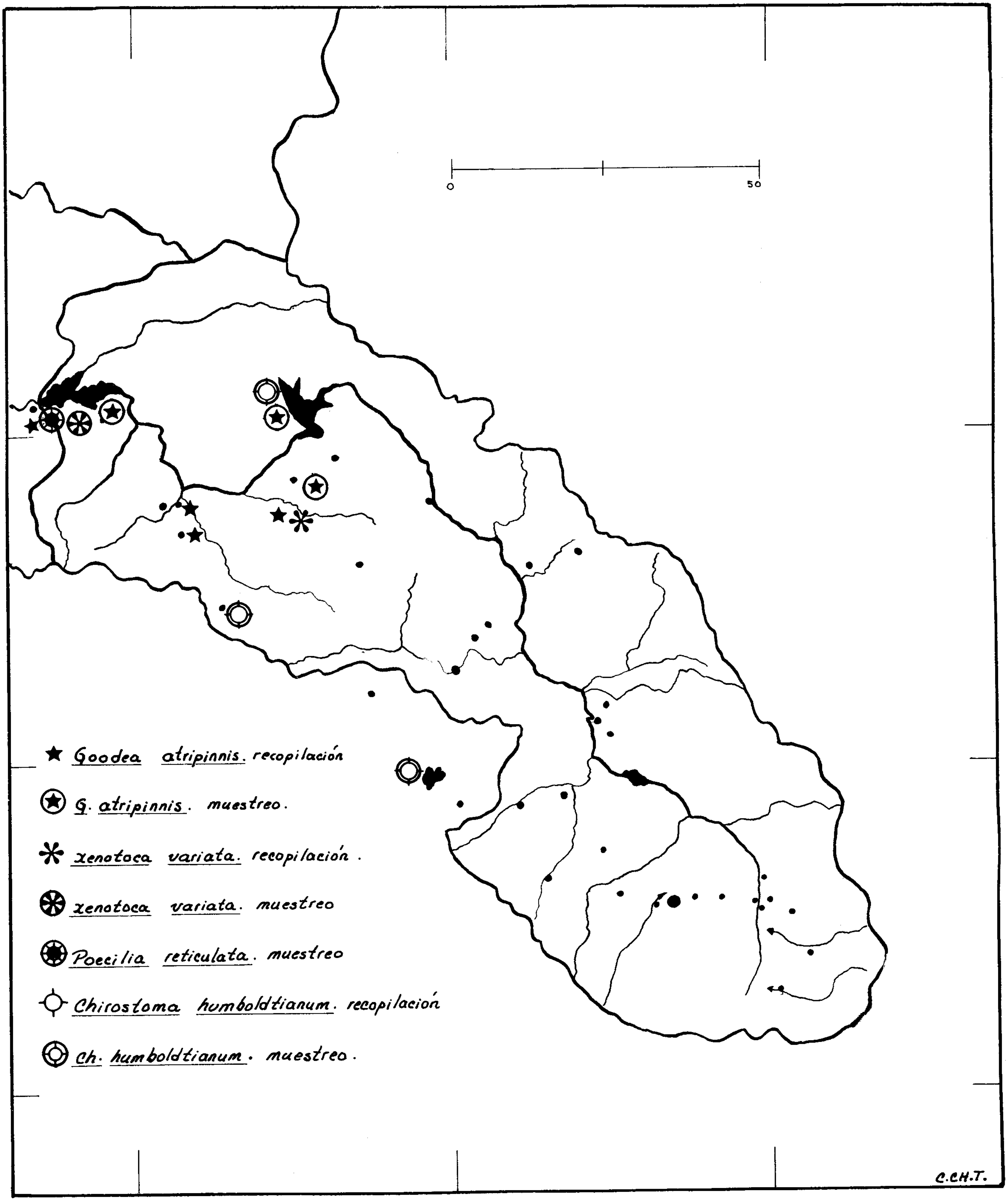

FIG. 6.- DISTRIBUCION GEOGRAFICA DE CUATRO ESPECIES DE PECES EN EL ALTO LERMA.

ESPECIE	Altitud m.s.n.m	Temperatura °C	Turbiedad UFT	Sólidos Suspendidos p.p.m.	Vegetación	Tipo de Sustrato	O_2 p.p.m.	pH	Dureza p.p.m.	Sulfatos p.p.m.	Nitratos p.p.m	Fosfatos p.p.m.
Carassius auratus	2520 a 2700	19-26	10-80	0.0-140	Emergente y poca sumergida.	Lodo Compacto, suave, arcilloso.	6.2-10.3	7.4-8.5	30-70	14-58	0.0-1.76	0.33-1.65
Cyprinus carpio	2170 a 2345	22-25	600	0.0-360	Ausente	Lodo compacto. suave.	7.2- 7.5	8.2	50	24-26	0.0-1.0	1.1 -
Notropis sallei	2552 a 2700	19-26	10-80	15-140	Ausente, Emergente Sumergida	Lodo suave.	6.7-10.3	7.4-7.8	30-70	14-32	0.0-1.76	0.33-2.7
Goodea atripinnis	1990 a 2345	22-25	50-600	0.0-360	Ausente, Emergente Abundante	Lodo suave y compacto.	4.2- 7.5	7.7-8.2	40-50	7.0-26	0.0-1.0	0.48-1.1
Lermichthys multiradiatus	2520 a 2690	19-26	35-135	0.0-140	Ausente Emergente	Lodo suave y compacto.	6.2-10.3	7.4-8.5	60-90	13-58	0.0-2.6	1.15-2.7
Xenotoca variata	1990	26	3	ND	Sumergida	Lodo suave.	4.2	7.1	75	8.0	2.0	3.0
Poecilia reticulata	1990	26	3	ND	Sumergida	Lodo suave.	4.2	7.1	75	8.0	2.0	3.0
Chirostoma humboldtianum	2170 a 2552	19-25	10-600	0.0-360	Ausente, Sumergida	Lodo arcilloso. Rocoso.	6.7- 7.5	7.5-8.2	30-50	14-26	0.0-1.0	1.1 -1.58
Chirostoma jordani	2700	20	50	130	Ausente	Lodo suave.	6.8	7.8	40	14	0.0	0.33
Chirostoma riojai	2552 a 2570	19-26	80-135	25-140	Ausente, Emergente	Lodo suave y compacto.	6.6-10.3	7.4-7.8	70-90	13-32	0.0-1.76	2.3 -2.7

FIGURA 7.- LIMITES MINIMO Y MAXIMO DE ALGUNAS VARIABLES FISICO-QUIMICAS EN QUE SE ENCONTRARON LAS DIFERENTES ESPECIES QUE COMPONEN LA ICTIOFAUNA DEL ALTO LERMA. SE PROPORCIONAN TAMBIEN DATOS DE SUSTRATO Y TIPO DE VEGETACION.

Histological changes in organ tissues of Lahontan cutthroat trout (*Salmo clarki henshawi*) living in lakes of different salinity - alkalinity

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ABSTRACT

Lahontan cutthroat trout from nine lakes in which salinity ranged from 90 to 12000 mg l^{-1} and alkalinity from 60 to 3500 mg l^{-1} as HCO_3^- were examined for sublethal histological changes in gill, kidney, and liver tissues. Gill chloride cell hyperplasia, gill lamellar epithelial separation, kidney glomerular swelling, blood congestion in kidneys, and deposition of hyalin droplets in kidney glomeruli, tubules, and hemopoietic tissues were the histological alterations statistically associated with differences in lakewater chemistry.

Deposition of hyalin in kidney tubules was the only histological change judged pathological and whose severity appeared sufficient to jeopardize normal organ function. Differences in lakewater chemistry explained nearly 90% of the variability observed in severity of tubular hyalin degeneration, SO_4^{2-} was the ion most positively correlated with increasing tubular hyalin. Results suggested that Lahontan cutthroat trout will develop slight to moderate hyalin degeneration in kidney tubules in lakes where salinity and SO_4^{2-} concentrations equal or exceed 5000 mg l^{-1} and 2000 mg l^{-1}, respectively. (Jour. Fish. Biol, in press)

Cambios histologicos en tejidos organicos de Lahontan cutthroat trout (Salmo clarki henshawi) viviendo en lagunas de salinidad - alcalinidad variable

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SUMARIO

Lahontan cutthroat trout de nueve lagunas en las cuales salinidad varió de 90 a 12000 mgl^{-1} y alcalinidad 60 a 3500 mgl^{-1} como HCO_3 estuvieron examinado por cambios histológicos subletal en tejidos de branquia, riñón, y hígado. Hiperplasia de la celula cloruro de la branquia, separación de laminilla epitelial branquial, protuberancia glomerual del riñón, congestión sangrial en los riñones, y deposición de gotitas de hialina en riñón glomeruli, tubulas, y tejidos hemopoieticos fueron las alteraciones histológicas asociadas por estadistica con diferences en química del agua lagunal.

Deposición de hialina en tubulas de riñón fué el único cambio histológico determinado como patalógico y cuyo severidad apareció suficiente a poner a riesgo función normal del órgano. Diferences debido a la química del agua lagunal explican casi 90% de la variabilidad observado por severidad de tubular hialina degeneración, SO_4^{2-} fué el ion más positivemente correlacionado con aumento de tubular hialina. Resultas sugieren que Lahontan cutthroat trout desarrollará ligera a moderada degeneración de hialina en riñón tubulas en lagos donde salinidad y SO_4^{2-} concentraciones igualen o sobrepasan 5000 mgl^{-1} y 2000 mgl^{-1}, al respectivo. (Jour. Fish. Biol., in press)

Status of Native Fishes in Big Smoky Valley, Nevada

John W. Pedretti[1], Thomas M. Baugh[2] and James E. Deacon[1]

Abstract - Twenty-six springs on the floor of Big Smoky Valley, Nevada, were surveyed in August and September, 1984, to determine the presence or absence of the tui chub (*Gila bicolor* ssp.) and the Big Smoky Valley speckled dace (*Rhinichthys osculus lariversi*). The results of this survey were compared with earlier surveys. *Gila bicolor* ssp. was found in only two of the six sites from which it had been previously reported. This species was also collected from two new localities. *Rhinichthys osculus lariversi* was found in both of the two previously reported sites. One new locality for this species was also recorded.

Estado actual de los peces indígenos del valle Big Smoky de Nevada

Resumen - En agosto y septiembre de 1984 se efectuaron observaciones de veintiseis manantiales del valle Big Smoky de Nevada para verificar la presencia del tui chub (*Gila bicolor* ssp.) y el Big Smoky Valley speckled daçe (*Rhinichthys osculus lariversi*). Se encontraron *Gila bicolor* solo en dos de los seis lugares donde antes se habian observado. Dicha especie ademas se encontró en dos lugares nuevos. *Rhinichthys osculus lariversi* se observó en los dos lugares anteriormente notados. Tambien se observó dicha especie en un lugar nuevo.

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MORPHOMETRICS OF AGOSIA CHRYSOGASTER (GIRARD)

Results of univariate and multivariate phenetic analyses of 50 morphometric and 5 meristic characters of *Agosia chrysogaster*, a small cyprinid endemic to the Sonoran Desert Region, are presented. The more than 1200 specimens examined were from 52 localities representing all 12 major river basins (Bill Williams, Arizona to Rio Sinaloa, Sinaloa) to which the species is native.

The presently monotypic genus needs review. Specimens form two major phenetic clusters. Rios Yaqui and Sonora, as well as Willcox Playa basin group with more southern basins, and rivers from Río de la Concepción northward form another cluster. Temporally discrete samples from single localities appear to indicate a high level of temporal variability in mean morphometry of populations. Morphometry and multivariate morphometric distance among localities are poorly correlated with geographic variables (latitude, longitude, elevation, straight line distance) but morphologic distance is correlated with drainage distance among localities. Much of the difference between the two major groups is related to the way in which they are sexually dimorphic, but the two discriminate on axes which also contain much seasonal variation within populations.

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ESTUDIOS MORFOMETRICOS DE *AGOSIA CHRYSOGASTER* (GIRARD)

Se presentan resultados de analises fenéticos univariables y multivariables de 50 carácteres morfometricos y 5 meristicos de *Agosia chrysogaster*, un ciprinido pequeño endemico de la Región del Desierto de Sonora. Mas de 1200 ejemplares fueron examinados de 52 sitios que representan todas las 12 cuencas (Bill Williams, Arizona al Río Sinaloa) donde se encuentran poblaciones nativas.

Este genero ahora clasificado como monotipico necesita revisión. Los ejemplares forman dos grupos fenéticos mayores. Peces de los rios Yaqui y Sonora y Playa Willcox caen con otros rios mas al sur, mientras los de los rios desde Río de la Concepción al norte forman otro grupo). Muestras tomadas de ciertos sitios a varios tiempos durante un año indican alto nivel de variación temporal en la morfometría promedia de poblaciones. Morfología y distancia morfometrica multivariable entre poblaciones demostran correlacion debil con datos geograficos (latitud, longitúd, altura, distancia por linea recta) pero distancias por drenaje entre sitios de muestreo estan correladas con distancia morphometrica entre las poblaciones de *Agosia*. Gran parte de la diferencia entre los grupos mayores se debe al modo de expresión del dimorfismo sexual entre cada grupo, pero los grupos se clasifican por axes morfometricos multivariables que tambien contienen mucha variación entre estaciones dentro de un solo población.

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Title: The Soda Springs Aquifer: Chances for the Continued Survival of the Mohave Chub (*Gila bicolor mohavensis*)

C. Robert Feldmeth and Thomas W. Bilhorn

The presence of the Mohave chub at Soda Springs represents the only population of this endangered species within its original range. Hybridization with the introduced arroyo chub (*Gila orcutti*) has occurred in all other suitable habitats along the Mojave River drainage. The proposal of the Army Corps of Engineers to alter the flow of water down the Mojave River by construction of a gate on an existing dam upstream from Victorville raises the question of how the aquifer at Soda Springs will be affected by retention of recharge water to the Soda Lake system.

We have recently completed an examination of the water quality and hydrology of the Soda Springs aquifer as it pertains to the continued survival of the Mohave chub. The results of these studies will be presented in order to understand the changes that are likely to occur at Soda Springs and how they might affect the chub.

Population Modeling Analysis of Truckee River Flows and the Endangered Cui-ui (Chasmistes cujus) of Pyramid Lake, Nevada

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ABSTRACT: Cui-ui, endemic to Pyramid Lake, Nevada, historically migrate into the lower Truckee River each spring to spawn. Since completion of Derby Dam in 1906, river flows and the resulting level of Pyramid Lake have dramatically decreased. Cui-ui access to the river has been intermittent during the last 50 or so years. Marble Bluff Dam and Fishway, completed in 1976, permitted partial access for spawning, but river flows are still inadequate during most years. Some cui-ui have successfully negotiated the fishway each spring since 1980, but 92 percent of the present adult spawning population in Pyramid Lake is represented by the 1969 year class, now 16 years old. Some juveniles are now being monitored in the lake and, hopefully, represent other year classes to be recruited into the adult spawning population before the 1967 year class becomes reproductively defunct. USFWS, Reno, Nevada, has been developing a methodology for computer modeling of cui-ui population trends under varying water management proposals for the Truckee/Carson River Basins. The model utilizes a physical river model developed by USBR, assigns habitat suitability ratings to the flows generated by the USBR model, and subsequently uses both known and assumed cui-ui population and life history data to compute a hypothetical population index at varying river flows and lake levels. These indices can be compared to predict which river management scheme(s) would be most beneficial for cui-ui.

STATUS AND FUTURE OF RANID FROGS IN ARIZONA

There are five frogs of the genus *Rana* currently described which are native to Arizona. The Tarahumara Frog, *R. tarahumarae*, has been extirpated from its limited range north of the U.S.-Mexico border in Arizona, but apparently healthy populations remain in Mexico. Four species of leopard frog (*R. pipiens*, *R. chiricahuaensis*, *R. blairi*, *R. yavapaiensis*) appear to be experiencing varied reductions of range and abundance. A fifth species of leopard frog (Relict Leopard Frog, *R. onca*) may have existed in the Virgin River drainage in the northwestern corner of the state. Another leopard frog of questionable origin is present along the lower Gila and Colorado rivers, and has replaced *R. yavapaiensis* at these localities. This species may be introduced, or is possibly an undescribed form which,due to spotty collections along the lower Gila River, had until now escaped detection. Morphological, acoustic, and electrophoretic studies are currently assessing the status of this frog.

The introduced bullfrog, *R. catesbeiana*, is widespread in Arizona, and has been implicated in the decline of native frogs in several areas of the west. The particular success of the bullfrog and exotic fishes in the lower Colorado River is the likely cause for the disappearance of *R. yavapaiensis* from this portion of its former range. Other threats to native frogs in Arizona include dewatering, destruction of riparian areas, overcollecting, and environmental pollution.

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EL ESTADO Y EL FUTURO DE LAS RANAS EN ARIZONA, E.U.A.

Hay cinco especies de ranas ahora descrito del género Rana que se encuentra en el estado de Arizona, E.U.A. El Tarahumara Frog (Rana tarahumarae) ha hecho extinguido de su distribución pequeño en los E.U.A., sin embargo populaciones que parecen como buenos todavia existen en los Estados Unidos de Mexico. Parece que cuatros especies de rana leopardo (Rana pipiens, R. chiricahuaensis, R. blairi, R. yavapaiensis) están sufriendo de reduciones variados de distribución y abundancia. Otro especie de rana leopardo (Relict Leopard Frog, R. onca) además de los cuatro, posiblemente existó en el vertiente del Virgin River en el noroeste del estado de Arizona. Otra rana leopardo, de origen questionable, existe en el extremo inferior del Gila River y del Colorado River y ha reemplazado R. yavapaiensis en aquellos localidades. Este especie posiblemente fuera introducido o posiblemente sería forma todaviá no descrito porque hasta ahora no fue descubierto a causa de pocas colectas de ejemplares por el extremo inferior del Gila River. Al presente con investigaciones morphológicos, acusticos y electrophoreticos estan avaluando el estado de aquella rana.

La rana grande (R. catesbeiana) que es introducido, vive en todos partes de Arizona y se le ha implicado en el declinación de las ranas indígenas en varios partes del este del estado. El buen exito de la rana grande y de pesces exoticos en el extremo inferior del Colorado River es la causa probable de su desaparición del R. yavapaiensis de este parte de su distribución. Otras amenazas a las ranas indígenas en Arizona incluyen el gasto de água, el destrucion de lugares alrededores de águas, colectionando excesivo, y el contaminación del ambiente.

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HABITOS ALIMENTICIOS DE LA TRUCHA DE SAN PEDRO MARTIR, Salmo nelsoni (EVERMANN).

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RESUMEN.

Esta es la primera contribución sobre los hábitos alimenticios de la trucha de San Pedro Mártir (Salmo nelsoni Evermann).
Los contenidos estomacales de 55 ejemplares (65-215 mm LP) procedentes de varias localidades de la Sierra San Pedro Mártir, B.C. Mexico, fueron examinados cualitativamente y cuantitativamente de acuerdo al Indice de Importancia Relativa.

Veintiún artículos alimenticios fueron reconocidos y agrupados dentro de 12 categorías mayores. La dieta de la trucha de San Pedro Mártir está compuesta principalmente por insectos (78%), de los cuales los tricópteros (27.5%), odonatos (16.2%) y coleópteros (15.8%) son los componentes tróficos más importantes. No se encontraron diferencias cualitativas significativas de la dieta en los diferentes grupos de tallas.

INTRODUCCION.

La determinación cualitativa y cuantitativa del contenido estomacal de una especie íctica, nos permite entender mas adecuadamente la forma de como son explotados los recursos alimenticios en el medio ambiente, y también de una manera indirecta, podemos conocer su disponibilidad en la comunidad.
Salmo nelsoni (Evermann) es una especie endémica de los arroyos de la pendiente occidental de la Sierra San Pedro Mártir, B.C. Mexico (Follett, 1960; Ruiz y Contreras, 1985), y cuyo conocimiento sobre la ecología alimenticia es aún desconocida.
Esta primera contribución tiene como objetivo principal, investigar cualitativa y cuantitativamente la dieta de la trucha de San Pedro Mártir y contribuir de esta manera con información básica, para futuros estudios autoecológicos y de manejo poblacional de ésta especie.

MATERIAL Y METODOS.

Los contenidos estomacales de 55 ejemplares de truchas de un rango de 65-215 milímetros en longitud patrón, fueron colectadas con carnada "mosca" artificial, usando caña de pescar; en tres localidades de la Sierra San Pedro Mártir, B.C. (Fig.1), y analizados desde el punto de vista cualitativo y cuantitativo.

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Los ejemplares preservados en isopropanol 50% fueron disectados en el laboratorio y el contenido estomacal fue identificado y cuantificado, bajo un microscopio estereoscópico.

Los contenidos estomacales fueron simultaneamente examinados usando los metodos de frecuencia de ocurrencia (FO), numérico (N), y volumen aparente(VA), todos descritos por Lagler (1978) e Hyslop (1980). Los artículos alimenticios fueron identificados hasta la taxa más baja posible, y posteriormente agrupados en categorías alimenticias mayores para su análisis cualitativo y cuantitativo. La identificación de los artículos alimenticios se basa en criterios de Chu (1949), Usinger (1963), Pennak (1978), y Powell y Hogue (1979).

El Indice de Importancia Relativa (George y Hadley, 1979) fue calculado para cada categoría mayor, este método integra los metodos de frecuencia de ocurrencia, numérico y volumétrico, sin embargo reemplazamos el método volumétrico por el de volumen aparente debido a la dificultad para estimar adecuadamente artículos alimenticios pequeños.

La ecuación utilizada es:

$$IIR = \%FO + \%N + \%VA$$

donde: % FO= porciento de frecuencia de ocurrencia,
% N = porciento por número,
% VA= porciento por volumen aparente.

Para comparar las diferencias en la dieta entre los diferentes tamaños de truchas, separamos a éstas en tres grupos:

Primér grupo: truchas menores de 150 mm LP
Segundo grupo: truchas de 150 a 200 mm LP
Tercer grupo: truchas mayores de 200 mm LP

donde el método utilizado para comparar los contenidos estomacales fue el Indice de Similitud de Jaccard (Brower y Zar, 1977).

RESULTADOS.

En el análisis sistemático se reconocieron veintiún artículos alimenticios incluídos en 12 categorías alimenticias mayores (tabla I), donde los grupos mejor representados en especie-presa fueron coleoptera y trichoptera.

Los tricópteros (IIR= 27.6%), odonatos (IIR= 16.2%), coleópteros (IIR= 15.8%), y anfípodos (IIR= 11.6%) fueron los componentes tróficos más importantes en la dieta de esta especie (tabla II, fig.2).

En la figura 3, se integran las estimaciones de %FO, %N, y %VA en una misma gráfica y donde se puede apreciar claramente, la gran contribución (número y biomasa) de los grupos trichoptera, coleoptera y odonata en la dieta de este pez, sin embargo el resto de las categorías alimenticias contribuyen muy poco en la dieta de la trucha.

En la comparacion de los tres grupos de tallas examinadas no se encontró ninguna diferencia cualitativa, con respecto a su alimentación (fig. 4).

Los grupos 1 y 2 de la figura 4, presentan una gran similitud (CCj= 0.833) sin embargo, el grupo 1 tiene una mayor afinidad con el grupo 3 (CCj=0.733).

DISCUSION Y CONCLUSIONES.

Nuestros resultados demuestran que la trucha de San Pedro Mártir (Salmo nelsoni Evermann), tiene una dieta compuesta principalmente por insectos, de los cuales los tricópteros, coleópteros y odonata fueron las categorías alimenticias más importantes. La dieta de ésta especie es muy similar a la reportada en otros salmónidos, tal como Salmo gairdneri (e.g. Whales, 1946; Maciolek y Needham, 1951; Lackey, 1969; Swift, 1970; Elliott y Jenkins, Jr., 1972).

Las categorías alimenticias mayores tales como los tricópteros, coleópteros y odonatos, son posiblemente los recursos alimenticios más abundantes y disponibles en este medio ambiente.

En los tres grupos de tallas de las truchas, no se encontraron diferencias cualitativamente significativas con respecto a la dieta, tal vez debido a que éstas toman indiferentemente los recursos alimenticios disponibles. Esto podría ser causado por la simplicidad de la estructura trófica de la comunidad, la cual es típica de los ecosistemas acuáticos lóticos.

AGRADECIMIENTOS

Nuestro agradecimiento a E.Phil Pister, quien proporcionó gentilmente los especimenes de truchas que el colectó durante sus varias excursiones a la --Sierra San Pedro Mártir, B.C.; también gracias al finado Katsuo Nishikawa y a Carlos Yruretagoyena, por proporcionar datos ecológicos del área de estudio. A Sergio Salazar quien revisó la traducción en inglés del manuscrito.

FEEDING HABITS OF THE SAN PEDRO MARTIR TROUT, Salmo nelsoni

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ABSTRACT

The feeding habits of the San Pedro Martir trout (Salmo nelsoni Evermann) are reported for the first time.

The stomach contents of 55 specimens (65-215 SL) collected in several localities from the Sierra San Pedro Martir, B.C., Mexico, were examined both qualitatively and quantitatively according to the Relative Importance Index. Twenty-one food items were recognized systematically and were grouped into 12 major categories. The diet of the San Pedro Martir trout is mainly composed of insects (78%), of which the trichoptera (27.5%), odonata (16.2%), and coleoptera (15.8 %) are the most important groups.

We did not find any significant qualitative difference in the diet of several trout size groups.

INTRODUCTION

A qualitative and quantitative determination of the stomach contents of a fish species allows us to understand more accurately the way food resources are "exploited" in the environment. Also, in an indirect way, we can know their relative availability in the community.

Salmo nelsoni (Evermann) is a species endemic to streams from the western slope of the Sierra San Pedro Martir. B.C., Mexico (Follett, 1960; Ruiz and Contreras, 1985). Knowledge of the feeding ecology of this species is still unknown.

Investigation of the qualitative and quantitative apsects of the diet of the San Pedro Martir trout will aid future autecological and management studies of this endemic species.

MATERIALS AND METHODS

Fifty-five trout (65-215 mm SL) were collected with artificial trout flies from three localities in the Sierra San Pedro Martir, B.C., Mexico (fig. 1). The stomach contents were analyzed from qualitative and quantitative points of view.

Specimens were preserved in 50% isopropanol, dissected in the laboratory, and the stomach contents were identified and quantified under a stereoscopic microscope.

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The stomach contents were examined using the frequency of occurrence (FO), numerical (N), and apparent volume (AV) methods described in Lagler (1978) and Hyslop (1980). The food items were identified to the lowest possible taxon, and later grouped into major food categories for qualitative and quantitative analysis. The identification of food items was based on the criteria of Chu (1949), Usinger (1963), Pennak (1978), and Powell and Hogue (1949).

The Relative Importance Index (George and Hadley, 1979) was calculated for each major food category. This index integrates the frequency of occurrence with numerical and volume methods. We replaced the volumetric method with the volume method because of the difficulty in accurately measuring the smaller food items.

The equation used is:

$$RII = \%FO - \%N - \%AV$$

where: %FO= frequency of occurrence percent
%N = numerical percent
%AV= apparent volume percent

To compare the difference in the diet between several trout length cohorts, we separated the trout into three groups:

First group: trout less than 150 mm SL
Second group: trout between 150 and 200 mm SL
Third group: trout over 200 mm SL

The method used to compare the stomach contents was the Similarity Index of Jaccard (Brower and Zar, 1977).

RESULTS

In the systematic analysis, we recognized twenty-one food items included in twelve major food categories (Table 1). Coleoptera and Trichoptera were the best-represented prey species in our samples.

The Trichoptera (RII= 27.6%), Odonata (RII= 16.2%), Coleoptera (RII= 15.8%) and Amphipoda (RII= 11.6%) are the most important trophic components in the diet of the species (Table II, figure 2).

In Figure 3 we integrated the %FO, %N, and %AV assessments in the same graph. This graph indicates the great contribution (number and biomass) that the Trichoptera, Coleoptera and Odonata groups make in the diet of this fish. However the remaining food categories contribute little to the diet of this species.

In comparing the three size groups of the trout examined, we did not find any qualitative differences in the diet (see figure 4). The groups 1 and 2 show a high similarity (CCj= 0.833) and group 1 has a greater affinity to group 3 (CCj= 0.733).

DISCUSSION AND CONCLUSIONS

Our results show that the San Pedro Martir trout, <u>Salmo nelsoni</u> (Evermann) has a diet composed mostly of insects, of which the Trichoptera, Coleoptera, and Odonata, were the most abundant food categories.

The diet of the species is very similar to that reported for other salmonids, such as Salmo gairdneri (e.g. Wales, 1946; Maciolek and Needham, 1951; Lackey, 1969; Swift, 1970; and Elliot and Jenkins, Jr., 1972).

Trichoptera, Coleoptera, and Odonata are most likely the more abundant and available food resources in the environment.

In the three trout sizes, we did not find any significant qualitative difference, perhaps due to the fact that they exploit the available food resources in similar ways. This might be caused by the simplicity of the trophic structure of the community which is typical of lotic aquatic ecosystems.

ACKNOWLEDGMENTS

The authors express their gratitude to Phil Pister who generously supplied the fish specimens from his collecting travels to the Sierra San Pedro Martir, B.C., to Katsuo Nishikawa (deceased) and Carlos Yruretagoyena, who supplied ecological data of the study area, and to Sergio Salazar for his valuable aid in the translation of this paper.

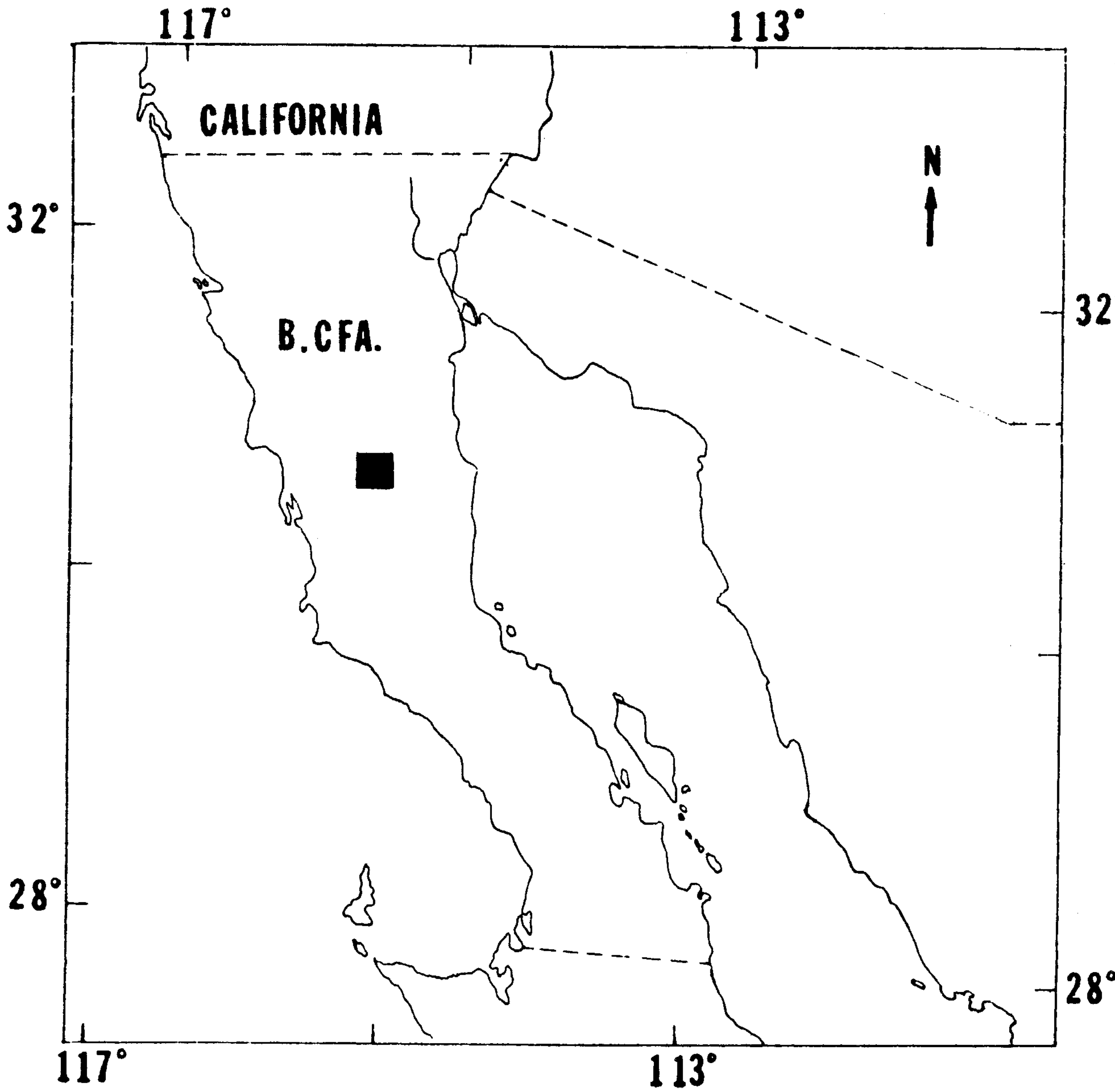

Figura 1. SITUACION GEOGRAFICA DEL AREA DE ESTUDIO

Figure 1. Geographical Situation of Study Area

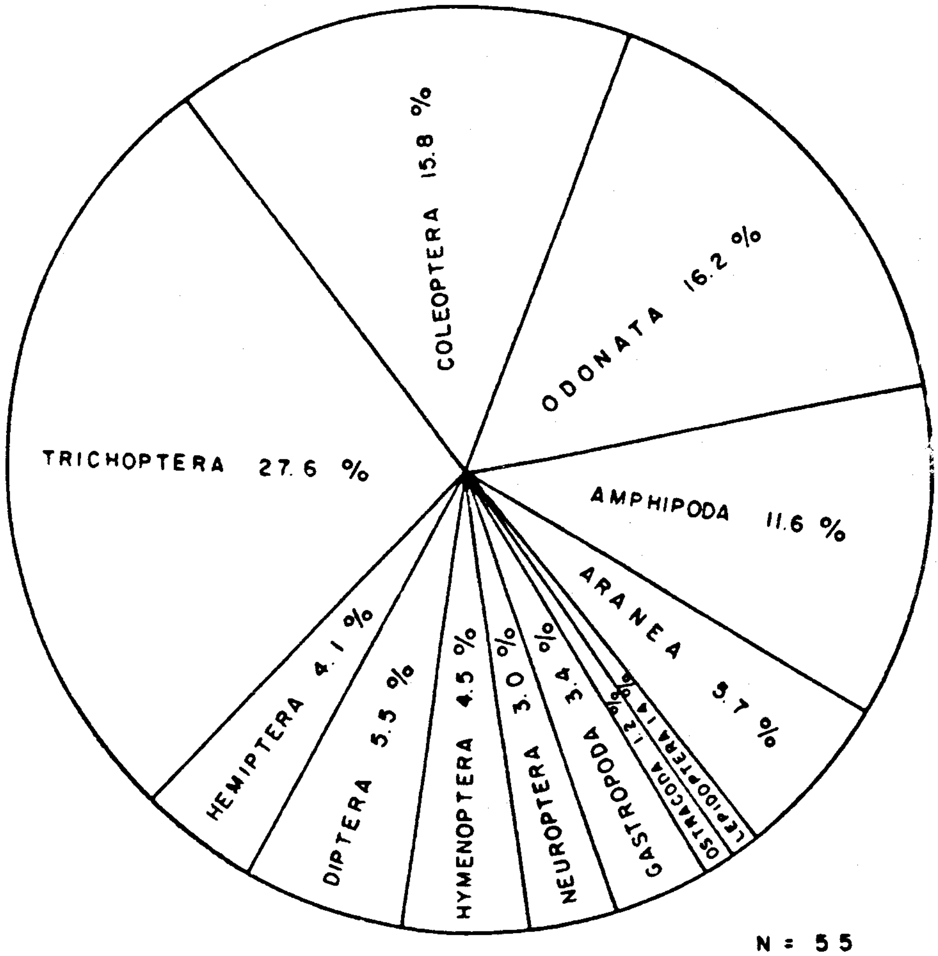

Figura 2. ESPECTRO TROFICO DE LA TRUCHA DE SAN PEDRO MARTIR <u>Salmo nelsoni</u> (EVERMANN), DE ACUERDO AL INDICE DE IMPORTANCIA RELATIVA (IIR).

Figure 2. Trophic Spectra of the San Pedro Mártir trout <u>Salmo nelsoni</u> (Evermann), according to the Relative Importance Index (RII).

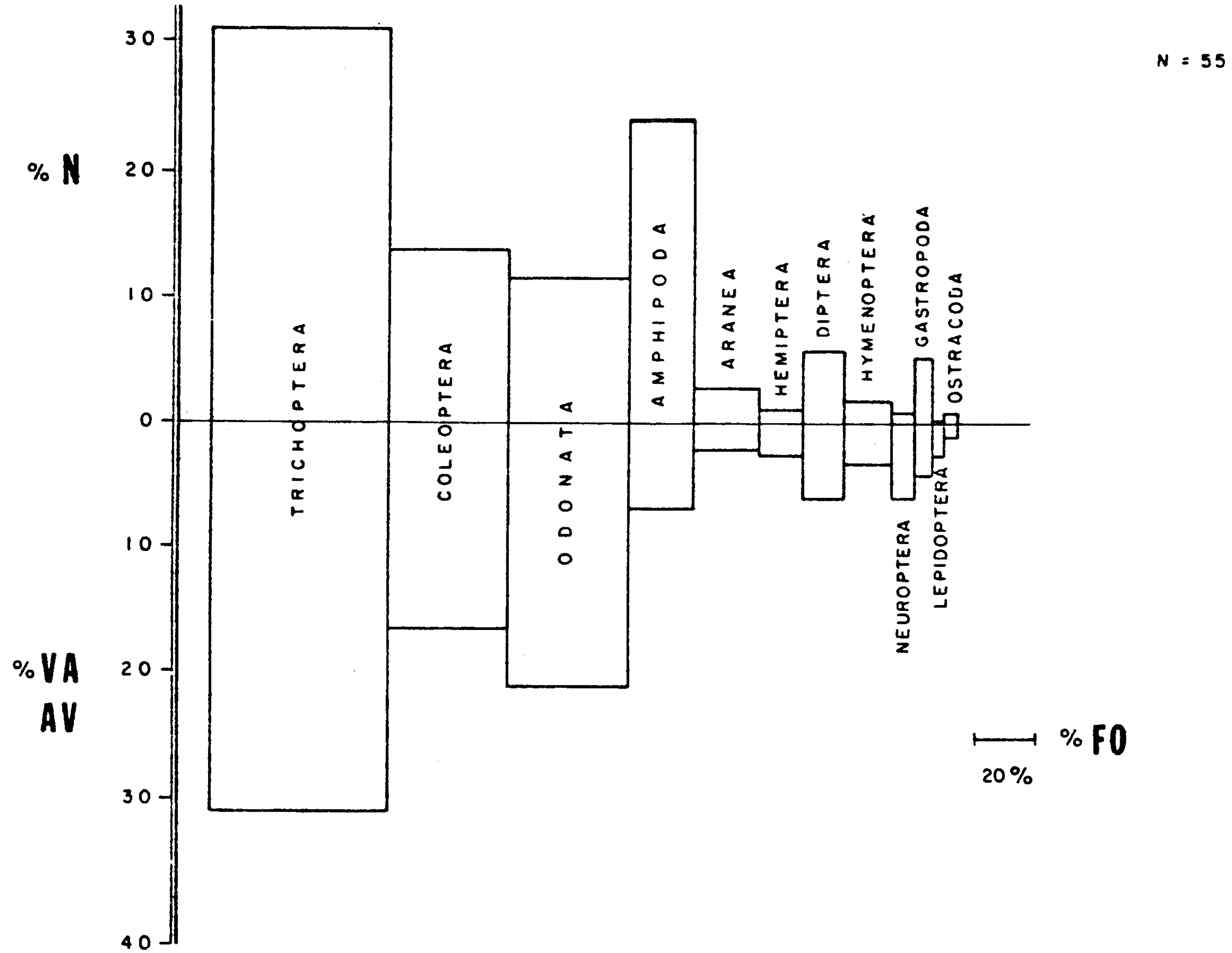

Figura 3. CONTRIBUCION DE LAS CATEGORIAS ALIMENTICIAS MAYORES EN LA DIETA DE LA TRUCHA DE SAN PEDRO MARTIR (Salmo nelsoni Evermann), BASADO EN LA INTEGRACION DE 3 METODOS DE ANALISIS: %FO, %N, %VA.

Figure 3. Contribution of the Major Food Categories in the San Pedro Mártir Trout (Salmo nelsoni Evermann), Based upon the Three Methods (%FO, %N, %AV) Integration.

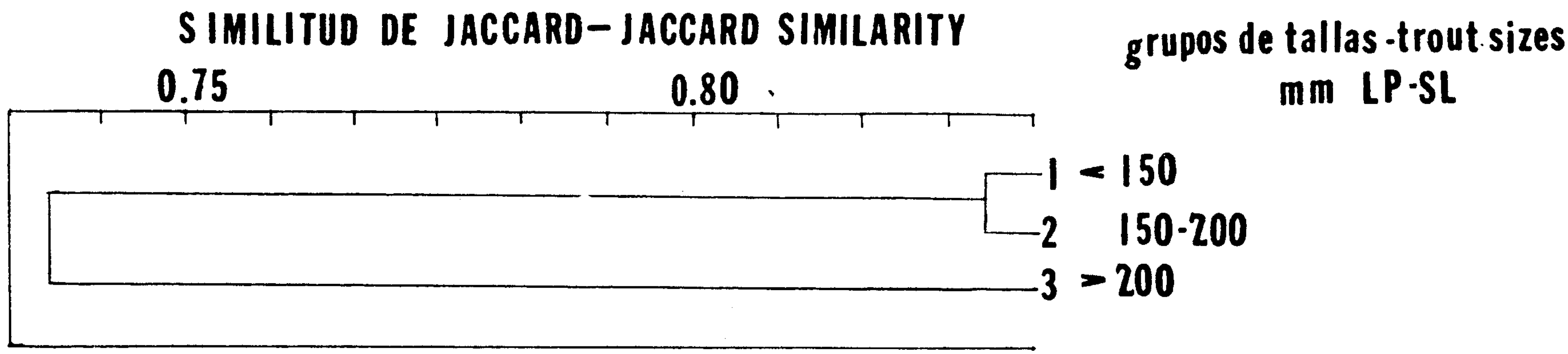

Figura 4. DENDROGRAMA DE SIMILITUD ENTRE LOS DIFERENTES GRUPOS DE TALLAS DE LA TRUCHA DE SAN PEDRO MARTIR _Salmo nelsoni_ Evermann.

Figure 4. Dendrogram of Similarity between Several Trout Sizes of _Salmo nelsoni_ Evermann, from Sierra San Pedro Mártir, B.C., México.

Tabla I. LISTA SISTEMATICA DE LOS ARTICULOS ALIMENTICIOS ENCONTRADOS EN EL CONTENIDO ESTOMACAL DE LA TRUCHA *Salmo nelsoni* (Evermann).
Table I. Systematic list of the Food Items found in the Stomach Contents of Trout *Salmo nelsoni* (Evermann).

CATEGORIAS Categories	ARTICULOS IDENTIFICABLES Recognized Items
GASTEROPODA	Gasteropoda
ARANEA	Aranea
OSTRACODA	Ostracoda
AMPHIPODA	Amphipoda
ODONATA	Zygoptera (larvas)
	Coenagriidae (larvas)
HEMIPTERA	Belostomatidae (*Belostoma* sp.)
	Notonectidae (*Notonecta* sp.)
NEUROPTERA	Sialidae
COLEOPTERA	Dytiscidae (*Agabus* sp)
	Hydrophilidae (*Hydrophilus* sp.)
	Carabidae
	Haliplidae
LEPIDOPTERA	Lepidoptera (larvas)
TRICHOPTERA	Helicopsychidae (*Helicopsyche* sp.)
	Hydropsychidae (*Hydropsyche* sp.)
	Leptoceridae (*Leptocella* sp.)
HYMENOPTERA	Formicidae
	Apoidea
DIPTERA	Heleidae (larvas)
	Blephariceridae

Tabla II. COMPOSICION EN PORCIENTO DE LAS CATEGORIAS ALIMENTICIAS MAYORES DE ACUERDO A SU FRECUENCIA DE OCURRENCIA (FO), NUMERICO (N), VOLUMEN APARENTE (VA) E INDICE DE IMPORTANCIA RELATIVA (IIR), PARA LA TRUCHA DE SAN PEDRO MARTIR *Salmo nelsoni* (EVERMANN). N= 55 (65-215 mm LP).

Table II Percent Composition by Major Food Categories in Frecuency of Ocurrence(FO), Numerical (N), Aparent Volume (AV), and Relative Importance Index (RII) of the San Pedro Mártir trout *Salmo nelsoni* (EVERMANN). N=55 (65-215 mm SL).

CATEGORIAS ALIMENTICIAS MAYORES Major Food Categories	%FO FO	%N N	%VA AV	*IIR RII	%IIR RII
TRICHOPTERA	58.2	31.3	30.6	120.1	27.6
COLEOPTERA	38.2	14.2	16.3	68.7	15.8
ODONATA	38.2	11.6	20.7	70.5	16.2
AMPHIPODA	20.0	24.1	6.6	50.7	11.6
ARANEA	20.0	2.8	2.0	24.8	5.7
HEMIPTERA	14.5	1.2	2.3	18.0	4.1
DIPTERA	12.7	5.6	5.8	24.1	5.5
HYMENOPTERA	14.5	2.0	3.1	19.6	4.5
NEUROPTERA	7.3	0.8	5.2	13.3	3.0
GASTEROPODA	5.4	5.1	4.3	14.8	3.4
LEPIDOPTERA	3.6	0.3	2.3	6.2	1.4
OSTRACODA	3.6	1.0	0.8	5.4	1.2

*IIR= %FO + %N + %VA

RII= %FO + %N + %AV

LITERATURA CITADA - REFERENCES

Brower, J. W [illegible] H. Zar 1977. *Field and Laboratory Methods for Gene[illegible] Ecology*. Wm. C. Brown Co. Publishers, Dubuque, Iowa, 234 pp.

Cho, H. F. 1949. *How to Know the Immature Insects*. Wm. C. Brown Co. Publishers, Dubuque, Iowa, 234 pp.

Elliot, G. V. & T. M. Jenkins, Jr. 1972. Winter food of trout in three high elevation Sierra Nevada lakes. *Calif. Fish and Game*, 58 (3):231-237.

Follett, W. I. 1960. The freshwater fishes- their origin and affinities. *In*: Symposium on the biogeography of Baja California and adjacent seas. *Syst. Zool.*, 9(3-4):212-232.

George, E. L. & W. F. Hadley. 1979. Food and habitat partitioning between rock bass (*Ambloplites rupestris*) and small-mouth bass (*Micropterus salmoides*) young of the year. *Trans. Amer. Fish Soc.*, 108:253-261.

Hyslop, E. J. 1980. Stomach contents analysis- A review of methods and their application. *J. Fish Biol.*, 17:411-429.

Lackey, R. T. 1969. Food interrelationships of salmon, trout, alewives, and smelt in a Maine lake. *Trans Amer. Fish Soc.*, 1969 (4):641-646.

Lagler, K. F. 1978. *Freshwater Fishery Biology*. Wm. C. Brown Co. Publishers, Dubuque, Iowa, 421 pp.

Maciolek, J. K. & P. R. Needham. 1951. Ecological effects of winter conditions of trout foods in Convict Creek, California, 1951. *Trans. Amer. Fish Soc.*, 1951:202-217.

Pennak, R. W. 1978. *Fresh Water Invertebrates of the United States*. Second edition, J. Wiley & Sons, N.Y., 803 pp.

Powell, J. A. & C. H. L. Hogue. 1979. *California Insects*. University of California Press, Berkeley. Vol. VII-IX:388 pp.

Ruiz-Campos, G. & S. Contreras-Balderas. 1985. Ecological and zoogeographic checklist of inland fishes from the Baja California Peninsula, Mexico. *Proceed. Desert Fishes Council*, Seventeenth Annual Symposium, 1985, Furnace Creek, Calif.

Swift, M. C. 1970. A qualitative and quantitative study of trout food in Castle Lake, California. Calif. Fish & Game, 56 (2):109-143.

Usinger, R. L. (ed.) 1963. Aquatic Insects of California: with keys to North American Genera and California Species. University of California Press, Berkeley, 508 pp.

Wales, J. H. 1946. Castle Lake trout investigations first phase: Interrelationships of four species. California Fish and Game, 32 (3):109-143.

LARVAL RAZORBACK SUCKER, _XYRAUCHEN TEXANUS_, IN LAKE MOHAVE, AZ-NV.

Razorback sucker in Lake Mohave are large and old, with no evidence of recruitment for several decades. Adults spawn successfully and larvae are produced. Larvae were abundant in the littoral zone from mid-January into April 1984-85. Growth from 7mm at hatch to 10-12mm was evident, but larvae disappeared at _ca_. 12mm. Intensive sampling by trawl failed to locate larvae in open waters of the lake. Stomach analyses of littoral and epilimnetic predators provided little evidence for consumption of significant numbers of larvae. Yet, caged larvae attained lengths in excess of 30mm, nearly 3X that of wild fish, and a cohort produced by wild adults in a predator-free backwater reached lengths of 20mm in a month. The latter were eliminated by predation after breach of the backwater; nearly 40% of invading green sunfish contained an average of 3.9 larval razorback. Foods of larval razorback were zooplankters predominated by _Bosima_ and _Daphnia_. Qualitative and quantitative differences in zooplankton communities, but not larval diets, were evident between the backwater and Lake Mohave. Food resource availability may in part explain greater size and increased survival in the former. Predation impacts are likely significant, but remain unquantified.

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LARVA DE RAZORBACK SUCKER, (XYRAUCHEN TEXANUS), EN LAKE MOHAVE, ARIZONA - NEVADA

Razorback sucker en Lake Mohave son grandes y viejos, sin evidencia de aumento de la población adulta por varias décadas. Adultos desovan con éxito y larvas están producido. Larvas estuvieron abundante en la zona litoral medios de enero hasta por abril 1984-85. Crecimiento de 7mm a hacer eclosión a 10-12mm estuvo evidente, pero larva desapareció a casi 12mm. Toma de muestras por traul falló en localizar larva en los aguas abiertas de la laguna. Análisis del estómago de predadores del litoral y del epilimneo proveó poca evidencia de consumo de numeros significantes de larva. Aún, la largura de larva enjaulada alcanzó más de 30mm, casi trés veces lo de larva salvaje, y larva producido por adultos salvajes en agua aislada sin predadores logró lagura de 20mm durante un més. Los últimos fueron eliminados por predación despues de brecha del area aislada, casi 40% de los green sunfish (<u>Lepomis cyanellus</u>) que invadieron tuvieron un promedio de 3.9 larva de razorback sucker. Alimentos de larva de razorback sucker son zooplancton <u>Bosmina</u> y <u>Daphnia</u> predominante. Diferencias cualitativas y cuánticas en comunidades de zooplacton, pero no dietas de larva, fueron evidente entre el agua aislada y Lake Mohave. Disponibilidad del recurso alimenticia por un parte puede explicar la diferencia en tamaño y aumento de supervivencia. El impacto de predación probable tiene significanción, pero hasta ahora no está cuantificado.

Desert Fishes Council
Seventeenth Annual Symposium.
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Una Nueva Especie de Pez Pecīliido del Género *Xiphophorus*, de Coahuila, México.

A New Species of Poeciliid Fish of the Genus *Xiphophorus*, from Coahuila, México.

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RESUMEN

Una nueva especie de pez pecīliido del género *Xiphophorus*, se describe como endémica a una pequeña cuenca satélite del Rīo Salado en Múzquiz, Coahuila, México. El nuevo taxon se define por la siguiente combinación única de caracterīsticas: cuerpo con manchas marmoleadas grandes a medianas en los lados, principalmente hacia atrás y abajo; la mayorīa de las espinas del radio 3 bīfidas; -- sierra proximal del radio 4p poco o no retrorsa; la sierra distal del mismo no convergente; gonopodio negro; generalmente 10 radios dorsales y 18 caudales; -- comúnmente 17 branquiespinas; coracoides subtriangular, fuertemente convexo hacia atrás, que sobrepasa notoriamente los radiales, sin apófisis; supracleitra con la cabeza fuertemente proyectada hacia atrás. El nombre especīfico se refiere a la coloración marmoleada. La nueva especie es extremadamente cercana al grupo xiphidium-couchianus-gordoni.

ABSTRACT

A new species of *Xiphophorus*, fish family Poeciliidae, endemic to a small satellite basin of the Rīo Salado at Múzquiz, Coahuila, México, is described. The new taxon is recognized by the following combination of characters: body with medium to large marmorated spots especially low and posterior on sides; most ray 3 spines bifid; distal serrae of ray 4p not converging at tips; proximal serrae of ray 4p little or no retrorse; gonopodium black; usually 10 dorsal and 18 caudal rays; gill rakers usually 17; Coracoid subtriangular, elongate strongly convex, past back the radials, without process; supracleithrum with anterior end tri or bicuspid; cleithrum with the head strongly projecting backwards. The specific name refers to the marmorated coloration. The new species is very close to xiphidium-couchianus-gordoni.

DISTRIBUTION AND STATUS OF THE LOACH MINNOW, TIAROGA COBITIS, IN NEW MEXICO. David L. Propst, New Mexico Department of Game and Fish and Kevin R. Bestgen, Colorado State University.

The loach minnow, *Tiaroga cobitis*, is endemic to the Gila River drainage of Arizona and New Mexico. Within this area the range and abundance of the fish has been reduced by a variety human-caused factors. Most notable of these are stream modifications such as dam construction, channelization, and elevated sediment loads, and the introduction of non-native fishes. The loach minnow currently is found sporadically in the San Francisco River from the Arizona-New Mexico border upstream to near the village of Reserve, New Mexico. It barely penetrates, if at all, most San Francisco River tributaries. The only exception, the Tularosa River, supports loach minnow from the village of Cruzville downstream to its confluence with the San Francisco River. In the Gila River drainage, the loach minnow occurs in the Cliff-Gila Valley reach of the river, the lowermost stretches of the West and Middle forks of the Gila River, and much of the East Fork of the Gila River. Its absence in some areas is due mainly to the paucity of suitable habitat. However, non-native predators are probably the main reason for its current exclusion from canyon reaches of the Gila River. Within the current New Mexico range of the species, viable populations are found primarily in a portion of the Tularosa River near U.S. Forest Service Road 233, the San Francisco River in the vicinity of the Kelly Mountains, and the Cliff-Gila Valley reach of the Gila River. Elsewhere, loach minnow numbers are low. Survival of the loach minnow is largely dependent upon maintenance of its preferred riffle habitat, free of excessive sedimentation, and exclusion of non-native predators such as the channel and flathead catfishes (*Ictalurus punctatus* and *Pylodictus olivaris*).

DEVELOPMENT OF BLUE LINK SPRING
A REFUGIUM FOR HIKO WHITE RIVER SPRINGFISH

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ABSTRACT

Blue Link Spring, an artesian thermal spring originating on Bureau of Land Management (BLM) administered lands, was successfully developed as a permanent refugium for the Hiko White River springfish (Crenichthys baileyi grandis) through the cooperative efforts of the Nevada Department of Wildlife (NDOW) and the BLM. A Release Site Description and Plan prepared by NDOW; an Environmental Analysis conducted by the BLM; and a Cooperative Agreement, signed by the two agencies, satisfied BLM policy requirements for the introduction and established management direction for the site. Development efforts included piping of water from the spring source to an existing pond which was physically altered, with the use of explosives to create a suitable refugium. Two successful transplants were conducted by NDOW. Monitoring of habitat conditions and population status is an ongoing effort shared equally by the two agencies.

The Hiko White River Springfish was officially listed as endangered soon after their establishment in Blue Link Spring. Consequently, this project work will play an important role in the recovery of the species.

RESUMEN

El manantial "Blue Link", un manantial termal artesiano que nace en las tierras administradas por el Bureau of Land Management (BLM), se ha desarrollado con buenos resultados como refugio para los "Hiko White River Springfish" (Crenichothys baileyi grandis) a traves de los esfuerzos conjuntos del Nevada Department of Wildife (NDOW) y del BLM. Una descripcion del lugar donde fueron depositados y del proyecto preparado por el NDOW; un estudio ambiente dirigido por el BLM, y un acuerdo Cooperativo firmado por los dos departamentos, han cumplido los requisitos del BLM para la introduccion, administracio y direccion establecida. El desarrollo de las obras incluye la canalizacion del aqua desde el manantial a un charco existente que habia sido alterado mediante el uso de explosivos para crear un refugio apropiado. El NDOW llevo a cabo con exito dos transplantes de la citada especie. El control de las condiciones del habitat y del estado de la poblacion es un esfuerzo continuo que se comparte igualmente entre los dos departamentos.

El "Hike White River Springfish" ha quedado oficialmente inscrito como especie en peligro poco despues de haber sido depositada en el Manantial "Blue Link". Como resultado, este proyecto desempenara un papel importante en la mejora de las especies.

THE DEVELOPMENT OF BLUE LINK SPRING
A Refugium For Hiko White River Springfish (C. baileyi grandis)

BACKGROUND

Crenichthys baileyi grandis is one of five subspecies of the genus Crenichthys inhabiting warm springs in the Pluvial White River drainage. During the last 20 years, C. b. grandis were restricted to Hiko Spring and Crystal Spring, located in the Pahranagat Valley of Lincoln County, Nevada. The introduction of tropical aquarium fishes and largemouth bass in recent years has decimated the population of C. b. grandis, once found in Hiko Spring and Crystal Spring. In 1965, mosquitofish (Gambusia affinus) and Poecilia mexicana were established at Hiko Spring. During this same year, largemouth bass were introduced into a downstream reservoir and became established at Hiko Spring a short time later. By 1967 C. baileyi grandis was extirpated from the outflow pond of Hiko Spring. (Deacon, 1979) By 1970, largemouth bass were no longer present at Hiko Spring and modification of the outlet structure from a canal to a pipe provides a barrier to the upstream migration of largemouth bass.

At Crystal Spring, 4.7 miles south of Hiko Spring, the C. b. grandis population declined following the establishment of Cichlasoma nigro fasciatuim (Convict Cichlid) and Poecila mexicana in the mid to late 1970s. (Courtenay and Deacon, 1982)

During the fall of 1983, 20 springfish were removed from the only naturally occurring population at Crystal Spring to develop a brood stock for reintroduction of the subspecies at Hiko Spring. Successful propagation at the University of Nevada - Las Vegas (UNLV) led to the release of 35 C. b. grandis into Hiko Spring in January, 1984. A second release of 40 C. b. grandis followed from UNLV stock was accomplished at Hiko Spring on March 22 of the same year.

Follow up trapping at Hiko Spring during the spring and summer failed to show any springfish. However, convict cichlids (Cichlasoma n. fasciatuim) were located in July through trapping efforts and reduced the chances for a successful springfish introduction into Hiko Spring (Baugh and Deacon, 1985)

In March of 1984, the Carson District Bureau of Land Management (BLM) and the Nevada Department of Wildlife (NDOW), began an inventory of warm water springs which could be developed as refugiums for threatened and endangered endemic fish species of Nevada. Foremost among springs inventoried was Blue Link Spring. Due to the spring's remote location at the south end of the Pilot Mountains in Mineral County, the potential for the introduction of undesirable fish species is very small. Coordination with Dave Buck, Regional Fisheries Supervisor for NDOW in Las Vegas, regarding the development of Blue Link Spring, revealed the plight of C. baileyi grandis and the need for a refugium for this specie.

SITE DESCRIPTION

Blue Link Spring originates as an artesian flow on a ridgetop and drains 93 feet downslope to a small wash. Upon entering the wash, water flows an additional

80 feet to a man-made reservoir which measures 63 feet by 105 feet. Maximum depth of the reservoir is five feet with an average depth of three feet. The estimated volume of the pool is .304 acre-feet. Although invertebrates life and submergent aquatic plants are well developed in the pool, no fish life has ever been recorded here. Outflow from the pond gradually diminishes before reaching any other water sources and there is no source for the previous establishment of native fish fauna.

The spring is located 11 air miles east and three air miles south of Sodaville, Nevada. The favored access route is an unimproved dirt road which begins on Highway 95, one mile south of Sodaville. Because of flash flooding in 1984 and 1985, travel time on the 18.1 mile dirt road is no less than two hours.

Blue Link Spring was surveyed for development as a refugium for C. baileyi grandis on September 14, 1984. Water quality monitoring determined the spring outflow to be potable for humans and suitable for fish life. Water flow from the spring is 19 gallons/minute with temperatures of 98 - 99 degrees Fahrenheit, however the water cools considerably in flowing 173 feet to the reservoir being influenced by ambient air temperature. In an effort to increase water temperatures in the pool, project developers planned to install a 1.5 inch diameter PVC pipeline to transport spring flow from Blue Link Spring directly to the pool. The water temperature regime desired for maintenance of Hiko White River springfish ranges from 68 - 95 degrees Fahrenheit.

BLM POLICY REQUIREMENTS

The act of releasing a native fish species into BLM administered waters not previously occupied by that species is defined by the BLM as an "introduction" and requires that a Release Site Description and Plan (or a Habitat Management Plan), Environmental Analysis, and a Cooperative Agreement be prepared prior to approval of this action. The Release Site Description and Plan, prepared September 17, 1984 by Mike Sevon, included an evaluation of the site, identification of current uses and potential conflicts and broad objectives of the plan. This plan was routed to several interested publics including four miners with claims in the area, the Mineral County Commissioners and the State Clearinghouse for their review and comment.

An Environmental Analysis of the introduction, although categorically excluded under the National Environmental Policy Act, was conducted by Dan Delany on September 25, 1984. It was concluded that the proposed action would not have a significant adverse affect on the environment at Blue Link Spring or the Hiko White River Springfish, or on its designated Critical Habitat.

The Cooperative Agreement, signed in February of 1985 by the Regional Supervisor of NDOW and the District Manager of the BLM, designated agency responsibilities for project construction and for accomplishing the introduction. Specifically, these were: (1) BLM would provide materials and labor necessary to install a springbox, (2) NDOW would supply materials and labor necessary to install pipelines and a valve, (3) maintenance costs and labor would be shared equally between NDOW and BLM, (4) NDOW would transport Hiko White River Springfish to Blue Link Spring, (5) monitoring responsibilities would be shared equally, and (6) upon a successful introduction effort, the BLM would propose withdrawal from mining of metalliferous minerals on five acres surrounding the project site.

PROJECT DEVELOPMENT AND MONITORING

Project construction began in October of 1984 with the installation of a redwood springbox and 180 feet of one and one-half inch polyvinyl chloride (PVC) pipe which diverted nearly the entire flow from the spring source into the existing one-tenth acre pond. In addition, a three-quarter inch PVC pipeline was extended from the springbox to an old existing bathtub which was used on occasion by the public. This line, unlike the main pipeline, was fitted with a shutoff valve and replaced an old makeshift steel pipeline. With the spring developed in this manner, it was no longer necessary for public users to tamper with the spring source in order to obtain access to bathing water. The entire development has remained undamaged to date.

Upon project completion, water temperatures were 98 degrees Fahrenheit at the pipe outlet into the pool, indicating very little temperature loss from that measured at the spring source. Subsequent monitoring from October 30 to December 19, 1984, using thermograph records and temperature profiles, however, indicated water temperatures inside the pool were not being maintained at a suitable level due to wind action across the surface of the pool and low (below freezing at night) ambient temperatures. It was then decided to create and "adjunct pool" which would open up into the pond yet would be small enough to maintain suitable water temperatures.

Mike Sevon secured the assistance of fellow NDOW employee and explosives expert, Norm Saake, to excavate two holes which were three feet deep, three and one-half feet apart and three feet from the shoreline of the pond. They placed a 25 pound charge of ammonium nitrate into each hole. The explosion created an adjunct pool which was three and one-half feet deep, 18 feet long and 16 feet wide. They rerouted the pipeline into the center of the adjunct pool and transplanted aquatic vegetation, primarily Chara, from the pond into the newly formed habitat.

The adjunct pool was monitored six weeks later in what was felt to be the harshest of weather conditions. Aquatic vegetation had successfully been established and water temperatures ranged from 67.1 degrees Fahrenheit to 81.3 degrees Fahrenheit, despite 32 degrees Fahrenheit ambient temperatures and 15 to 20 mile per hour winds. Blue Link Spring was determined at this time to be suitable as a permanent refugium for Hiko White River Springfish.

TRANSPLANT EFFORTS

The initial transplant took place on February 12, 1985, when Tom Baugh, PhD, University of Nevada, Las Vegas and Donna Withers, NDOW, transported 59 Hiko White River Springfish to Blue Link Spring in a 48 quart chest type cooler equipped with two small aquarium aerators. The fish were planted along the east shore of the pond, near the adjunct pool, where water temperatures were near 72 degrees Fahrenheit. Even though the trip took eight hours, all fish were in good health and showed no signs of stress.

The transplanted population was monitored in June of 1985. Although the majority of the fish observed were using the adjunct pool where water temperatures ranged from 83 degrees to 85 degrees Fahrenheit, many individuals were using the larger pond as well. Chara was abundant enough to provide excellent habitat for a visually estimated population of 400 individuals.

A second transplant of 178 Hiko White River Springfish was conducted by Donna Withers on October 14, 1985. Even though poor road conditions increased transport time to 26 hours, only two juvenile fish died in transit.

A mark and recapture population estimate was conducted by Donna Withers, Mike Sevon and Dan Delany immediately following the second transplant. Nine unbaited minnow traps, wrapped with fine wire screen, were used to capture fish. The study results yielded a population estimate of 2,885 individuals which was probably near peak carrying capacity. A normal overwinter reduction in population size is expected.

CONCLUSIONS

Effective October 28, 1985, the White River Springfish and the Hiko White River Springfish were listed in the Federal Register as endangered. This action was taken because their natural populations were threatened by habitat alteration and by competition with exotic fish species. The close working relationship between NDOW and the BLM resulted in the timely development of Blue Link Spring as a permanent refugium for the Hiko White River Springfish. It is anticipated that this refugium will not only play an important role in the recovery of the species, but also provides a valuable data base for scientific research and for future development of refugiums for similar species.

REFERENCES

BAUGH, T.M., DEACON, J.E. and PEDRETTI, J.W., 1985. A Report on *Crenichthys baileyi grandis* in Crystal and Hiko Springs, in the laboratory and in Blue Link Springs. University of Nevada - Las Vegas.

DEACON, J.E., 1979. Endangered and Threatened Fishes of the West. Great Basin Nat. The endangered species: A symposium. No. 3. Brigham Young University.

COURTENAY, W.R. Jr. and DEACON, J.E., 1982. Status of introduced fishes in certain spring systems in southern Nevada. Great Basin Nat. 42(3): 361-366.

TRANSPORT ECOLOGY OF LARVAL FISHES IN THE GILA RIVER, NEW MEXICO

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ABSTRACT

Transport ecology of larval fish in the Gila River, New Mexico was investigated during the period 26 March 1984-26 May 1984. Preliminary results of the data collected at one of three sites (Cliff-Gila valley) was presented. A total of 19,941 specimens were taken in 84 drift net samples; 2% of the fish collected were cyprinid larvae (*Meda fulgida*, *Agosia chrysogaster*, *Tiaroga cobitis*) and 98% were catostomid larvae (*Catostomus insignis* and *Catostomus clarki*). Peaks in drift density occurred on April 4 and May 7, when 144,000 and 645,000 larvae/day, respectively, passed through the study area. Approximately 13.5 million larval fish were transported through the Cliff-Gila valley site during the eight week period. Larval fish were primarily diurnal drifters, 87% of all cyprinids and 79% of all catostomids were collected during the noon and dusk sample periods. Larvae also exhibited diel variation in distribution across the stream channel. The ratio of fish in nearshore versus midstream nets was 6.5:1 in noon samples but decreased to nearly 1:1 in dawn samples. The causitive mechanisms of transport were complex and different for day and night drift events. Daytime drift was thought to be a consequence of obtaining and maintaining optimal feeding positions and was characterized by short, saltatory movements along the stream margin. Nighttime drift was the result of larvae moving from shallow, cold backwaters into the warmer mainstream channel. Fish were probably transported a relatively greater distance at night because of loss of orientation. The total seasonal transport distance of larval fish is probably controlled by streamflow.

ECOLOGIA DEL TRANSPORTE DE LARVAS DE PECES EN EL RIO GILA, NUEVO MEJICO

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ABSTRACTO

La ecología del transporte de larvas de peces en el Rio Gila, Nuevo Méjico, fué investigada durante el período del 26 de Marzo al 26 de Mayo de 1984. Resultados preliminares de los datos colectados en uno de los tres sitios (Valle Cliff-Gila) fueron presentados. Un total de 19.941 especímenes fueron colectados en 84 muestras de malla de arrastre; 2% de los peces colectados fueron larvas de Cyprinidos (<u>Meda fulgida</u>, <u>Agosia chrysogaster</u>, <u>Tiaroga cobitis</u>) y 98% fueron larvas de Catostomidos (<u>Catostomus insignis</u> y <u>Catostomus clarki</u>). Picos en densidades ocurrieron el 4 de Abril y el 7 de Mayo, cuando 144.000 y 645.000 larvas/dia, pasaron respectivamente a través del area de estudio. Aproximadamente 13,5 millones de larvas de peces fueron transportadas a través del valle Cliff-Gila durante el período de ocho semanas. Las larvas de peces fueron primeramente diurnas, 87% de todos los Ciprinidos y 79% de todos los Catostómidos fueron colectados durante el período de muestreo del mediodia y el atardecer. Las larvas también mostraron variaciones en la distribución a través del canal de flujo. La relación de peces entre las mallas cercanas a la orilla versus las mallas en el medio del canal fueron 6,5:1 en las muestras tomadas al mediodia, pero disminuyeron a cerca 1:1 en las muestras del amanecer. Los mecanismos causantes de el transporte fueron complejos y diferentes entre el arrastre en la noche y el arrastre en el dia. El arrastre durante el dia se pensó que es una consecuencia de obtener y mantener posiciones optimas de alimentación, y fué caracterizado por movimientos cortos y de saltos a lo largo de las márgenes de la corriente. El arrastre durante la noche fué el resultado del movimiento de las larvas desde aguas poco profundas y frias hacia el canal de flujo principal mas caliente. Los peces fueron transportados probablemente una distancia relativamente grande durante la noche dado a la pérdida de orientación. La distancia total del transporte estacional de las larvas de peces es probablemente controlado por el flujo de la corriente.

Growth and Survival of Larval Razorback sucker (*Xyrauchen texanus*) in Ponds at 3 Fertilization Rates

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ABSTRACT

Razorback sucker larvae of wild Lake Mohave brood stock spawned at the U.S. Fish and Wildlife Hatchery, Dexter, New Mexico, were stocked in ponds at 3 fertilization levels: low, medium and high. Preliminary results indicate that differences in fertilization were not great enough to cause significant differences ($p=.9$) in survival among treatments. However, growth, measured as individual fish weight and total biomass, did vary. The low treatment had significantly ($p=.1$) smaller fish and lower total biomass than the high treatment and the medium treatment. Pairwise comparison of medium and high treatments showed no difference.

Crecimiento y Supervivencia de Larva de Razorback sucker (*Xyrauchen texanus*) en Estanques a Tres Tasas de Fertilización

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Sumario

Larva de Razorback sucker (*Xyrauchen texanus*) producido por reproductores silvestres de Lake Mohave al criadero del U.S. Fish and Wildlife Service, Dexter, New Mexico, estuvieron sembrado en estanques a 3 niveles de fertilización: bajo, mediano, y alto. Resultados preliminares indican que diferencias por fertilización no fueron suficiente a causar diferencias significantes (p .9) en supervivencia entre tratamientos. Sin embargo, crecimiento, así medida por peso individual del pez y por biomasa total, varió. El tratamiento bajo tuvo peces significante más pequeño (p=.1) y con biomasa mas bajo que el tratamiento alto y tratamiento mediano. No hubo diferencia entre tratamientos mediano y alto.

Who's Minding the Pool: On the Subspecific Identity of the Pupfish in Crystal Spring, Ash Meadows, Nevada

Jack E. Williams[1] and James E. Deacon[2]

Abstract - During a 1966 survey of Crystal Spring, none of the native pupfish, *Cyprinodon nevadensis mionectes*, could be found. However, exotic largemouth bass, *Micropterus salmoides*, were present in the spring pool. By 1975, pupfish were present in the spring and persist today, but their origin and subspecific identity have been questioned. A meristic examination of recently collected pupfish from Crystal Spring (unknown), Point-of-Rocks Springs (*C. n. mionectes*) and Marsh Spring (*C. n. pectoralis*) was conducted in order to determine which pupfish was present in Crystal. The sample from Crystal Spring agreed with the description of *C. n. mionectes*. A review of historical records and field notes indicates that the native pupfish in Crystal Spring probably were not completely eliminated from the entire spring system and repopulated the spring pool when the predatory bass were removed. Fishing pressure and inhibition of spawning by the warm spring water (30.9 C) are hypothesized as causing the extirpation of the bass.

Sobre la identidad subespecífica del *Cyprinodon nevadensis* (pupfish) de Crystal Spring, Ash Meadows, Nevada

Resumen - Durante una observación de Crystal Spring, efectuada en 1966, no se encontró ningún *Cyprinodon nevadensis mionectes* (pupfish) indígeno pero sí se observaron *Micropterus salmoides*, especie no nativa. Desde 1975 hasta el día de hoy existen pupfish en el manantial pero han sido de origen e identidad subespecífica dudosos. Una observación merística de pupfish de especie desconocida tomados de Crystal Spring, Point-of-Rocks Springs (*C. m. mionactes*) and Marsh Spring (*C. m. pectoralis*) acaba de efectuarse para identificar los peces de Crystal. Los peces de éste parecen idénticos a *C. n. mionectes*. Un repaso de notas históricas indica que los pupfish indígenos probablemente no se eliminaron del todo del sistema manantial de Crystal Spring y que su población resurgió con la ausencia de los *Micropterus*. Se cree que la extirpación de éstos ha sido resultado de la intensidad de la pesca y la alta temperatura del agua (30.9 C).

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Differing Perspectives On Razorback Sucker Management In The Upper And Lower Colorado River Basins

by
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Razorback sucker, Xyrauchen texanus, has declined throughout the Colorado River drainage and is of concern to fishery resource managers in the Southwest. In June 1985 representatives from various state and federal agencies and universities met to discuss the status of razorback sucker and potential management strategies. This session summarizes that meeting and invites comments from the Council membership regarding management of the razorback sucker in the Colorado River drainage.

The differing status of razorback sucker in the upper and lower basins has resulted in two management strategies. Upper Colorado River Basin management supports Federal listing under the Endangered Species Act (ESA), as amended, as a threatened species with critical habitat. Listing could provide upper basin managers with funding (Section 6, ESA) and habitat protection (Section 7, ESA) for studying declining razorback sucker populations in largely unmodified river reaches. In constrast, lower basin management is directed toward attempted reestablishment of razorback sucker in historic range in lieu of listing. Data gathered during reintroduction and monitoring efforts are coupled with ongoing research on persisting lower basin populations to answer questions regarding reasons for decline, life history, and recovery prospects.

Perspectivas Diferentes Sobre Manejo De Razorback Sucker Entre Alta y Baja Cuencas Del Rio Colorado

Por
James E. Brooks
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Razorback sucker, <u>Xyrauchen texanus</u>, ha declinado por toda la cuenca del río colorado y es una cosa que preocupa administradores de recursos pesqueras del sudoeste. En junio 1985, representantes de varias agencias y universidades estatal y federal reunieron para discutir el estado del razorback sucker y estrategias potenciales de manejo. Esta sesíon va a resumir dicha reunion y invita comentarios de los miembros del consejo en cuanto el manejo del razorback sucker en la cuenca del río colorado.

El estado variable del razorback sucker entre alta y baja cuencas ha resultado en dos estrategias de manejo. Administracíon de la alta cuenca apoya su registracíon federal bajo el "endangered species act" (ESA), tal como reformado, como especia amenazada con hábitat critico. Registracíon puede proveer administradores de la alta cuenca con fondos (seccíon 6, ESA) y proteccíon de hábitat (Seccíon 7, ESA) para estudiar las poblaciones de razorback sucker en decadencia en secciones de río no modificado. Hacer contraste, la administracíon de la baja cuenca está dirigido a tratar a restablecer el razorback sucker en áreas de distribucíon históricas en vez de registracíon. Datos que fueron acumulados durante reintroduccíon y observacíon están unido con investigaciones sobre poblaciones persistentes de la cuenca baja para resolver cuestiones sobre la declinacíon, biologí́a, y potencial de restablecimiento.

RAZORBACK SUCKER MANAGEMENT IN ARIZONA

Razorback sucker management in Arizona began in 1981 with a 10-year memorandum of understanding between Arizona Game and Fish Department (GFD) and U.S. Fish and Wildlife Service. Production is at Dexter National Fish Hatchery, New Mexico, with grow-out to larger sizes both there and at GFD Page Springs Hatchery. By 1985, more than 10 million juveniles, fingerlings, and fry have been stocked at 28 sites on the Gila, Salt, and Verde rivers and their tributaries. Stocking sites and downstream riverine reaches have been monitored annually, and reservoirs on each system were sampled in 1985. Few have been recaptured more than a few weeks after introduction. Post-stocking studies to evaluate dispersal and predation were carried out in 1984 and 1985. Fish 62-213 mm TL move downstream at night. Predation by introduced catfishes (*Pylodictis olivaris*, *Ictalurus punctatus*) has potential to remove significant percentages of stocked fish. It is recommended that razorback be stocked at upstream localities where predator populations are absent or small, in winter when predation may be reduced, or where predators have been removed or at least depleted. Introductions should be of a few individuals over a wide time span rather than abruptly in large groups. Intensive monitoring should be restricted to a single river system to better use limited resources and obtain better information on successes and/or failures. Possibilities for differential survival of raceway versus pond-reared fish and for training in predator avoidance should be investigated.

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MANEJO DE RAZORBACK SUCKER (XYRAUCHEN TEXANUS) EN ARIZONA

Manejo de razorback sucker en Arizona empezó en 1981 por un 10-año memorándum de entender entre Arizona Game and Fish Department (GFD) y U.S. Fish and Wildlife Service. Producción occurre a Dexter National Fish Hatchery, New Mexico, con crecimiento a tamaños grandes ahí mismo y a GFD Page Springs Hatchery. Por 1985, más de 10 milliones de juveniles, alevines, y cria han estado sembrado a 28 sitios en los rios Gila, Salt y Verde y sus tributarios. Sitios de siembra y extensiones del rio abajo han estado observado anualmente, y presas en cada sistema estuvieron muestrado en 1985. Pocos han estado recapturado más de unas cuantas semanas despues de introducción. Estudios postsiembras para evaluar dispersión y predación estuvieron hechos durante 1984 y 1985. Peces 62-213 mm TL muevan a los aguas abajo por la noche. Predación por bagres (Pylodictis olivaris, Ictalurus punctatus) tiene potencial a remover un porcentaje significante de peces sembrados. Está recomendado que razorback sucker estuviera sembrado a sitios en aguas arriba a donde poblaciones de predadores son ausentes o pequeños, en invierno cuando predación puede ser reducido, o cuando predadores han estado sacado o por lo menos agotado. Introducciones deben ser de pocos individuos atravesando un periodo largo en vez de repente en grupos grandes. Observación intensiva debe ser limitado a un solo sistema de rio a mejor utilizar recursos limitados y obtener mejor información de los exitos y/o los fracasos. Posibilidades por sobrevivencia diferencial de cultivo por canal vs. estanque y por entrenamiento a eludir los predadores deben ser investigados.

MANAGEMENT PLAN FOR THE RAZORBACK SUCKER (<u>XYRAUCHEN TEXANUS</u>) IN CALIFORNIA

Linda C. Ulmer

Fishery Biologist

California Department of Fish and Game

Region 5

ABSTRACT

Historically the razorback sucker was the most abundant fish species in the lower Colorado River. Since the late 1950's physical, chemical and biological alterations of the lower river ecosystem have resulted in a significant decline in population numbers. Today, although remnant populations are found in the mainstream storage reservoirs and in Senator Wash Reservoir, Imperial County, CA there is no evidence of successful recruitment. In the riverine sections and canals of the lower river bordering California only 33 razorbacks, all adults, have been collected since 1969. In 1984-1985 seven sub-adults, less than 356 mm total length, were taken from equalizing reservoirs off the Coachella Canal in Imperial County, CA. This collection indicated possible mainstrem spawning in the Imperial Division of the lower river.

In 1985 the State of California approved a management plan for the razorback. This plan is based on a decade of reintroduction and research program data and represents a viable and conservative approach by which this endangered fish may be recovered within historic California habitats. In the winter of 1986 California Department of Fish and Game in association with the U.S. Fish and Wildlife Service will initiate a ten year reintroduction and monitoring program in the lower Colorado River. Without this effort this once-abundant native species will continue to decline until extinction.

Status of the Razorback sucker in the Green River, Utah

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Abstract--The razorback sucker, once widely distributed in the mainstem rivers of the Colorado River Basin is still found today in riverine habitat of the Green River Basin, where it may be more numerous than in other locations in the Upper Colorado Basin. Although historic data prior to 1970 is scant, records from the 1890's suggest that the fish was never as abundant in the upper basin as in the lower. Some areas formerly supporting the razorback in the upper basin have been altered by water development and the fish extirpated from them. The Fish and Wildlife Service has studied the rare and endangered fishes in the Green since 1979. A systematic sampling program from 1979-81 indicated that the razorback was very rare, and was only 11% as abundant as the endangered Colorado squawfish. However, subsequent studies from 1981-84, including radiotelemetry, revealed that the razorback is not very susceptible to capture except during spring spawning. Razorback spawning was documented from 1981-84 with the capture of 47 fish in breeding condition and tentative identification of larvae. Since no young juveniles were collected, recruitment is apparently very low. Growth of adults measured from the interval between capture/recapture of tagged fish (from 16 years) averaged less than 5 mm/year. These data suggest that the razorback should be considered endangered in the upper basin and immediate steps should be taken to protect and recover it.

STATUS OF THE RAZORBACK SUCKER *XYRAUCHEN TEXANUS* IN THE COLORADO RIVER UPSTREAM FROM LAKE POWELL

Charles W. McAda

U. S. Fish and Wildlife Service
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The razorback sucker *Xyrauchen texanus* is distributed throughout the upper Colorado River from upper Lake Powell to Rifle, CO. However, few specimens have been collected in recent years and the species is considered rare. The razorback sucker is listed as endangered by the state of Colorado and is protected by the state of Utah, but it currently receives no federal protection. The Fish and Wildlife Service (FWS) has collected 23 razorback suckers from the upper Colorado River since 1982. This number compares with 165 subadult and adult Colorado squawfish *Ptychocheilus lucius* and 300 adult humpback chub *Gila cypha* collected during the same time period with equivalent effort. The latter species are listed as endangered by FWS.

Colorado Division of Wildlife crews collected 7 razorback suckers in the Colorado River between 1979 and 1984 (personal communication, John Hawkins, Colorado State University). They estimated that 50 or more Colorado squawfish were handled for every razorback collected. One razorback sucker has been collected in the Gunnison River since 1980 (personal communication, P. Holden, Biowest). Razorback suckers are infrequently collected from the Dirty Devil and Colorado River arms (personal communication, K. Lashmett, Bureau of Reclamation) and San Juan River arm (personal communication, W. Gustaveson, Utah Division of Wildlife Resources) of upper Lake Powell.

Current evidence indicates the razorback sucker is in a tenuous position in the upper Colorado River. Of the four rare large-river fishes native to the upper basin, only the bonytail *G. elegans* is less common. In addition, no evidence of successful recruitment to the population has been found in recent years. The lack of recruitment indicates that the population will continue to decrease as individuals age and die. Adequate funds for research and management are needed to identify reasons for the continuing population decline and to reverse the trend.

NEVADA DEPARTMENT OF WILDLIFE'S ENDEMIC FISH PROGRAM -- 1985

Presented by: Donna Withers, Endemic Fish Biologist

In late 1984, the Nevada Department of Wildlife initiated a state-wide endemic fish program. A biologist is stationed at the Las Vegas office, since the majority of the sensitive fish species exist in the southern half of Nevada. The primary direction of the program is to develop a solid database on the State's sensitive fish species, with special emphasis on species proposed or considered candidates for federal listing. Time is also devoted to endangered and threatened species recovery efforts. Work is accomplished by the endemic fish biologist, other regional fishery biologists, and through contract.

The State of Nevada currently supports fourteen endangered species and two threatened species. The White River spinedace (Lepidomeda albivallis), White River springfish (Crenichthys baileyi baileyi), and Hiko White River springfish (Crenichthys baileyi grandis) were added to the Endangered Species List in 1985. The Railroad Valley springfish (Crenichthys nevadae), the Fish Creek Springs tui chub (Gila bicolor euchilla), and the Desert dace (Eremichthys acros) are still awaiting final ruling on their proposed threatened status. The Virgin River roundtail chub (Gila robusta seminuda) is proposed for endangered status.

Major activities undertaken by the NDOW endemic fish biologist include:

1. Development of Blue Link Spring in Mineral County and subsequent release of Hiko White River springifsh (Crenichthys baileyi grandis). -- population has exploded since the first release in February 1985.

2. Capture and transfer fifty Pahranagat roundtail chub, (Gila robusta jordani), from the Burns Ranch reach of the Ash Springs outflow to the Dexter National Fish Hatchery in New Mexico.

3. Monitor the expansion of the re-introduced population of Hiko White River springfish (Crenichthys baileyi grandis) at Hiko Spring.

4. Inventory the population of Pahrump killifish, (Empetrichthys latos latos), at the Shoshone Ponds Resource Area.
   -- population has declined from 1984 levels.

5. Determine status of native fish population in the White River Valley -- Lepidomeda albivallis, Rhinichthys osculus velifer, Catostomus clarki, Crenichthys baileyi thermophilus, Crenichthys baileyi albivallis.

Contracts let by NDOW for the 1984 and 1985 seasons included the following projects:

1. Survey of the native fishes of the White River and Carpenter River drainages.

2. Status and distribution of *Gila bicolor euchilla* at Fish Creek Springs, of *Gila bicolor* in Railroad Valley, Little Fish Lake Valley, Hot Creek Valley, Big Smokey Valley and Fish Lake Valley.

3. Conduct age and growth studies on the Pahrump killifish (*Empetrichthys latos latos*), and monitor the three refugia populations.

4. Determine the subspecific identity of the pupfish, *Cyprinodon nevadensis*, in Crystal Spring, Ash Meadows.

5. Study the annual variation in population size of the Warm Spring pupfish, (*Cyprinodon nevadensis pectoralis*) at School Springs, Ash Meadows.

6. Describe the physical characteristics of the Crystal Springs outflow (Lincoln County) with reference to the re-introduction of Pahranagat roundtail chub (*Gila robusta jordani*).

7. Propagation and rearing of Hiko White River springfish (*Crenichthys baileyi grandis*) in aquaria.

8. Determine the population status of the Railroad Valley springfish (*Crenichthys nevadae*).

As of September 1985, thirty-seven (37) species and subspecies of fish and amphibians are on the Candidate List. Gathering information on many of these species will be accomplished in 1986.

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

Department of Zoology
Arizona State University
Tempe, Arizona 85287
January 13, 1986

RESOLUTION 85-1

RELATIVE TO THE MOHAVE RIVER FORKS DAM WATER CONSERVATION PROJECT AND ITS IMPACT ON THE MOHAVE TUI CHUB, A STATE AND FEDERALLY LISTED ENDANGERED SPECIES.

WHEREAS the activities of man have extirpated the Mohave tui chub (*Gila bicolor mohavensis*) from its native habitat, the Mohave River, and reduced its population in its native range to habitat at Soda Springs, and

WHEREAS the water table at Soda Springs is dependent upon flows from the Mohave River, and

WHEREAS the U.S. Army Corps of Engineers' 1985 report on the Mohave River Dam states that the proposed Mohave River Forks Dam Water Conservation Project could result in an average decline in the water table at Soda Springs of from 0.5 to 2.0 feet per year, and

WHEREAS the lowering of the water table at Soda Springs would exert serious impacts on the Mohave tui chub habitat, now therefore be it

RESOLVED that the Desert Fishes Council, an organization numbering in excess of 300 persons and comprising a nationwide and international representation of federal, state, and university scientists and resource specialists, members of conservation organizations, and individuals concerned with long-term environmental values, assembled at the Council's Seventeenth Annual Symposium on November 16, 1985 at Death Valley National Monument, does hereby recommend against the Mohave River Forks Dam Water Conservation Project, and be it further

RESOLVED that copies of this resolution be forwarded to the District Engineer of the U.S. Army Corps of Engineers, Los Angeles District; the General Manager of the Mohave Water Agency; the Director of the U.S. Fish and Wildlife Service; the Director of the California Department of Fish and Game; and to other agencies and individuals as appropriate.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

W.L. Minckley
Chairman

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

Department of Zoology
Arizona State University
Tempe, Arizona 85287

January 13, 1986

RESOLUTION 85-2

RELATIVE TO ACTUAL AND PROPOSED WATER DIVERSIONS FROM THE MOHAVE RIVER AND THEIR IMPACTS ON THE MOHAVE TUI CHUB, A STATE AND FEDERALLY LISTED ENDANGERED SPECIES.

WHEREAS the activities of man have extirpated the Mohave tui chub (_Gila bicolor mohavensis_) from its native habitat, the Mohave River, and reduced its native range to habitat at Soda Springs, and

WHEREAS the water table at Soda Springs has been shown to be dependent upon flows from the Mohave River, and

WHEREAS there are present, and will be future, demands upon the hydrologic resources of the Mohave River and its tributaries, and

WHEREAS the lowering of the water table at Soda Springs would exert serious impacts upon the Mohave tui chub, now therefore be it

RESOLVED that the Desert Fishes Council, an organization numbering in excess of 300 persons and comprising a nationwide and international representation of federal, state, and university scientists and resource specialists, members of conservation organizations, and individuals concerned with long-term environmental values, assembled at the Council's Seventeenth Annual Symposium on November 16, 1985 at Death Valley National Monument, does hereby recommend against both present and future demands upon the hydrologic resources of the Mohave River and its tributaries, including surface water, subsurface flow, and any water resulting from high flow events, in consideration of the serious environmental impacts to the Mohave tui chub and native riparian resources along the Mohave River, and be it further

RESOLVED that copies of this resolution be forwarded to the State Water Resources Control Board; the City of Adelanto; George Air Force Base; the Southern California Water Association; the Crestline-Lake Arrowhead Water Agency; the District Engineer of the U.S. Army Corps of Engineers, Los Angeles District; the General Manager of the Mohave Water Agency; the Director of the U.S. Fish and Wildlife Service; the Director of the California Department of Fish and Game; and to other agencies and individuals as appropriate.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

W.L. MINCKLEY
CHAIRMAN

ATTENDANCE LIST, SYMPOSIUM XVII, DEATH VALLEY NATIONAL MONUMENT, NOVEMBER 14-16, 1985.

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Beula Edmiston	Friends of Wildlife	Monterey Park, CA 91754
Tasker Edmiston	" " "	" " " "

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

EIGHTEENTH ANNUAL SYMPOSIUM

The Four Seasons Convention Center

St. George, Utah

November 20-22, 1986

EL CENTRO ECOLOGICO DE SONORA; UNA INSTITUCION DE ESTUDIO DE LA FLORA Y FAUNA DEL DESIERTO SONORENSE

ING. MANUEL GARCIA PUEBLA *
OC. LOURDES JUAREZ ROMERO **

Gracias al esfuerzo del pueblo de Sonora y a la visión de sus gobernantes , ha sido posible la creación de esta Institución entre cuyos principales objetivos destacan el fomento a la educación ecológica y la realización de investigación científica.

Para cubrir tales objetivos, esta Institución de reciente creación y cuyas instalaciones están asentadas en un área que abarca cerca de 1000 Has., tiene una zona de exhibición en donde se muestran al público más de 485 especies del Desierto Sonorense y de otros desiertos del mundo; una zona de investigación con equipo de laboratorio básico donde se realiza investigación científica en las áreas de: botánica, ecología marina, mamíferos mayores y menores, entomología, herpetología y limnología; una zona de reproducción con extensión de 130 Has. para producir especies como: borrego cimarrón, berrendo, venado cola blanca, etc.; y por último una zona de reserva en donde las características ecológicas se mantienen sin alteración alguna.

Con respecto a educación, se difunden los principios básicos para la conservación de los ecosistemas naturales y así motivar la conciencia del pueblo para el cuidado del patrimonio natural heredado.

Actualmente el área de Limnología se ha iniciado en la investigación de la Ictiofauna del Estado y cuenta con un área de exhibición para las especies de peces más representativas del Desierto Sonorense.

*Director General C.E.S.

** Jefe del Area de Limnología C.E.S.

Edificio Alonso 202, Hermosillo, Sonora, México. Tel.: 278-81 y 388-23

centro ecológico de Sonora

THE CENTRO ECOLOGICO DE SONORA: AN INSTITUTION FOR STUDY OF THE FLORA AND FAUNA OF THE SONORAN DESERT

Engineer Manuel Garcia Puebla, General Director, Centro Ecológico de Sonora, and Oceanographer Lourdes Juárez Romero, Supervisor, Area of Limnology, Centro Ecológico de Sonora, Apartado Postal 1497, Hermosillo, Sonora

Thanks to the people of Sonora and the vision of their government, it has been possible to create this public institution which has public education in ecology and scientific research as its principle objectives.

To address these objectives, the recently created institution located on about 1000 hectares on the outskirts of Hermosillo has an exhibition zone in which are displayed more than 485 species of the Sonoran Desert and other deserts of the world. The separate research facilities contain basic laboratory equipment employed in studies in the general areas of botany, marine ecology, small and large mammals, entomology, herpetology and limnology. About 130 hectares are devoted to a separate reproduction zone for species such as desert bighorn sheep, antelope and white tail deer. The remainder of the Centro is maintained as an unaltered native vegetation preserve.

In its role as educator, the Centro attempts to educate the public in basic principles of natural ecosystem conservation in an attempt to develop a public awareness of the need for care and protection of the country's natural heritage.

ABSTRACT

Fish designs on Mimbres Pottery

Fish are frequently depicted on Mimbres pottery. Approximately 6,000 photographs of Mimbres pottery designs are in the Maxwell Museum of Anthropology archives, Albuquerque, New México. A review of the archives revealed several similarities among the fish designs. None of the designs permit description to the species level.

Jerry Burton
U.S. Fish & Wildlife Service, OES
Albuquerque, NM

Present Status and Recovery Potential of the Big Spring Spinedace (*Lepidomeda mollispinis pratensis*)

Randy M. McNatt
U.S. Fish and Wildlife Service
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ABSTRACT

The Big Spring spinedace was listed as threatened with critical habitat by the U.S. Fish and Wildlife Service on March 28, 1985. The subspecies is endemic to the Meadow Valley Wash drainage, Lincoln County, Nevada and currently exists only in a few Km of stream within Condor Canyon, northeast of Panaca, Nevada. The spinedace was uncommon in the outflow of Panaca Spring in 1938 when first collected by Robert Miller and Carl Hubbs and was extirpated from this locality by 1959 due to agricultural modifications of the system and introduction of non-native fishes. Extinction seemed probable, but, in 1977, biologists from the Nevada Department of Wildlife discovered a small spinedace population in Condor Canyon about 7.5 Km upstream from Panaca Spring. Spinedace were transplanted further upstream and the subspecies currently exists in only 6.4 Km of stream. Threats include the presence of introduced fishes, increasing human disturbance of the area, pollutants from upstream agriculture, catastrophic flooding, and reduction in streamflow from groundwater pumping and agricultural diversions. A recovery plan is being developed which proposes to secure the existing population and to establish at least one other self-sustaining population within the Meadow Valley Wash drainage. As part of the recovery plan, research on spinedace life history requirements is necessary to determine future management activities in Condor Canyon, and to allow selection of optimum introduction sites.

THE ENDANGERED WOUNDFIN AND WATER MANAGEMENT IN THE VIRGIN RIVER, UTAH, ARIZONA, NEVADA.

James E. Deacon

Attempts to define conditions permitting compatible existence of endangered fishes and water development projects in Virgin River Basin of Utah, Arizona and Nevada have met with limited success. One major water project (Warner Valley) was abandoned in 1980 because of jeopardy to the endangered woundfin. A substitute water project (Quail Creek) was completed in 1985 following acceptance of conditions judged essential to insure survival of woundfin. Flow requirements specified for that project, however, were apparently violated for at least 112 days in June-October 1985 and 108 days during June-September 1986.

In late May 1985, the entire flow of Virgin River immediately below the new Quail Creek diversion structure disappeared into sink holes that developed in the river bed. At about that time discharge into the river bed from the hot saline Pah Tempe springs located about 4.8 km downstream increased from about .33 to an estimated 1.2 m^3/sec. Native fish populations declined throughout the Utah segment of Virgin River in 1985 and reproduction was poor to nonexistent above Quail Creek. Some species recovered and reproduced well following improvements in water quality in 1986. Degraded water quality, of course, also adversely affected farmers dependent on irrigated agriculture.

The exotic red shiner added another environmental challenge to native fishes when, during 1985 and 1986, it, for the first time, became the dominant species throughout the Arizona/Nevada reach of Virgin River. During this period native species declined. The red shiner first appeared in the Utah reach of Virgin River in 1984, dominated the population by 1986, and may be responsible for introducing the Asian tapeworm into the native fishes of Virgin River.

Management of endangered species in Virgin River requires a continuous flow of information on population status, habitat requirements and biotic interactions. Furthermore that information must continuously be integrated into the numerous water management activities in the system. Unanticipated environmental changes such as the increased discharge from the salt spring plus uncontrollable changes such as establishment of the red shiner complicate an already precarious ecological system. Failure of water managers to maintain "a minimum of 86 cfs as measured below La Verkin Power Plant....before reservoir diversions could be made" exacerbated the already considerable endangered species problems in Virgin River in 1985 and 1986.

Enthusiastic promotion of water development without careful attention to environmental and agricultural values can lead not only to a degradation of the quality of life in southwestern Utah but also to violations of legal as well as ethical responsibilities.

THE SUBSPECIFIC IDENTITY OF THE AMARGOSA PUPFISH (*CYPRINODON NEVADENSIS*) FROM SHOSHONE SPRINGS, INYO COUNTY, CALIFORNIA

Frances R. Taylor and John W. Pedretti

Robert R. Miller at the November 1969 Desert Fishes Council Symposium stated that the pupfish inhabiting the Shoshone Spring outflow was an intergrade between *Cyprinodon nevadensis amargosae* and *Cyprinodon nevadensis shoshone* and that the Shoshone pupfish was extinct in pure form. Selby (1977) reports finding no pupfish in the entire Shoshone Springs system. During the summer of 1986, pupfish were found in large numbers in most components of this spring system. Preliminary conventional meristic and morphometric analysis demonstrates that the population presently inhabiting Shoshone Springs and its outflow agrees most closely with the diagnosis provided by Miller (1948) for *C. n. shoshone*. It is possible that *C. n. shoshone* may have survived precariously in the nearly impenetrable marshy outflow below Shoshone Spring. Their subsequent re-establishment throughout the system apparently followed re-establishment of favorable habitat conditions. Threats to this pupfish population include chlorinated water from the swimming pool which drains into the outflow and recent modifications of the outflow channel by heavy equipment.

STATUS AND DISTRIBUTION OF THE TUI CHUB (*GILA BICOLOR*) IN FISH LAKE VALLEY, ESMERALDA COUNTY, NEVADA

John W. Pedretti and Lisa G. Heki

Springs on the floor of Fish Lake Valley were surveyed on March 31-April 4, July 28-29, 1985 and September 5-7, 1986 to determine the status of tui chub (*Gila bicolor*) populations previously reported from the area. Results were compared with earlier surveys conducted by Carl L. Hubbs in 1934, Robert R. Miller in 1937, and Donald W. Sada in 1983. *G. bicolor* were extant in two isolated spring systems but have apparently been extirpated from Fish Lake spring due to habitat modification and the presence of introduced fishes. A spring-fed channelized ditch found to contain chub in July 1985 was dry in September 1986.

THE INFLUENCE OF THE CONVICT CICHLID ON GROWTH AND REPRODUCTION OF WHITE RIVER SPRINGFISH

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The Hiko White River Springfish (Crenichthys baileyi grandis) was extirpated from Hiko Spring between February 1966 and June 1967 (Minckley and Deacon, 1968; Deacon, 1979; Williams and Wilde, 1981). Efforts to re-establish the Hiko Spring population have been made over the past few years by University of Nevada, Las Vegas and Nevada Department of Wildlife (Baugh et al. 1985). Springfish were first stocked into Hiko Spring on 24 January, 1984, and had reproduced by 11 February, 1985 (Baugh et al. 1985). At that time reproduction of the newly introduced Convict Cichlid (Cichlasoma nigrofasciatum) was also demonstrated (Baugh et al. 1985). Sympatry of the convict cichlid and springfish populations at Ash Spring and Crystal Spring demonstrated that springfish populations become depressed in the presence of cichlids (Courtenay et al. 1985).

This experiment was designed to examine the growth and reproductive success of springfish living sympatrically with convict cichlids, and to determine how cover influences the outcome. Our hypothesis is that the Hiko White River Springfish will grow more rapidly and reproduce more successfully in the absence of convict cichlids and that cover will enhance growth and reproduction of springfish.

Springfish and cichlids were kept in separate 208.2 1 stock aquaria for three months prior to introduction into experimental aquaria. Experimental fish were weighed (volume displacement), measured (T.L. mm) and sexed. Allopatric populations containing five pair of springfish or five pair of cichlids were established in each of two aquaria with and without cover. Sympatric populations, each containing three pair of springfish and two pair of cichlids, were established in each of two aquaria with and without cover. Cover consisted of assorted rocks and plastic plants all used in approximately equal amounts. Spawning grass was placed in all aquaria to encourage spawning. Fish were fed Tetramin Staple Food at a rate of approximately six percent body weight twice daily to ensure that food would not become a limiting factor. All aquaria were maintained at a temperature of 23 - 26C. One Aquarium suffered a heater malfunction and was therefore terminated. Undergravel filtration was used in the experimental aquaria while the stock aquaria were filtered with outside power filters. Daily observations of aggressive activity, and fin or body damage were made.

Table 1 summarizes data on mean growth of springfish and cichlid populations. With cover available, springfish in allopatric populations grew 3-4 time more in both volume and length than was true for springfish occurring sympatrically

Table 1. Average individual increase in volume ($\bar{X}L$) and length ($\bar{X}L$) in sympatric and allopatric experimental populations of White River springfish and convict cichlids fed 12 percent body weight per day for 63 days.

	Allopatric				Sympatric			
	cover		no cover		cover		no cover	
	$\bar{X}V$	$\bar{X}L$	$\bar{X}V$	$\bar{X}L$	$\bar{X}V$	$\bar{X}L$	$\bar{X}V$	$\bar{X}L$
springfish	.36	6.2	.27	5.8	.12	1.65	.23	5.3
cichlids	1.19	5.9	1.80	10.1	1.72	10.5	2.34- 2.39	17.7- 18.4

Table 2. Mean number of chases by cichlids per observation period and percent of population sustaining fin damage during the experimental period in sympatric and allopatric experimental populations of White River Springfish and convict cichlids.

	Allopatric				Sympatric			
	cover		no cover		cover		no cover	
	chase	fin	chase	fin	chase	fin	chase	fin
springfish	0	0	0	0	.15	0	.32	0
cichlids	.41	50	.70	60	.71	62.5	.64	87.5

with cichlids. However, in sympatric populations, cover appears to depress growth of springfish. Interestingly, in the absence of cover, little difference in growth between sympatric and allopatric populations was noted.

Cichlids in sympatric populations grew more rapidly than in allopatric populations. Cover also had a uniformly depressing effect on growth of cichlids.

Cichlid aggression (Table 2) was directed toward springfish in only a minor way but occurred more frequently in the absence of cover. No fin damage or other injury was sustained by springfish as a consequence of cichlid aggression throughout the experimental period. Intraspecific aggression by cichlids appears more intense under sympatric than under allopatric conditions and is also higher when cover is absent. These relationships are most clearly illustrated by the data on fin damage.

Reproduction of springfish was noted only in the allopatric populations. At termination, 15 springfish fry occurred in aquaria with cover while 2 fry occurred in aquaria without cover. Fry did not exist in the sympatric populations.

Data indicate that growth (Table 1) and reproduction of Hiko White River springfish is enhanced in allopatric populations by the availability of cover. Slower growth of springfish in sympatric populations when cover is available is puzzling and requires further investigation. Perhaps, in the presence of cichlids, springfish living in cover will feed less than populations that have cover. We notedno striking differences in springfish behavior under the varying experimental conditions however.

Table 1 demonstrates that growth in both volume and length of Hiko White River springfish is greater in allopatric than in sympatric experimental populations. The difference is clearly more striking when cover is available than when it is not. It also is clear that, under experimental conditions, cichlids prevent successful springfish reproduction. Aggressive encounters suggest that cichlids do harass springfish to some degree (Table 2) but that no physical damage results. The harassment may be sufficient to account for the reduced growth. We suspect that the failure of springfish to reproduce successfully may be a consequence of egg and/or fry predation by cichlids.

Table 1 also demonstrates that cichlids in sympatric populations grow considerably faster than in allopatric populations. This may be largely attributable to the fact that cichlid population density in our experimental design was considerably lower in sympatric populations which possessed only two pair of cichlids per 75.7 1 aquaria than allopatric populations which possessed five pair of cichlids per 75.7 1 aquaria. Weatherley (1972) cites many instances in which population density appears to influence growth of fishes. However, we doubt that food limitation could have been a significant factor in this case. Furthermore, the higher fin damage in sympatric populations (Table 2) appears inconsistent with behavioral conditions that would permit faster growth. It is apparent that cover reduces the amount of fin damage sustained by cichlids in either sympatric or allopatric populations.

These data suggest that the convict cichlid is capable of reducing growth rate and inhibiting successful reproduction of the Hiko White River springfish. Cover enhances growth and reproduction of springfish in allopatric populations but apparently does not, or has a negative influence in sympatric populations. Adult springfish sustain no physical damage while occurring sympatrically with cichlids. Cover also reduces aggressive encounters between springfish and cichlids.

Literature Cited

Baugh, T.M., J.E. Deacon and D. Withers. 1985. Conservation efforts with the Hiko White River Springfish. Journal of Aquariculture & Aquatic Sciences. 4(3):49-53.

Courtenay, W.R., Jr., J.E. Deacon, D.W. Sada, R.C. Allan and G.L. Vinyard. 1985. Comparative status of fishes along the course of the pluvial White River, Nevada. Southwest Nat. 30(4):503-524.

Deacon, J.E.. 1979. Endangered and threatened fishes of the west. Great Basin Nat. Mem. 3:41-64.

Minckley, W.L. and J.E. Deacon. 1968. Southwestern fishes and the enigma of "endangered species." Science 159:1424-1432.

Weatherley, A.H. 1972. Growth and Ecology of Fish Populations. Academic Press Inc., London.

Williams, J.E. and G.R. Wilde. 1981. Taxonomic status and morphology of isolated populations of the White River springfish, Crenichthys baileyi (Cyprinodontidae). Southwest Nat. 26:485-503.

ARIZONA SPRING SNAILS (HYDROBIIDAE; PROSOBRANCHIA; RISSOACEA)

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ABSTRACT

A diverse fauna of Arizona Hydrobiidae is documented as a result of recent collecting from numerous springs in the state. The fauna is composed of 14 species in two genera, Pyrgulopsis Call and Pilsbry and Tryonia Stimpson. Thirteen species are described as new and the fourteenth represents a new record for the state. All of the species have relatively restricted distribution, and eight are endemic to a single spring or spring complex. All congeners are allopatric to one another.

Stepwise canonical discriminant function analyses using sets of shell and anatomical data confirmed the distinctiveness of the 12 species of Arizona Pyrgulopsis, as classification of (grouped) topotypes was 89-93% based on analysis using shell data and 100% for analyses using anatomical data. The discriminent analyses also confirmed that differentiation among congeners largely involves male anatomy (especially penial features), as this data set yielded the best separation of species in plots of scores on the first two discriminant functions.

CARACOLES DE MANATIALES (HYDROBIIDAE, PROSOBRANCHIA, RISSOACEA) DE ARIZONA

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RESUMEN

Como resultado de colectas recientes de varias manantiales del estado, se documents una fauna diversa de Hydrobiidae en Arizona. La fauna está compuesta de 14 especies dos géneros, Pyrgulopsis Call y Pilsbry y Tryonia Stimpson. Trece especies son nuevas y la otra se registra en el estado por primara vez. Todas las especies tienen distribuciones restringidas, y 8 son endémicos a un sólo ojo de agua ó a un complejo de ojos. No se encuentran las especies congenericas viviendo simpátricas.

Análises de distinción canónica por pasos clasifican topotipos (agrupados) de Pyrgulopsis con exactitud de 89-93% utilizando carácteres de la concha y con exactitud de 100% utilizando carácteres de anatomía blanda, asi confirmando distinción de las especies. Las mismas análises tambien indican que la diferención entre especies congenericas es principalmente en la anatomía de los machos (especialmente carácteres del pene), como esta clase de datos produce mayor separación de especies en gráficas del las primeras dos funciones de distinción.

COLORADO RIVER SQUAWFISH REINTRODUCTION STUDIES

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On October 8, 1986 approximately 36,000 juvenile (50-100 mm TL) Colorado River squawfish, Ptychocheilus lucius, produced at Dexter National Fish Hatchery were released into historic range in the Verde River in Central Arizona. Prior to release, fish were divided into two equal groups, one was conditioned for one week in a raceway in which maximum possible current (.04 average, 0.15 m/s range) was maintained while the other group was held in a raceway lacking detectable currents. Although each group was fed at equal rates, the diet of current conditioned fish was oxytetracycline treated to produce marks on bones. Prior to stocking, groups were differentially marked with spray-applied florescent pigments. Despite essentially equal treatment, groups differed slightly upon stocking. Current conditioned fish were on average smaller and at any given length weighed slightly less than did fish of the other group.

After stocking, group specific squawfish dispersal was monitored using an array of hoop nets set at intervals up to 2 km upstream and downstream of the release site. Seines and electrofishing were also deployed to supplement data obtained from hoop nets, and gill and trammel nets were run to sample predators for evidence of predation on squawfish. Although not yet analyzed, predators were collected and stomachs frozen. Field observations indicate that Ictalurus natalis and Micropterus dolomeiui were the principal predators on squawfish. Tetracycline marks on bones should allow group-specific identification of squawfish in stomachs.

Preliminary analyses indicate that current conditioned squawfish initially moved downstream more rapidly than did non-current conditioned fish after mid-morning release into a quiet reach. Within 24 hours after release, however, nearly all fish of both groups had moved downstream beyond the last hoop net at 2 km below the release site. By comparison, less than 1% of the total squawfish caught were taken in the net 100 m above the release site, and only one was taken in the net 400 m above. With exception of the initial movement following stocking, squawfish movement was markedly crepuscular with very large hoop net catches between 6:00 and 8:00 PM.

ESTUDIOS DE REINTRODUCCIONES DE SQUAWFISH DEL RIO COLORADO

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El 8 de Octubre, 1986, fueron liberados en el Río Verde de la parte central de Arizona aproximadamente 36,000 squawfish del Río Colorado, Ptychocheilus lucius, producido por la Estación de Pisicultura Nacional de Dexter. Antes de soltarlos, los peces fueron compartidos a dos grupos iguales, uno de los cuales se acondicionó por una semana en estanque con corriente (.04 m/s promedio, 0.15 m/s rango) mientras el otro grupo se mantuvo en estanque sin corriente. Dietas administradas a los grupos fueron iguales fuera del hecho que la dieta del grupo mantenido en corriente contuvo oxitetraciclino para producir marcas en los huesos. Ademas, cada grupo recibió marcas de distintos colores de pigmentos aplicados por rocio de aire compresado. A pesar del tratamiento esencialmente igual, los grupos variaron en tamaño y peso al soltarlos. Los del grupo expuesto a corriente tuvo un tamaño promedio menor y a cualquier tamaño pesaron menos de los del grupo no expuesto a corriente.

Despues de soltarlos al rio la rata y dirección de dispersión de ambos grupos fueron medidos por medio de series de redes de aros colocados arriba y abajo del sitio de liberación de los peces. Ademas se emplearon chinchorros y otros tipos de redes (agalladeras y "trammel") y pesca electrica. Observaciones en el campo indicaron que Ictalurus natalis y Micropterus dolomeiui comieron squawfish. Aunque no analizados, fueron congelados los estómagos de todas especies de peces predadores para análises subsecuentes para evidencia de predación de squawfish. Marcas de tetraciclino permitirán identificación de los squawfish encontrados en estómagos a su propio grupo experimental.

Análises preliminares indican que despues de liberarlos en medio manana, los acondicionados a corriente bajaron inicialmente con la corriente del rio a una rata mas rapida que los no expuesto antes a corriente. Sin embargo, dentro de 24 horas de su liberación, casi todos los peces de ambos grupos hubieron pasado la red a 2 km abajo del sitio donde fueron soltados. En comparación, menos de 1% de todos los squawfish muestreados cayeron en la red 100 m arriba del sitio de liberación y un solo espécimen cayo en la de 400 m arriba. Fuera del moviemiento inicial, movimiento de squawfish fue crepuscular con las muestras mas grandes occurriendo entre 6:00 y 8:00 PM.

RED SHINER VS. NATIVE FISHES: REPLACEMENT OR DISPLACEMENT?

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ABSTRACT

The introduced red shiner, Notropis lutrensis, has been implicated with reductions in the range and abundance of fishes native to southwestern desert streams. Non-overlapping distributions of red shiner and federally threatened Gila River endemics, Meda fulgida and Tiaroga cobitis, are thought to be evidence of competitive interactions resulting in historic reductions in range and abundance of these two native forms. A recent range expansion of red shiner into the Gila River of New Mexico and complementary distribution of red shiner and native cyprinids was documented, but does not indicate that competitive interactions are occurring. Habitat degradation, reduction in streamflow, and high summer water temperatures in the Gila River below the Middle Box supressed native fishes prior to invasion of red shiner and allowed this fish to colonize and dominate the community. In the Gila River above the Middle Box, abundant populations of native fishes including threatened forms exist, and despite a colonization date similar to that in the lower river, red shiner constitutes less than 1% of the community. Analogous situations in the San Francisco River, NM and the Verde River, AZ suggest that a transition zone exists. In its native range, red shiners are most abundant following reductions of other indigenous forms caused by habitat degradation. Thus, abundant, diverse indigenous faunas appear to inhibit establishment of large populations of red shiner. The red shiner appears to merely fill voids in Gila River fish communities caused by prior habitat degradation. Maintenance of permanent streamflow and pristine habitat are critical to sustain native fishes and supress populations of red shiner.

FOOD AVAILABILITY AND MORTALITY FOR LARVAL RAZORBACK SUCKER, *Xyrauchen texanus* **

by
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Starvation of fishes early in life has been suggested as a potential cause of mortality on a significant scale and thus a major factor in reducing recruitment to adult populations.

In Lake Mohave, Arizona-Nevada, mean size of captured larval razorback sucker is 10.6 mm total length (TL). Stomachs are mostly empty and lake zooplankton density appears low at the time of razorback hatching. No recruitment to the adult population has been detected.

Laboratory experiments were performed at the United States Fish and Wildlife Service, Dexter, New Mexico facility at water temperatures of 18°C. To determine when larval razorback sucker must encounter food or die, larvae were started on food at 4-day intervals. Those larvae fed beginning 25 and 29 days post-hatch had significantly higher mortalities than those larvae fed 5, 9, 13, and 17 days after hatching. The effect of varying food density on mortality was also investigated. Fish receiving 10 nauplii per liter per 8-hour period had greater than 70% mortality, while those receiving 50 nauplii per liter per period had less than 30% mortality. Fish which received no food throughout the experiment, as well as those fed at varying time periods or prey densities, experienced peak mortalities between 20 and 30 days post-hatch. The point of irreversible starvation was determined to be between 17 and 21 days post-hatch, and the critical period between 7 and 17 days post-hatch.

The results are discussed in relation to observations on razorback sucker larvae in Lake Mohave.

**The Council's first Best Student Paper award went to Diana Papoulias for the research described herein. We offer our sincere congratulations to Diana for her excellent contribution!

DISPONIBILIDAD DE ALIMENTO Y MORTALIDAD DE LARVA DE RAZORBACK SUCKER, *Xyrauchen texanus*

por
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Se ha sugerido que inanición de peces recién eclosionado tenga potencial a causar mortalidad en escala grande y así puede ser un factor en la reducción de reclutamiento a poblaciones adultas.

En Lake Mohave, Arizona-Nevada, el tamaño promedio de larva de razorback sucker es 10.6 mm largura total. La mayoria de los estomagos de los peces están vacios y densidad de zooplancton en la presa parece bajo durante tiempo de eclosión de razorback sucker. No reclutamiento a la población adulta ha sido documentado.

Experimentos laboratorios fueron cumplidos al criadero de la agencia estadounidense, Fish and Wildlife, en Dexter, New Mexico. Temperatura del agua fue 18 centigrados durante el periodo experimental. El periodo en cual larva de razorback sucker deben encontrar alimento o morir fue determinado. Se empezaron a alimentar larvas a intervalos de 4 días empezando 5 días después de eclosión. Larvas alimentado 25 y 29 días después de eclosión tuvieron mortalidad más alta que las larvas alimentado 5, 9, 13, y 17 días después. El efecto de variar densidad de alimento en mortalidad también había investigado. Peces recibiendo 10 nauplios por litro por 8 horas tuvieron mortalidades más de 70%, a la vez peces recibiendo 50 nauplios por litro tuvieron mortalidades a menos de 30%. Larvas que nunca recibieron alimento por todo el experimento, más las larvas de los otros dos experimentos, sostuvieron mortalidades principalmente entre 20 y 30 días después de eclosión.

Los resultados están relacionado a las observaciones de larva de razorback sucker en Lake Mohave.

ENDANGERED FISHES OF CATARACT CANYON

by

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ABSTRACT

Fisheries investigation in Cataract Canyon of the Upper Colorado River, Utah, in 1986 yielded a total of 23 species, including the endangered Colorado squawfish and humback chub. The total of 505 squawfish included 456 YOY, 44 juveniles, and 5 adults. The 33 humpback chub included 21 YOY, 9 juveniles, and 3 adults. The 7 native species composed only 17.5% of the catch, while the 16 non-native species made up 82.5% of the numbers caught. At least 2 more years of investigations are planned in the Cataract Canyon area, and current data are too preliminary for any conclusions.

INTRODUCTION

Since 1981, the Bureau of Reclamation (BOR) has been funding the collection of biological data on endangered fishes in the upper reaches of Lake Powell, Utah. The collection of these data is part of the Colorado River Fisheries Investigations, a joint BOR-Fish and Wildlife Service (FWS) agreement designed to investigate and monitor life history and biological requirements of the endangered fishes in the Colorado River System. These joint studies are intended to gain a better understanding of the fish currently listed as endangered under the Endangered Species Act of 1973, P.L. 93-205; the Colorado squawfish (Ptychocheilus lucius), humpback chub (Gila cypha), bonytail (Gila elegans), as well as the candidate razorback sucker (Xyrauchen texanus).

Since the discovery of 45 large adult Colorado squawfish in Gypsum Canyon in spring of 1980 (Persons et al. 1982), attention has been drawn to the waters of upper Lake Powell and to their possible ecological importance to the endangered fishes. From 1982 to 1984, investigations by BOR were concentrated in the upper reaches of Lake Powell, from Gypsum Canyon to Hite Marina (Figure 1). Little was known of the free-flowing Colorado River immediately above the lake in Cataract Canyon, except for investigations by FWS (Valdez et al. 1982). In 1985, BOR initiated investigations in Cataract Canyon. Results of the 1985 investigation, conducted by Ecosystems Research Institute (Valdez et al. 1985), indicated the presence of substantial numbers of young squawfish and humpback chub, as well as the possible presence of bonytail in Cataract Canyon with a possible relationship to upper Lake Powell. This prompted further investigations by BOR, and in 1986, BIO/WEST of Logan, Utah, was contracted to continue these studies for possibly 3 years.

The objectives of this investigation are to:

1. Determine spawning locations of endangered fish in Cataract Canyon,

2. Determine if humpback chub populations exist in Cataract Canyon, and

3. To what extent the operation of Lake Powell influences nursery habitat of Colorado squawfish in the Gypsum Canyon area.

Although the investigation was concentrated in the 16-mile reach of Cataract Canyon from the confluence of the Green and Colorado Rivers to Imperial Canyon in upper Lake Powell (Figure 1), sampling was also conducted in the 50 miles of the two rivers above the confluence starting at the Potash and Mineral Bottom launches. Cataract Canyon is a whitewater reach with 26 major rapids, and is managed by Canyonlands National Park.

METHODS

Six sample trips were conducted through Cataract Canyon between July 11 and October 6, 1986. Each trip consisted of 8 days on the river.

Three whitewater rafts were used on each sample trip. An 18-foot Riken Havasu was used as an electrofishing raft and a 17-foot Riken Havasu was used as a netting boat. Each raft was powered by a 25-horsepower Mercury XD outboard motor. A 23-foot motorized J-rig was used to carry camp gear and as a support craft.

Sampling gear included 220-volt DC electrofishing, gill nets, trammel nets, seines, kick screens, and larval drift nets. All endangered fish were measured and weighed, and those over 200 mm total length were equipped with serially-numbered Carlin dangler tags. Young fish that could not be identified were preserved in 10% buffered formalin and forwarded to the Larval Fish Laboratory in Fort Collins, Colorado. A concerted effort was made to minimize mortality to all fished, including short-term sets on all gill and trammel nets, and immediate return of all identifiable fishes.

RESULTS

Summary of Fish Collections

A total of 23 species of fish were handled during this investigation (Table 1). This list of species is nearly identical to that presented for the 1985 investigation which reported 22 species (Valdez et al. 1985).

The five most common species of fishes captured in Cataract Canyon in 1986 were sand shiner, red shiner, channel catfish, flathead minnow, and carp. These species made up 91.5% of the total catch by number.

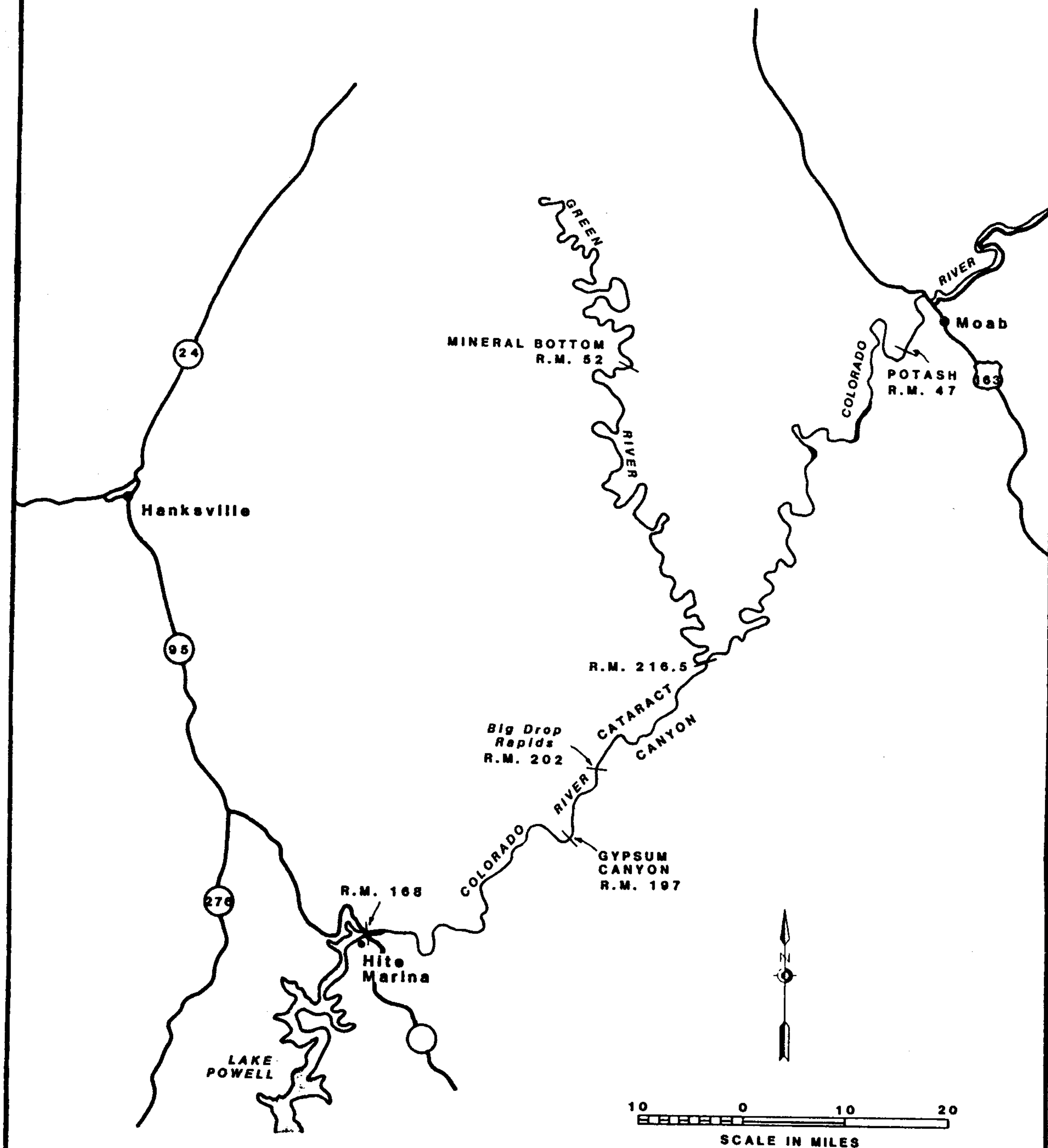

Figure 1. Cataract Canyon Study Area.

Table 1. A list of fish species and numbers captured in the region of Cataract Canyon during six 8-day trips from July 11 to October 6, 1986.

SPECIES	NATIVE	NON-NATIVE	NUMBER	PERCENTAGE
Sand shiner		X	3471	29.0
Red shiner		X	3297	27.6
Channel catfish		X	1897	15.9
Fathead minnow	X		1162	9.7
Carp		X	1118	9.3
Colorado squawfish	X		505	4.2
Flannelmouth sucker	X		176	1.5
Speckled dace	X		104	0.9
Roundtail chub	X		71	0.6
Humpback chub	X		33	0.3
Gambusia		X	29	0.2
Bluehead sucker	X		23	0.2
Gila sp.			17	0.1
Largemouth bass		X	14	0.1
Black bullhead		X	13	0.1
Green sunfish		X	12	0.1
Walleye		X	7	0.1
Plains killfish		X	5	<0.1
Striped bass		X	2	<0.1
Black crappie		X	2	<0.1
White sucker		X	2	<0.1
Northern pike		X	1	<0.1
Brown trout		X	1	<0.1
Smallmouth bass		X	1	<0.1

Of the 23 species, 16 are non-native and only 7 are native. As a percentage of total catch, the ratio of non-native to native fishes was 82.5 to 17.5. The endangered species (Colorado squawfish, 4.2% and humpback, 0.3%) made up 4.5% of the total catch. Bonytail and razorback sucker were not captured in Cataract Canyon in 1986.

Colorado Squawfish

A total of 505 Colorado squawfish were captured during this 1986 investigation, including 456 young of the year (YOY), 44 juveniles, and 5 adults (Table 2). Of the 5 adults captured, two had been previously tagged by the FWS in the Green River about 172 and 120 miles upstream 3 years before. as with 1985, the majority of the YOY squawfish were captured on the Green River, above the Colorado River confluence. The majority of juveniles captured belonged to the 1985 year class. Twenty of the 44 juveniles were found in large isolated

Table 2. Numbers of Colorado squawfish and humpback chub captured in the Cataract Canyon region in 1986 by age categories.

AGE CATEGORY	COLORADO SQUAWFISH	HUMPBACK CHUB
YOY	456	21
JUVENILE	44	9
ADULT	5	3
	505	33

pools where their death seemed imminent because of lack of oxygen or desiccation. The same phenomenon was seen in YOY; however, these often occurred in smaller, low-lying pools that eventually became inundated by higher river flows in late summer. The number of endangered fish that succumb to death by becoming stranded in isolated pools is unknown.

The hatching date of each YOY squawfish captured in 1986 was estimated by using a formula developed by Haynes et al (1985), and these data were compared with hatching dates for YOY captured in 1985 (Valdez et al. 1985). Weekly hatching dates indicate that Colorado squawfish captured in the region of Cataract Canyon in 1986 hatched between June 19 and September 9, 1986 (Figure 2). The majority of the fish sampled (62%) hatched between July 30 and August 19. In 1985, hatching was estimated to occur between May 1 and August 26, with the majority (60%) occurring between June 26 and July 22. These preliminary data show that hatching varied between the 2 years by a full month. Water temperatures and river flows for the same time period indicate that hatching in 1986 was delayed because suitable squawfish spawning temperatures of 22 to 25 C did not occur unit mid-July. Kaeding et al. (1986) have indicated that late spawning by Colorado squawfish disadvantages the young, which have to enter the winter season relatively smaller and presumably weaker.

Humpback Chub

A total of 33 humpback chub were captured during this 1986 study. This included 21 YOY, 9 juveniles, and 3 adults (Table 2). All of the YOY and most of the juveniles were identified by the Larval Fish Laboratory (LFL). Many of these specimens were classified by the LFL as "possible Gila cypha" because the diagnostic characteristics of some did not positively distinguish them from the sympatric roundtail chub (G. robusta). Many YOY and juveniles, however exhibited characters considered very typical of the species. The 3 adults were also considered typical humpback chub; these were weighed, measured, tagged, photographed, and released.

HATCHING DATES FOR YOY COLORADO SQUAWFISH

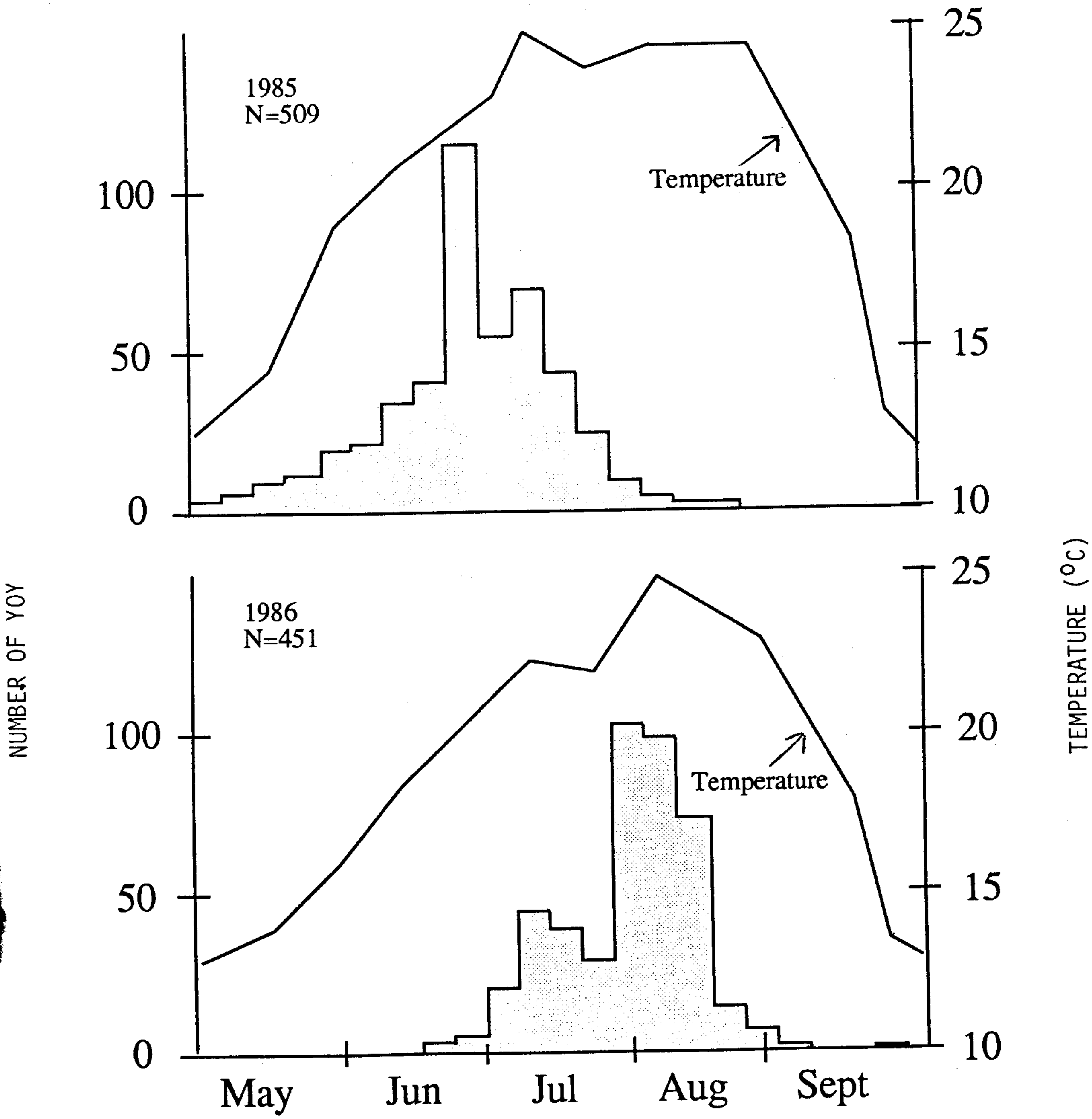

FIGURE 2. Weekly hatching of Colorado squawfish in 1985 and 1986, based on back calculations from lengths of YOY (Haynes, et al. 1985) captured in Cataract Canyon.

Summary

The presence of some very young squawfish and humpback chub in Cataract Canyon and upper Lake Powell suggests that some spawning by these species occurs in these areas. The presence of young endangered fish here also indicated that fish possibly drift into the area from upstream to use it as a nursery. The high turbulence and turbidity as well as flows that have varied from 20,000 to nearly 100,000 cfs have hindered our efforts considerably. Reproductive efforts by these fishes may be occurring in whitewater areas where present sampling gear is ineffective. For Colorado squawfish, we plan to continue sampling suspected spawning areas with a variety of gear including drift nets in an effort to capture recently hatched fish near spawning sites. For humpback chub, efforts will be made with a variety of gear, including angling, to locate concentrations of adults and possibly spawning sites. Angling has been used successfully for locating adults in the Yampa and Green rivers (Personal communication with H.M. Tyus, FWS, Vernal, Utah, October 1986).

The reader is cautioned that at this time, these data are preliminary. Two more years of investigations are planned for the Cataract Canyon area to enable us to make management recommendations to preserve and promote the recovery of these endangered fishes.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Valdez, R., R. Smith, P. Morgan, and B. Nilson. 1982. Colorado River Investigations, pp 100-279 In W.H. Miller, J.J. Valentine, and D.L. Archer (eds.) Colorado River Fishery Project Final Report: Part 2, Field Investigation. U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Valdez, R.A., R.J. Ryel and R.D. Williams. 1985. Endangered Fish of Cataract Canyon: The Importance of the Colorado River above Lake Powell to the Colorado squawfish, humpback chub and bonytail. U.S. Bureau of Reclamation, Salt Lake City, Utah.

Haynes, C.M., R.T. Muth, and T.P. Nesler. 1985. Identification of habitat requirements and limiting factors for Colorado squawfish and humpback chub. Job Final Report SE-3-4, Colorado Division of Wildlife, Ft. Collins, CO. 62. pp.

Kaeding, L.R., D.B. Osmundson, and C.R. Berry, Jr. 1986. Temperature as a resource limiting Colorado squawfish in the upper Colorado River Basin. Upper Colorado River Basin Researchers Meeting, Vernal, Utah, February 1986.

PECES AMENAZADOS DEL CAÑON CATARACT - 1986

por

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y

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RESUMEN

Investigaciones ictiológicas en el Cañon Cataract del Rio Colorado en el estado de Utah, en 1986, producieron un total de 23 especies, incluyendo los peces amenazados, Colorado squawfish y humpback chub. El total de 505 squawfish consistieron 456 jovenes del ano (YOY), 44 juveniles, y 5 adultos. Los 33 humpback chub incluyeron 21 YOY, 9 juveniles, y 3 adultos. Los 7 especies nativos fueron compuestos de solamente 17.5% de la pesca, minentras que los 16 especies exóticos consistieron 82.5% de los numeros pescados. Al minimo, se planean 2 mas años de investigaciones en el Cañon Cataract, y los datos presentados son preliminarios.

THE LIKELIHOOD OF PERSISTENCE OF SMALL POPULATIONS OF LARGE ANIMALS

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I. INTRODUCTION

The primary articles of faith in cryptozoology are that undiscovered populations of known animals exist in unexpected places (e.g., the mountain lion *Felis concolor* in the eastern United States) and that there are yet undiscovered species living in poorly explored or otherwise inaccessible localities (e.g., the "monster" in Loch Ness). Thus, animals of interest to cryptozoologists have populations that are either supposed to be sparsely distributed over a large area or exist as a small group in one particular spot; both cases involve small numbers of animals. The question I will address here is whether populations of such animals are likely to exist in a viable state.

Population biologists have only recently become interested in the problem of population viability, primarily as a response to the increasing threats of extinction for dozens of endangered species. As one example, the requirement to manage National Forest System habitats to maintain "viable populations of wildlife and fish" (Salwasser et al. 1984) led to a series of workshops sponsored by the USFS to explore the concept of minimum viable population size. These workshops stimulated considerable theoretical work on this problem, and a book will soon be published on this topic (Soule 1986).

The most important theoretical conclusion from work in this area is that stochastic processes play an extremely critical role in the survival of small populations. These processes separate naturally into three categories: (1) environmental uncertainty, (2) populational uncertainty, and (3) genetic uncertainty. Uncertain environmental factors range from major catastrophes (e.g., fires, earthquakes, major storms, pandemic disease, etc.) to mildly unpredictable environmental variation such as year to year changes in weather patterns. Uncertain demographic factors include random variations in sex ratio, age of first reproduction, number of offspring, distribution of offspring over the lifetime of an individual, and time of death. Genetic uncertainty includes inbreeding (the mating of related individuals) and loss of variation through genetic drift.

POPULATION VIABILITY IN GENERAL

In the most general terms, a population's short- and mid-term survival potential is determined primarily by its resilience and its fitness. Resilience refers to a population's ability to survive in the face of normal birth and death events, which in turn are determined by the species' reproductive potential, social system, generation time, and the nature and severity of random environmental perturbations. A population's fitness depends on its having the appropriate set of genes to cope with its environment; this in turn is largely determined by the presence of sufficient genetic variation to maintain normal fecundity and viability under the prevailing ecological circumstances. Beyond this, a population's long-term survival potential is related to its adaptability, or its ability to evolve. Adaptability depends upon the maintenance of sufficient genetic variation to adjust to environmental change through the process of natural selection.

Species populations normally have considerable capacity to resist threats to their survival through various kinds of responses, i.e., they have adequate resilience, fitness, and adaptability. However, very small populations, and hence, very rare species have much less capacity to resist those threats because of their increased susceptibility to the deleterious effects of stochastic events.

II. DEMOGRAPHIC FACTORS

Demographers usually model population growth by variations of two basic equations. The first is exponential growth,

$$dN/dt = rN$$

where N is the number of individuals in the population and r is the instantaneous rate of increase, is a fair estimator of population increase in an unlimited environment. Many insect populations, especially those of crop pests, grow exponentially for a time. Eventually, however, something puts the brakes on population growth and numbers decline, usually precipitously. It is highly unlikely that the exponential growth model has any applicability to cryptozoology.

The second model of population growth is referred to as the logistic equation. Under this model a population grows exponentially until it reaches a point where the rate of growth begins to decline as resources become increasingly limiting. Eventually the population stabilizes at a point called the carrying capacity (K), defined as the number of individuals that a given area can support.

$$^{dN}/_{dt} = rN\left(\frac{K-N}{K}\right)$$

This logistic model is more applicable to cryptozoological situations; however, it is generally unrealistic, since few populations have been observed to rise to some level and then remain constant over time. Rather, they fluctuate because the values of r and K change, both deterministically and stochastically.

Fluctuations in r are at the heart of the population peristence problem. Any factor contributing to a decrease in its growth rate is a potential threat to a population's persistence; however, most natural populations continually face such changes without going extinct. This is because some of these factors may be density-dependent--that is, they operate less intensively as population size decreases. Or, the operation of some negative factors may be discontinuous in time or space so that they either diminish before exterminating a population or affect only a segment of it at a time. Thus, most fluctuations in r usually have little long-term effect on the size and persistence probabilities of large populations.

However, as populations become smaller, the risk of extinction increases dramatically. MacArthur (1972) modeled the extinction process as a function of r, K, and the per capita birth rate (b), and predicted that populations with high growth rates, high per capita birth rates, and large K's (in the thousands), had expected times to extinction which were very large. However, for populations with lower r's and b's, extinction was likely to be fairly rapid below a threshold value of K that was in the tens to low hundreds, depending on the values of the former parameters. Since MacArthurs's model did not consider the effects of age structure on the population, we have to interpret these figures as the numbers of <u>breeding individuals,</u> not total population size. A second model by Richter-Dyn and Goel 1972) also predicted a threshold effect for population persistence of approximately the same order of magnitude. Since large animals tend to have low r's and low b's, these models suggest that large, rare species can persist if the number of breeding indiviuals in their populations are above these threshhold values.

However, these models do not account for any variability in growth rates that might result from random variation in birth and death processes. May (1973) incorporated these factors, which we now call individual demographic stochasticity or Vi, into a second-generation model and concluded that random fluctuations in population size should be roughly proportional to $1/\sqrt{K}$. This implies that Vi will result in a population of about 100 individuals varying between 90 and 110 ($100 \pm \sqrt{K}$, or 10). Thus, May's result suggests that the effects of individual demographic stochasicity are unlikely to cause extinction in any but the smallest populations.

More recent models by Leigh (1981) and Goodman (1986) tend to support this conclusion. These models show that Vi is an important factor only for the survival of very small populations, and the importance of Vi declines rapidly with increases in population size. This is because individual variations in survivorship or reproduction tend to be compensated by the contributions of more and more individuals. Thus, as populations achieve even relatively modest numbers, predicted times to extinction calculated on the basis of Vi alone become quite large.

However, these models also make a critical point: The expected survival time of a population depends critically on the variability of its growth rate, and this variability actually consists of <u>two</u> components, the individual demographic stochasticity (Vi) modeled above, and environmental stochasticity (Ve). This second component, environmental stochasticity, is essentially independent of population size, and it poses problems for population persistence that can be extremely severe. Examples of this kind of variation are population-wide changes in the probabilities of death or reproduction related to the vagaries of climate, disease, competition, predation, or resource availability. Goodman's model shows that with realistic estimates of the effects of Ve factored in, times to extinction become much shorter and much less responsive to higher values of K than those predicted by previous models which only considered the effects of Vi. Furthermore, environmental stochasticity results in times to extinction which increase only gradually with population size, rather than exhibiting threshold effects. If environmental variability is high, very large K's are required to achieve reasonably long times to extinction. Even an increasing population can have a relatively short predicted time to extinction if it has a low rate of increase and a relatively high variance in this rate.

Taking these factors into consideration, how likely is it that some of the subjects of cryptozoological investigation exist as viable populations? Let us look at one example. Sheldon and Kerr (1972) and Scheider and Wallis (1973) calculated the maximum probable population density of monsters in Loch Ness based on ecologically defensible principles. Both groups conclude that this lake could support 10-20 individuals of 1000-1500 kg monsters about 8 m long. Larger numbers of smaller creatures could be supported, but these would not be suitably monstrous. Even if we assume that 20 monsters could live in the lake, it is extremely unlikely that all of them would be members of the breeding population; some are likely to be too old and others too young to reproduce.

A population consisting of fewer than 20 breeding individuals is at serious risk of extinction from the effects of individual demographic stochasticity alone, and a population of this size could not withstand the effects of any environmental stochasticity whatsoever. Although Loch Ness has a fairly constant temperature of about 5.6 degrees C (Rines et al. 1976), other factors, such as food supply, are probably much more important potential contributors to a disastrous population-wide fluctuation in birth or death probabilities. Thus, we can conclude that the persistence of a viable population of monsters in Loch Ness from some indefinite time in the past is extremely unlikely. Even if 20 do exist here at the moment, the population is precipitously close to extinction.

II. GENETIC FACTORS

In addition to random demographic factors, genetic uncertainty can threaten population viability as well. Genetic uncertainty refers to random changes in a population's genetic makeup which have deleterious effects on the ability of individuals to survive and reproduce, as well as on the capacity of populations to respond adaptively to changes in their environments. The two major genetic factors causing deleterious effects are inbreeding depression and genetic drift.

Inbreeding depression results from the expression of deleterious genes as a result of the mating of close relatives. Most populations carry a "genetic load" of deleterious alleles. These alleles are usually rare and not particularly harmful in the heterozygous state; however, when closely related individuals mate, the chance of their offspring inheriting deleterious alleles in the homozygous state is increased. When deleterious alleles appear as homozygotes, they often result in the decline of various fitness traits such as fertility, fecundity, and viability. If population size is large enough, natural selection can elminate the individuals expressing the deleterious recessive alleles, and the effects on the population as a whole will be minimal. However, if the population size is too small for selection to work effectively, the deleterious genes may become fixed in the population.

Furthermore,the deleterious effects of inbreeding can interact with random demographic events and result in even more severe threats to the persistence of small populations. For example, as population size becomes smaller, the incidence of inbreeding is likely to increase. As inbreeding increases, the incidence of reproductive failure is likely to increase as well. This results in a further reduction of population size, increasing inbreeding even more. Soon, a population can be caught in a downward spiral of ever decreasing viability, generally leading to its extinction.

Random changes in gene frequencies in populations are called genetic drift; these random changes sooner or later result in the loss of genetic variation, the rate of loss being dependent on population size. In small populations this loss can be quite severe and rapid. For example, in a population with 10 individuals contributing progeny to subsequent generations, 40% of the genetic variability in the population will be lost within ten generations. As was mentioned earlier, the fitness of a population depends on the presence of sufficient variation in its gene pool to maintain normal fecundity and viability. Likewise, a population's adaptability, or its ability to evolve, also depends on a sufficient reserve of different genes to adjust to environmental change through the process of natural selection.

Thus, in order to maintain population fitness and adaptability, a population must be large enough to prevent intense inbreeding and serious reductions in genetic variation by random drift. Unfortunately, the number of individuals actually involved in contributing progeny, and therefore genes, to subsequent generations is generally only a small fraction of the total population size. A population containing several hundred individuals (N) may have a genetically effective size (Ne) of only 10 or 20 in some species.

The genetically effective size of a population is reduced by any of a variety of factors that represent departures from a genetically ideal situation (Wright 1931). These include the presence of nonbreeding individuals, skewed sex ratios, non-random tendencies for inbreeding or outcrossing, random variation in progeny survivorship, the loss of genetic variability that may have occurred during previous periods of low population size (the "bottleneck" effect), and the tendency of the individuals of some species to mate with individuals from an area that may be smaller than the area occupied by the population as a whole (the population structure effect). The cumulative effects of these factors are multiplicative and are usually expressed as the ratio of Ne/N.

The results of low Ne's on population fitness can be devastating. For example, let us assume that our population of monsters in Loch Ness consists of 20 individuals, and that the ratio of Ne/N is somewhere between 0.2 to 0.4, figures typical of large vertebrates. This means that the genetically effective size of the population is between 4 and 8. At this size, the expected rate of increase in inbreeding in each generation (ΔF) is equal to 1/[2Ne], or between 6 and 13 percent. This is well above the level where natural selection for performance and fertility can balance inbreeding depression, which is about 1% (Frankel and Soule 1981).

The loss of heterozygosity in this population can be estimated by the formula

$$H = (1-1/2N)^t$$

where t is the number of generations involved. With Ne's this small about 6 to 13% of the genetic variation in the population will be lost each generation. After 10 generations, if Ne's stay the same, only 28-54% of the original variation will be retained. Losses such as these pose serious threats for short-term survival; survival over longer periods depends on an even broader array of genetic resources.

RECAP AND CONCLUSIONS

According to current theory in population biology, the risk of extinction of a population depends on the number of individuals the habitat can support (K), its per capita birth rate, its rate of growth (r), the variability of its growth rate (Vi and Ve), and its genetically effective size (Ne). Although all populations are at some risk of extinction from various events that affect their demographic patterns and genetic composition, the risk is decidedly greater in small, isolated populations. If a rare species can maintain a minimum breeding population size somewhere above the mid tens to low hundreds, the exact number depending on its growth rate and per capita birth rate, the odds favor its persistence, provided that there is no evironmentally-caused variation in these rates. However, if environmental variation affects birth and death processes in any significant way, a minimum viable population needs to be much larger to avoid extinction from demographic factors alone.

Even at population sizes that are adequate to buffer populations from extinction from the effects of Vi and Ve, low genetically effective sizes can cause additional problems. Ne's below 50 or so result in levels of inbreeding and loss of genetic variation that also threaten short-term persistence. An Ne of 500 is probably the minimum necessary for continuing evolution (Franklin 1980, Frankel and Soule 1981, Lande 1986). Since the actual number of individuals necessary to maintain an effective population size this large is likely to be considerably greater than 500, it is clear that extreme rarity is a condition that precludes much potential for evolutionary change.

There are a few documented cases of small populations which have persisted for thousands of years. One of the most striking examples is the Devil's Hole pupfish Cyprinodon diabolis which has survived in a tiny spring in the Nevada desert for 10-20,000 years (Miller 1981) with population sizes fluctuating seasonally from 150 to 400 individuals (Deacon 1979). This rather remarkable situation has resulted at least in part from the physical conditions in this spring which are are very constant, at least until recently when it has been adversely affected by human activities (Williams et al. 1986). The historical influence of Ve on the persistence of this population must have been very small indeed. As predicted, C. diabolis has evidently lost all measurable genetic variability (Turner 1974).

Whatever combination of factors may have occurred to allow the Devil's Hole pupfish to hang on in its tiny habitat for tens of millenia, current theory in population biology suggests that its case is a very rare exception. If viable populations of large animals, still unknown to science, are still "out there", they must either elude detection very well by sophisticated behavioral traits or live in extremely remote or unaccessible areas with virtually constant environments. In either event they must continue to maintain breeding populations that number in the mid tens to low hundreds in order to persist.

REFERENCES

Deacon, J.E., 1979. Endangered and threatened fishes of the West. Great Basin Nat. Mem. 3: 41-64.

Frankel, O.H. and M.E. Soule, 1981. Conservation and Evolution. Cambridge Univ. Press, Cambridge.

Franklin, I.R., 1980. Evolutionary change in small populations. pp. 135-149 in M.E. Soule and B.A. Wilcox (eds.) Conservation Biology: An Evolutionary-Ecological Perspective. Sinauer Associates, Sunderland, MA.

Goodman, D., 1986. Considerations of stochastic demography in the design and management of reserves. In M.E. Soule, (ed.) Viable Populations. Cambridge University Press (in press).

Lande, R., 1986. The maintenance of genetic variability in small populations. In M.E. Soule, (ed.) Viable Populations. Cambridge University Press (in press).

Leigh, E.G., Jr., 1981. The average lifetime of a population in a varying environment. J. Theor. Biol. 90: 213-239.

MacArthur, R.H., 1972. Geographical Ecology. Harper and Row, NY.

May, R.M., 1973. Stability and Complexity in Model Ecosystems. Princeton Univ. Press, Princeton, NJ.

Miller, R.R., 1981. Coevolution of deserts and pupfishes (genus *Cyprinodon*) in the American southwest. Pp. 39-94 in R.J. Naiman and D.L. Soltz (eds.) Fishes in North American Deserts. Wiley Interscience, NY.

Richter-Dyn, N. and N.S. Goel, 1972. On the extinction of colonizing species. Theor. Pop. Biol. 3: 406-433.

Rines, R.H., H.E. Edgerton, C.W. Wyckoff, and M. Klein, 1976. Search for the Loch Ness monster. Technology Review, March/April 1976: 25-40.

Salwasser, H., S.P. Mealey, and K. Johnson, 1984. Wildlife population viability: a question of risk. Trans N. Amer. Wildl. & Nat. Res. Conf. Vol. 49. pp. 421-429.

Scheider, W. and P. Wallis, 1973. An alternate method of calculating the population density of monsters in Loch Ness. Limnology and Oceanography 18: 343.

Sheldon, R.W., and S.R. Kerr, 1972. The population density of monsters in Loch Ness. Limnology and Oceanography 17: 796-798.

Soule, M.E. (ed.), 1986. Viable Populations. Cambridge University Press (in press).

Turner, B.J., 1974. Genetic divergence of Death Valley pupfish species: Biochemical versus morphological evidence. Evolution 28: 281-294.

Williams, J.E., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye, 1986. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona-Nevada Academy of Science 20: 1-62.

Wright, S., 1931. Evolution in Mendelian populations. Genetics 28: 114-138.

STOCHASTIC PROCESSES AND POPULATION PERSISTENCE IN DESERT FISHES

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Abstract

Species populations normally have considerable capacity to resist threats to their survival. However, small populations have much less capacity to resist those threats because of their increased susceptibility to the deleterious effects of stochastic events. Three stochastic processes play extremely important roles in the survival of small populations; these are (1) demographic uncertainty, (2) environmental uncertainty, and (3) genetic uncertainty. The effects of these processes are discussed in detail, and some management recommendations to alleviate them are made.

I. INTRODUCTION

Desert fishes tend to have populations that exist as a small groups in one or a few particular spots; the question I will address here is how long such populations are likely to survive. Population biologists have only recently become interested in this problem, primarily as a response to the increasing threats of extinction for dozens of endangered species. As one example, the requirement to manage National Forest System habitats to maintain "viable populations of wildlife and fish" (Salwasser et al 1984) led to a series of workshops sponsored by the USFS to explore the concept of minimum viable population size. These workshops stimulated considerable theoretical work on this problem, and a book will soon be published on this topic (Soule' 1987).

The most important theoretical conclusion concerning the biology of small populations is that stochastic processes play an extremely critical role in their survival. These processes separate naturally into three categories: (1) demographic uncertainty, (2) envionmental uncertainty, and (3) genetic uncertainty. Uncertain demographic factors include random variations in sex ratio, age of first reproduction, number of offspring, distribution of offspring over the lifetime of an individual, and time of death. Uncertain environmental factors range from major catastrophes (e.g., "hundred year" floods or droughts, influx of highly toxic materials, etc.) to mildly unpredictable environmental variation such as year to year changes in runoff and flow patterns. Genetic uncertainty includes inbreeding (the mating of closely related individuals) and loss of variation through genetic drift.

In the most general terms, a population's short- and mid-term survival potential is determined primarily by its resilience and its fitness. Resilience refers to a population's ability to survive in the face of normal birth and death events, which in turn are determined by the species' reproductive potential, social system, generation time, and the nature and severity of random environmental perturbation. A population's fitness depends on its having the appropriate set of genes to cope with its environment; this in turn is largely determined by the presence of sufficient genetic variation to maintain normal fecundity and viability under the prevailing ecological circumstances. Beyond this, a population's long-term survival potential is related to its adaptability, or its ability to evolve. Adaptability depends upon the maintenance of sufficient genetic variation to adjust to environmental change through the process of natural selection.

Species populations normally have considerable capacity to resist threats to their survival through various kinds of responses, i.e., they have adequate resilience, fitness, and adaptability. However, small populations have much less capacity to resist those threats because of their increased susceptibility to the deleterious effects of stochastic events.

II. DEMOGRAPHIC AND ENVIRONMENTAL STOCHASTICITY

Fluctuations in r, the intrinsic rate of increase, are at the heart of the population peristence problem. Any factor contributing to a decrease in its growth rate is a potential threat to a population's persistence; however, most natural populations continually face such changes without going extinct. This is because some of these factors may be density-dependent--that is, they operate less intensively as population size decreases. Or, the operation of some negative factors may be discontinuous in time or space so that they either diminish before exterminating a population or affect only a segment of it at a time. Thus, most fluctuations in r usually have little long-term effect on the size and persistence probabilities of large populations.

However, as populations become smaller, the risk of extinction increases dramatically. MacArthur and Wilson (1967) and MacArthur (1972) modeled the extinction process as a function of three parameters: r, K (the carrying capacity), and the per capita birth rate, b, where the per capita death rate is r - b. They predicted that populations with high growth rates, high per capita birth rates, and large K's (in the thousands), had expected times to extinction which were very large. However, for populations with lower r's and b's, extinction was likely to be fairly rapid below a threshold value of K that was in the tens to low hundreds, depending on the values of the former parameters. A second model by Richter-Dyn and Goel (1972) also predicted a threshold effect for population persistence of approximately the same order of magnitude. Since none of these models considered the effects of age structure on the population, we have to interpret these figures as the numbers of breeding individuals, not total population size.

Furthermore, these models do not account for any variability in growth rates that might result from random variation in birth and death processes; hence, their applicability to natural populations is limited. May (1973) continued the analysis of these factors, now called "demographic stochasticity" or Vi, into a second-generation model and concluded that random fluctuations in population size should be roughly proportional to $1/\sqrt{K}$. This implies that Vi will result in a population of about 100 individuals varying between 90 and 110 (100 $\pm \sqrt{K}$, or 10). Thus, May's result suggests that the effects of individual demographic stochasicity are unlikely to cause extinction in any but the smallest populations.

More recent models by Leigh (1981) and Goodman (1986, 1987) tend to support the idea that Vi is an important factor only or the survival of very small populations, and that the importance of Vi declines rapidly with increases in population size. This is because individual variations in survivorship or reproduction tend to be compensated by the contributions of more and more individuals. Thus, as populations achieve even relatively modest numbers, predicted times to extinction calculated on the basis of Vi alone become quite large.

However, these models also make two critical points. The first is that the expected survival time of a population depends critically on the variability of its growth rate. Second, this variability actually consists of two components, the demographic stochasticity (Vi) discussed above, and "environmental stochasticity", or Ve. Environmental stochasticity poses problems for population persistence that can be extremely severe since it is essentially independent of population size. Examples of this kind of variation are population-wide changes in the probabilities of death or reproduction related to the vagaries of climate, disease, competition, predation, resource availability, or human interference.

Goodman (1987) has shown that with realistic estimates of the effects of Ve factored in, times to extinction become much shorter and much less responsive to higher values of K than those predicted by models which either ignore any variance in growth rate or only consider the effects of Vi. Furthermore, environmental stochasticity results in times to extinction which increase only gradually with population size, rather than exhibiting threshold effects. If environmental variability is high, very large K's are required to achieve reasonably long times to extinction. Even an increasing population can have a relatively short predicted time to extinction if it has a low rate of increase and a relatively high variance in this rate. Likewise, density dependence in mean growth rate makes little difference in estimated time to extinction compared to calculations with density independent growth.

II. GENETIC STOCHASTICITY

In addition to random demographic and environmental events, genetic uncertainty can threaten population viability as well. Genetic uncertainty refers to random changes in a population's genetic makeup which have deleterious effects on the ability of individuals to survive and reproduce, as well as on the capacity of populations to respond adaptively to changes in their environments. The two major genetic factors causing deleterious effects are inbreeding depression and genetic drift. In general, to maintain population fitness and adaptability, a population must be large enough to prevent intense inbreeding and serious reductions in genetic variation by random drift, and these effects must be viewed in the context of the species' past history.

In natural populations the number of individuals actually involved in contributing progeny, and therefore genes, to subsequent generations is generally only a small fraction of the total population size. A population containing several hundred individuals (N) may have a genetically effective size (Ne) of only 10 or 20 in some species. The genetically effective size of a population is reduced by any of a variety of factors that represent departures from a genetically ideal situation. These include the presence of nonbreeding individuals, skewed sex ratios, non-random tendencies for inbreeding or outcrossing, non-Poisson variation in progeny survivorship, the loss of genetic variability that may have occurred during previous periods of low population size (the "bottleneck" effect), and the tendency of individuals of some species to mate with others from an area that may be smaller than the area occupied by the population as a whole (the population structure effect). The cumulative effects of these factors are multiplicative and are usually expressed as the ratio of Ne/N. Between generations, Ne is the harmonic mean of the within-generation Ne's.

Inbreeding depression results from the expression of deleterious genes as a result of the mating of close relatives. Most populations carry a "genetic load" of deleterious alleles. These alleles are usually rare and not particularly harmful in the heterozygous state; however, when closely related individuals mate, the chance of their offspring inheriting deleterious alleles in the homozygous state is increased. When deleterious alleles appear as homozygotes, they often result in the decline of various fitness traits such as fertility, fecundity, and viability. If population size is large enough, natural selection can elminate the individuals expressing the deleterious recessive alleles, and the effects on the population as a whole will be minimal. However, if the population size is too small for selection to work effectively, the deleterious genes may become fixed in the population.

Furthermore,the deleterious effects of inbreeding can interact with random demographic events and result in even more severe threats to the persistence of small populations (Gilpin and Soule 1986). For example, as population size becomes smaller, the incidence of inbreeding is likely to increase. As inbreeding increases, the incidence of reproductive failure is likely to increase as well. This results in a further reduction of population size, increasing inbreeding even more. Soon, a population can be caught in a downward spiral of ever decreasing viability, generally leading to its extinction.

Random changes in gene frequencies in populations are called genetic drift; these random changes sooner or later result in the loss of genetic variation, the rate of loss being dependent on population size. In small populations this loss can be quite severe and rapid. For example, in a population with an effective size of 10 individuals 40% of the genetic variability in the population will be lost within 10 generations. Losses of this magnitude can pose serious threats for short-term survival since the fitness of a population usually depends on the presence of sufficient variation in its gene pool to maintain normal fecundity and viability. Likewise, a population's adaptability, or its ability to evolve, also depends on a sufficient reserve of different genes to adjust to environmental change through the process of natural selection.

Fortunately, rather low levels of gene flow between populations can alleviate the problems associated with inbreeding and drift. In general, the number of genetically effective migrants that must be exchanged among populations per generation to maintain panmixis is between one and two (Lande and Barrowclough 1987).

RECAP AND MANAGEMENT CONCLUSIONS

According to current theory in population biology, the risk of extinction of a population depends on the number of individuals the habitat can support (K), its per capita birth rate, its rate of growth (r), the variability of its growth rate (Vi and Ve), and its genetically effective size (Ne). Although all populations are at some risk of extinction from various events that affect their demographic patterns, the risk is decidedly greater in small, isolated populations.

However, if a population can maintain a minimum breeding size somewhere above the mid tens to low hundreds, the exact number depending on its growth rate and per capita birth rate, the odds favor its persistence, provided that there is no environmentally-caused variation in these rates. A good example is provided by the Devil's Hole pupfish Cyprinodon_diabolis. This species has apparently survived in a single spring for 10-20,000 years (Miller 1981) with population sizes fluctuating seasonally from 150 to 400 individuals (Deacon 1979). This rather remarkable situation has resulted from the physical conditions in this spring which are are very constant, at least until recently when it has been adversely affected by human activities (Williams et al. 1986). The historical influence of Ve on the persistence of this population must have been very small indeed.

On the other hand, populations of desert fishes in habitats with higher potentials for environmental variance are at serious risk of extinction. Recovery plans must recognize this important fact.

Even at population sizes that are adequate to buffer populations from extinction from the effects of Vi and Ve, low genetically effective sizes can cause additional problems. Ne's below 50 or so result in levels of inbreeding and loss of genetic variation that may also threaten short-term persistence. An Ne of 500 is probably the minimum necessary for continuing evolution (Franklin 1980, Frankel and

Soule' 1981, Lande and Barrowclough 1987). Since the actual number of individuals necessary to maintain an effective population size this large is likely to be considerably greater than 500, it is quite likely that many species of desert fishes have reached evolutionary dead ends. For example, C. diabolis has evidently lost all measurable genetic variability (Turner 1974).

Self-sustaining populations of many species of desert fishes in pre-settlement days almost certainly consisted of "metapopulations" --systems of small local units, each of which had its own stochastic dynamics. Local extinctions and recolonizations during occasional periods of high water were almost certainly important components of species persistence. This suggests that recovery plans should call for several populations, spaced far enough apart so that the environmental variation in them is a least partially independent, to be reestablished in the wild if at all possible. Furthermore, in order to facilitate recolonization following local extinctions and to alleviate the genetic problems associated with small, isolated units, such plans should also include artificial movement of individuals from population to population.

LITERATURE CITED

Deacon, J.E., 1979. Endangered and threatened fishes of the West. Great Basin Nat. Mem. 3: 41-64.

Frankel, O.H. and M.E. Soule' 1981. Conservation and Evolution. Cambridge Univ. Press, Cambridge.

Franklin, I.R., 1980. Evolutionary change in small populations. pp. 135-149 in M.E. Soule' and B.A. Wilcox (eds.) Conservation Biology: An Evolutionary-Ecological Perspective. Sinauer Associates, Sunderland, MA.

Gilpin, M.E., and M.E. Soule' 1986. Minimum viable populations: Processes of species extinction. Pp. 19-34 in M.E. Soule (ed.) Conservation Biology. The Science of Scarcity and Diversity. Sinauer Associates, Sunderland, MA.

Goodman, D. 1986. Considerations of stochastic demography in the design and management of reserves. Natural Resources Modeling 1: (in press).

Goodman, D., 1987. Considerations of stochastic demography in the design and management of reserves. In M.E. Soule' (ed.) Viable Populations. Cambridge University Press (in press).

Lande, R., and G.F. Barrowclough, 1987. Effective population size and its use in population management. In M.E. Soule' (ed.) Viable Populations. Cambridge University Press (in press).

Leigh, E.G., Jr., 1981. The average lifetime of a population in a varying environment. J. Theor. Biol. 90: 213-239.

MacArthur, R.H., 1972. Geographical Ecology. Harper and Row, NY.

MacArthur, R.H. and E.O. Wilson, 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, NJ.

May, R.M., 1973. Stability and Complexity in Model Ecosystems. Princeton Univ. Press, Princeton, NJ.

Miller, R.R., 1981. Coevolution of deserts and pupfishes (genus Cyprinodon) in the American southwest. Pp. 39-94 in R.J. Naiman and D.L. Soltz (eds.) Fishes in North American Deserts. Wiley Interscience, NY.

Richter-Dyn, N. and N.S. Goel, 1972. On the extinction of colonizing species. Theor. Pop. Biol. 3: 406-433.

Salwasser, H., S.P. Mealey, and K. Johnson, 1984. Wildlife population viability: a question of risk. Trans N. Amer. Wildl. & Nat. Res. Conf. Vol. 49. pp. 421-429.

Soulé, M.E. (ed.), 1987. Viable Populations. Cambridge University Press (in press).

Turner, B.J., 1974. Genetic divergence of Death Valley pupfish species: Biochemical versus morphological evidence. Evolution 28: 281-294.

Williams, J.E., D.B. Bowman, J.E. Brooks, A.A. Echelle, R.J. Edwards, D.A. Hendrickson, and J.J. Landye, 1986. Endangered aquatic ecosystems in North American deserts with a list of vanishing fishes of the region. Journal of the Arizona-Nevada Academy of Science 20: 1-62.

MICROHABITAT UTILIZATION PATTERNS OF SPIKEDACE IN NEW MEXICO

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The spikedace, Meda fulgida, is endemic to the Gila River drainage of southwestern United States. Within its historic range the species occurred mainly in intermediate-sized, mid-elevation streams having intermediate gradients and thermal regimes. In this study, the microhabitat of the spikedace was described along depth, velocity, and substrate dimensions. Study areas were in the Cliff-Gila Valley reach of the Gila River and the lowermost portions of the West and Middle forks of the Gila River (Forks area). Ontogenetic shifts in microhabitat utilization occurred among all life stages for each habitat parameter studied. Thus, spikedace larvae were found most commonly in water flowing ≤ 14 cm/sec (X = 8 cm/sec), in depths ≤ 32 cm (X = 8 cm), and over sand-dominated substrates. Juveniles were most common in water flowing ≤ 29 cm/sec (X = 17 cm/sec), in depths ≤ 32 cm (X = 16 cm), and over gravel and sand substrates. Adults most commonly occupied microhabitats with water flowing 29-60 cm/sec (X = 49 cm/sec), ≤ 32 cm deep (X = 19 cm), and with gravel and cobble substates. Seasonal (cold and warm) microhabitat utilization patterns were evaluated for adult spikedace in the Cliff-Gila Valley and Forks area. In the Forks area, no significant differences in water velocity occupied (X warm = 19 cm/sec and X cold = 21 cm/sec) were found, but a significant shift to shallower water in the cold season was found (X warm = 23 cm and X cold = 17 cm). Seasonal shifts in the Cliff-Gila Valley were opposite those detected in the Forks area. In the warm season, mean velocity was 49 cm/sec, but was 39 cm/sec in the cold season. Water depth did not change (X warm = 19 cm and X cold = 18 cm). Geographic comparisons in microhabitat utilization by adults revealed significant differences in water velocities and depths occupied between the Cliff-Gila Valley and Forks area. Most spikedace adults were found in water flowing ≤ 29 cm/sec (X = 21 cm/sec) in the Forks area, but in the Cliff-Gila

Valley most were in water 29-60 cm/sec (X = 36 cm/sec). Differences in water depth were less dramatic (X Forks = 19 cm and X Cliff-Gila = 21 cm). Consideration of within-site spikedace distribution patterns revealed that the species is generally limited to the shear zone along gravel-sand bars, quiet eddies on the downstream edge of riffles, and broad, shallow areas immediately above gravel-sand bars.

FURTHER THOUGHTS ON CONSERVING FISH GENOMES: PHILOSOPHIES AND PRACTICES

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Drawer E
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Despite recent advances in application of population genetic principles to conservation of threatened and endangered (T & E) biota, many questions and gaps remain in both the philosophy and practice of conservation genetics. Because we do not fully understand the nature and importance of allelic diversity in long-term survival of small populations, we should adopt a "conservative philosophy of conservation" and assume that genetic diversity is important and should be preserved. The philosophy of which levels of biotic, and hence genetic diversity, should receive priority (species vs. subspecies vs. populations) is undeveloped and deserves attention. From a practical perspective, many areas of conservation genetics of fishes need further development, including: detailed genetic information on T & E fishes; expansion of gene bank (hatcheries and cryopreservation) research and use around the world; experimental work on relationships between genetic variation and fitness; inclusion of aspects of fish life history and behavioral patterns in conservation genetic programs; consideration of biogeographic implications in genetic conservation; greater educational emphasis on modern genetic techniques in management; and much greater insight into functioning of the eukaryotic genome. Ultimately, a mature science of conservation genetic management of fishes will develop only through characterization of strong philosophical and practical goals developed by a variety of biological and political scientists.

Possible Reasons for the Decline of the Oregon Chub (Oregonichthys crameri)

Todd N. Pearsons

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Corvallis, OR 97331-3803

The Oregon Chub Oregonichthys (= Hybopsis) crameri is a small rare cyprinid restricted to the Willamette and Umpqua river systems in Oregon. The Oregon chub seems to be able to tolerate quite adverse physical conditions but has been declining rapidly. The Willamette variety is now restricted to four known localities each of which could be decimated by minor human accidents. Analysis of historical records and preliminary study on the Willamette variety of the Oregon chub implicate exotic fishes and stream channelization as contributing factors to its decline.

Causas posibles de la disminucioñ del Oregon chub

El Oregon chub Oregonichthys (= Hybopsis) crameri es un ciprino pequeño, poco frcuente y restringido a los sistemas fluviales Willamette y Umpqua en Oregon. Este pex, a pesar de poder tolerara condiciones ambientales adversas, ha estado declinando râpidamente. La variedad de este peg residiendo en el rio Willamette está ahora restringida a cuatro sitios conocidos y podria ser diezmada auñ por accidentes pequeños de origen humans. Un analisis del registro historico y restulados de un estudio preliminar sugieren que peces exoticos y la canalizacion de las corrieutes de agua son factores contribuyendo a la disminucion del Oregon chub en el rio Willamette.

PURSUING A SPORTFISHERY FOR ENDANGERED COLORADO SQUAWFISH

Patrick J. Martinez

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711 Independent Avenue
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ABSTRACT

Creation of a sport fishery for Colorado squawfish is a controversial idea that has been proposed since the species was listed as endangered. Current impetus for this activity in the Upper Basin stems from construction of Taylor Draw Dam on the mainstem White River six miles east of Rangely, Colorado. The dam, completed in 1984, created Kenney Reservoir which is a 10 km (6 mi.) long, 249 ha (615 A) impoundment having a maximum depth of 16 m (53 ft.). The Taylor Draw biological opinion prohibited a fishery in the reservoir that would compete with endangered fishes and also required strict adherence to an inter-agency memorandum of agreement which recommended exploring the feasibility of a reservoir fishery for Colorado squawfish. Initially, the reservoir was stocked with rainbow trout, however, it does not provide favorable trout habitat due to seasonally high turbidity and warm water temperatures. Local demand for a warmwater fishery, namely largemouth bass, resulted in agency intervention to prevent unauthorized introductions of non-salmonid sport fish which are suspected in the decline of endangered native fishes. In the absence of other acceptable or viable management alternatives, Colorado squawfish became a candidate for developing a fishery in Kenney Reservoir. Because escapement over the dam appears inevitable, it is questionable if a highly migratory species, such as Colorado squawfish, will remain in the reservoir. A major issue concerns introduction of hatchery reared squawfish into a river system where wild fish exhibit extensive migrations related to reproduction that may depend on early life cues. Further, mixing genetic stocks from different sub-basins via stocking has been scrutinized. It is anticipated that Colorado squawfish will have to exceed the maximum length attained by the similar, more common roundtail chub, 450 mm (18 in.), to provide fishermen with a distinctive product. Available information indicates that it may take 6-8 years to produce squawfish this size under temperature regimes in the Upper Basin. Colorado squawfish are readily caught with bait and artificial lures; however, they do not appear to be spectacular gamefish. Historic information suggests that squawfish, nicknamed "white salmon" by early settlers, offer excellent table fare, possessing both good flavor and texture. Illegal take of squawfish in other areas and fisherman acceptance of squawfish will be addressed though a vigorous information and education program. While circumstances surrounding this endeavor, including location, biology of the species, and current public atmoshere, do not portray a promising scenario, stocking of Colorado squawfish into Kenney Reservoir is scheduled for 1987/88. Efforts will be made to stock squawfish acquired from White River brood fish to minimize potential biological artifacts of artificial propagation and inter-basin genetic differences. The situation will be monitored to provide an evaluation of this endangered cyprinid as a sport fish.

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"
407 West Line Street
Bishop, California 93514

December 11, 1986

RESOLUTION 86-1

RELATIVE TO THE PROTECTION OF THE SHORTNOSE SUCKER AND LOST RIVER SUCKER

WHEREAS The shortnose sucker (Chasmistes brevirostris) and Lost River sucker (Deltistes luxatus) occur only in the upper Klamath Basin of south-central Oregon and north-central California, and

WHEREAS both species have declined drastically to the point that even the largest remaining populations in Upper Klamath Lake are in jeopardy, and

WHEREAS both species have been valuable sport species for dozens of years, staples in the diet of the Klamath Indian Peoples for thousands of years, and an integral feature of the Klamath River ecosystem for an even longer period, and

WHEREAS urgentaction is needed in order to prevent any further losses if these species are to be saved, now therefore be it

RESOLVED that the Desert Fishes Council encourages the U.S. Fish and Wildlife Service to immediately provide the protection of the Endangered Species Act to the shortnose sucker and Lost River sucker, and be it further

RESOLVED that the U.S. Fish and Wildlife Service assist in determining the causal factors in the population declines by providing funds and manpower into the ongoing research effort of the Oregon Department of Fish and Wildlife and the Klamath Tribe, and be it further

RESOLVED that copies of this resolution be forwarded to the Regional Director of the U.S. Fish and Wildlife Service; to the Director of the Oregon Department of Fish and Wildlife; to the Director of the California Department of Fish and Game; and to the Tribal Chairman of the Klamath Tribe.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514
January 8, 1987

RESOLUTION 86-2

RELATIVE TO THE PROTECTION OF THE ASH MEADOWS ECOSYSTEM

WHEREAS the Desert Fishes Council has for the past 17 years actively sought protection for Ash Meadows (Nye County, Nevada) and its large number of endemic species, and

WHEREAS the U.S. Congress recently appropriated funds for the purchase of land to allow the establishment of the Ash Meadows National Wildlife Refuge for the purpose of protecting the endemic flora and fauna, and

WHEREAS the U.S. Fish and Wildlife Service has stated that it is preparing a recovery plan which outlines the basic requirements to protect and enhance the four fishes, seven plants, and one insect presently listed by the Federal government as either threatened or endangered in Ash Meadows, and

WHEREAS this recovery plan also recognizes that protection may only be afforded by managing for the entire ecosystem and not any specific portion thereof, and

WHEREAS representatives of the U.S. Fish and Wildlife Service assured this Council at its Eighteenth Annual Symposium, and in correspondence relating thereto, that the intent of the Fish and Wildlife Service is to begin implementing this recovery plan in the near future, and

WHEREAS further planning will be undertaken to determine compatible uses of the refuge that do not adversely affect recovery actions or the status of these species, now therefore be it

RESOLVED that the U.S. Fish and Wildlife Service must proceed with due caution in the management of the refuge so as to permit public use in a manner compatible with the authorized purpose of the refuge as a preserve for its threatened and endangered biota, and be it further

RESOLVED that the Desert Fishes Council, an international organization numbering more than 400 individuals representing the general public, government and university scientists and resource managers, and private conservation organizations, meeting at its Eighteenth Annual Symposium in St. George, Utah on November 22, 1986, does hereby express its appreciation to the U.S. Fish and Wildlife Service for the attendance of its representatives for a discussion of these matters, and be it further

Desert Fishes Council Resolution 86-2 January 8, 1987

RESOLVED that the Desert Fishes Council requests, through correspondence to its Executive Secretary, to be kept fully informed of the progress of the Ash Meadows recovery and management plans, and be it further

RESOLVED that appropriate representatives of the U.S. Fish and Wildlife Service are hereby invited to attend the annual meeting of the Death Valley Hydrographic Area Committee, scheduled to be held on March 13, 1987, at Death Valley National Monument Headquarters, and to report to the assembled committee on the progress of these plans, and be it further

RESOLVED that copies of this resolution be forwarded to the Director of the U.S. Fish and Wildlife Service; the U.S. Fish and Wildlife Service Regional Director in Portland, Oregon; the Director of the Nevada Department of Wildlife; the Nevada Division of Forestry; and to appropriate members of the Nevada congressional delegation.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

Edwin P. Pister
Executive Secretary

Desert Fishes Council

"Dedicated to the Preservation of America's Desert Fishes"

407 West Line Street
Bishop, California 93514

January 9, 1987

RESOLUTION 86-3

RELATIVE TO THE MANAGEMENT OF THE BONNEVILLE CUTTHROAT TROUT IN THE GREAT BASIN NATIONAL PARK

WHEREAS the creation of the Great Basin National Park, Nevada was signed into law by the President on October 27, 1986, and

WHEREAS the new Park constitutes 77,000 acres of the Humboldt National Forest, which contains significant essential habitat for the native Bonneville cutthroat trout (_Salmo clarki utah_), and

WHEREAS in the past the Bonneville cutthroat trout has been managed as a sensitive species by the U.S. Forest Service and the Nevada Department of Wildlife in an interagency effort to maintain species viability and increase its range within the Great Basin and the Bonneville Basin, and

WHEREAS the management of this species will now be taken over by the U.S. National Park Service, and

WHEREAS the U.S. Forest Service and Nevada Department of Wildlife are concerned that this management may hamper established interagency efforts to effectively maintain and transplant the species to expand its range as part of a recovery effort to assist the U.S. Fish and Wildlife Service, which is now considering a "threatened" listing package for the species under the provisions of the Endangered Species Act of 1973, as amended, now therefore be it

RESOLVED that the Desert Fishes Council, meeting at its Eighteenth Annual Symposium in St. George, Utah on November 20-22, 1986, does hereby recommend that the transition team being established by the Forest Service and National Park Service to transfer resources management responsibility for the 77,000 acre National Park, include a Forest Service and Nevada Department of Wildlife fisheries biologist to assure that the future management of the Bonneville cutthroat trout will continue on an interagency basis between these three agencies to meet established state and federal goals and objectives, and be it further

DESERT FISHES COUNCIL
RESOLUTION 86-3

RE: BONNEVILLE CUTTHROAT TROUT

RESOLVED that copies of this resolution be forwarded to the Secretary of the Interior, the National and Regional Directors of the National Park Service, the Secretary of Agriculture, the Chief of the Forest Service and the Regional Forester of the Intermountain Region, the Supervisor of the Humboldt National Forest, the Governor of the State of Nevada, and the Director of the Nevada Department of Wildlife.

PASSED WITHOUT DISSENTING VOTE

ATTEST:

Edwin P. Pister
Executive Secretary

CURRENT STATUS OF DEVILS HOLE

Wayne Westphal, National Park Service, Shoshone, CA

Devils Hole experienced 0.34 inches of rain during a mid-August (1986) thunderstorm, covering the shelf (about 1/3 of it) with gravel.

On September 20 the *C. diabolis* count was 481, and it was found that the fish were primarily at some depth feeding on algae. We will need to wait for Springtime to determine to what extent algae has recolonized the shelf, and to what extent the fish are breeding.

Ike Winograd (U.S.G.S.) has been dating calcite deposits within Devils Hole. Pending Fish and Wildlife Service approval, U.S.G.S. would like to core-drill within Devils Hole to take their dates back to a million years or so.

Several break-ins have occurred at Devils Hole, with wire cutters, bolt cutters, and .357 magnum revolvers being used to gain access. The problem was at least partially solved when a suspect, who had been involved in other law violations in the area, was apprehended by local law enforcement authorities.

DESERT FISHES COUNCIL
RESOLUTION 86-3

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ATTENDANCE LIST, SYMPOSIUM XVIII, ST. GEORGE, UTAH, NOVEMBER 20-22, 1986.

Mignon Shumway	Calif. Dept. Fish & Game,	Bishop, CA 93514
R. E. Brown, Jr.	" " " "	" " "
Phil Pister	" " " "	" " "
Bob Furtek	REECo.	Las Vegas, NV 89114
Marty Jakle	U.S. Bureau of Reclamation,	Phoenix, AZ
Kevin Bestgen	Univ. New Mexico,	Albuquerque, NM 87131
Steve Platania	" " "	" " "
Glenn Clemmer	Nevada Heritage Program,	Carson City, NV 89710
Jim Williams	U.S. Fish & Wildlife Service/OES	Washington, D.C. 20240
Jack E. Williams	" " "	Sacramento, CA 95825
Clark Hubbs	Univ. Texas,	Austin 78712
Randy McNatt	U.S. Fish & Wildlife Service,	Reno, NV 89431
Bob Ruesink	" "	Salt Lake City, UT
Gail C. Kobetich	" "	Sacramento, CA 95825
Don W. Sada	" "	Reno, NV 89431
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