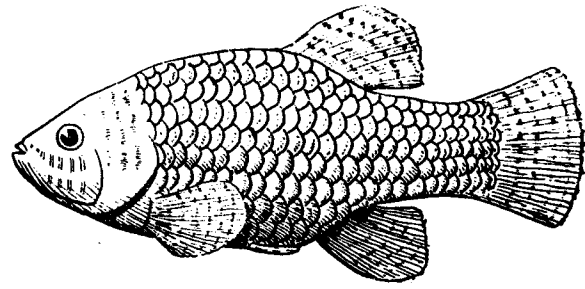


For Copying

# Desert Fishes Council



---

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

## THE RARE AND ENDANGERED FISHES OF THE DEATH VALLEY SYSTEM

A Summary of the Proceedings of the  
Second Annual Symposium Relating to  
Their Protection and Preservation

## Volume II

By

Edwin P. Pister

California Department of Fish and Game

Symposium Coordinator

Held at

Death Valley National Monument Headquarters

Furnace Creek, California

November 17 & 18, 1970

Produced by the Desert Fishes Council and California Department of  
Fish and Game in Cooperation with the U. S. National Park Service.

Submitted for publication October 8, 1971.

Desert Fishes Council, 407 West Line Street, Bishop, California 93514

## APPENDIX

- A. Origin of Major Springs in the Amargosa Desert of Nevada and Death Valley, California.
- B. A Proposal for Preservation of Endangered Fishes of the Death Valley System.
- C. List of those attending 1970 symposium.

## APPENDIX A

### ORIGIN OF MAJOR SPRINGS IN THE AMARGOSA DESERT OF NEVADA AND DEATH VALLEY, CALIFORNIA

by

Isaac J. Winograd

#### ABSTRACT

Studies of the hydrogeology of the southern Great Basin differ widely in their conclusions regarding the origin of major springs at Ash Meadows, in the Amargosa Desert, Nevada, and in the Furnace Creek-Nevares Spring area in Death Valley: First, ground water commonly moves between intermontane basins of the region via thick, highly fractured, and areally extensive Paleozoic carbonate rocks; the resulting lack of correspondence of topographic and ground-water divides precludes routine utilization of the water budget method in the study of these basins. Second, subsurface hydraulic data for the regional carbonate aquifer are sparse and difficult to interpret because of the complex subsurface disposition of, and hydraulic barriers within, the aquifer. A synthesis of hydrologic, geologic, geochemical, and isotopic data permits a first approximation of the subsurface watershed tributary to the cited spring groups.

Water temperature, chemistry, isotope content and head, and geologic relations, indicate that the major springs at Ash Meadows and in the Furnace Creek-Nevares-Spring area, though emerging from Quaternary strata, are fed by water moving directly from the underlying carbonate aquifer.

Joint use of potentiometric, geologic, and isohyetal maps indicates that the ground watershed tributary to Ash Meadows is no smaller than 4,500 square miles. The Ash Meadows ground water basin is bordered on the south and east by the Spring Mountains and Sheep Range (the principal recharge areas) and on the west by the Belled Range, Eleana Range, and Shoshone Mountain. A northern boundary was not definable, and some underflow from the southwestern White River ground water basin (namely, Pahrangat Valley and vicinity) 90 miles northeast of the springs, is likely. The hydrogeologic data do not support the conclusion of earlier studies that underflow from Pahrump Valley is the major source of the spring discharge at Ash Meadows; probably no more than a few percent comes from that valley.

Comparison of the size, climate, and discharge from the Ash Meadows basin with that of the surface watershed tributary to the Furnace Creek-Nevares Spring area indicates that most of the spring discharge in east-central Death Valley originates well beyond its confines. Disposition of the carbonate aquifer favors the movement of ground water into Death Valley from central Amargosa Desert; water in the carbonate aquifer in the latter area may be derived from the Ash Meadows basin, from the overlying valley fill, or both.

Five hydrochemical facies were distinguished by percentage of major cations and anions in ground water from 147 sources. The areal distribution of these facies provides quasi-independent evidence for a northeasterly source of the Ash Meadows discharge, absence of significant underflow from Pahrump Valley to Ash Meadows, and movement of water from the central Amargosa Desert to the Furnace Creek-Nevares Spring area. The data are also compatible with southwestward underflow into the Ash Meadows basin from the White River basin.

The deuterium content of 53 water samples from 27 major (valley-level) springs and select wells falls into several areally distinct groups. These patterns suggest that 35 to 45 percent of the Ash Meadows discharge is derived from the White River basin, underflow from Pahrump Valley is unlikely, and water discharging in the Furnace Creek-Nevares Spring area may be related to water in the carbonate aquifer within the Ash Meadows basin. The deuterium data are subject to several other interpretations; these are reviewed to illustrate the difficulty of using this, and other tracers (namely,  $H^3$ ,  $C^{14}$ , and  $O^{18}$ ), in the absence of considerable hydrogeologic and paleoclimatologic data. Unequivocal interpretations about the regional flow system are unlikely from isotopic data alone.

#### SELECTED REFERENCES

- Clebsch, Alfred, Jr., 1961, Tritium age of ground water at the Nevada Test Site, Nye County, Nevada: U.S. Geol. Survey, Prof. Paper 424-C, p. C122-C125
- Denny, C. S. and Drewes, Harald, 1965, Geology of the Ash Meadows quadrangle Nevada-California: U. S. Geol. Survey Bull. 1181-L, p. L1-L56
- Eakin, T. E., 1966, A regional interbasin groundwater system in the White River area, southeastern Nevada; Water Resources Res., v. 2, no. 2, p. 251-271
- Eakin, T. E. and Winograd, I. J., 1965, Interbasin movement of ground water in south-central Nevada -- Some implications, Abstracts for 1964: Geol. Soc. America, Special Paper 82, p. 52
- Grove, D. B., Rubin, Meyer, Hanshaw, B. B., and Beetem, W. A., 1969, Carbon-14 dates of ground water from a Paleozoic carbonate aquifer, south-central Nevada: U. S. Geol. Survey Prof. Paper 650-C, p. C215-C218
- Halliday, W. R., 1966, Depths of the earth; Harper and Row, New York, ch. 20, p. 273-282
- Hubbs, C. L. and Miller, R. R., 1948, The zoological evidence: Correlation between fish distribution and hydrographic history in the desert plains of western United States, in, The Great Basin, with emphasis on glacial and postglacial times: Bull. Univ. Utah, v. 38, no. 20, p. 18-166
- Hughes, J. L., 1966, Some aspects of the hydrogeology of the Spring Mountains and Pahrump Valley, Nevada, and environs, as determined by spring evaluation: Masters thesis, Univ. of Nevada, Reno
- Hunt, C. B. and Robinson, T. W., 1960, Possible interbasin circulation of ground water in the southern part of the Great Basin: U.S. Geol. Survey Prof. Paper 400-B, p. B273-B274
- Hunt, C. B., and Mabey, D. R., 1966, Stratigraphy and structure, Death Valley, California: U.S. Geol. Survey Prof. Paper 494-A
- Hunt, C. B., Robinson, T. W., Bowles, W. A., and Washburn, A. L., 1966, Hydrologic basin, Death Valley, California: U. S. Geol. Survey Prof. Paper 494-B, p. B1-B138
- Jennings, C. W., 1958, Geologic map of California, Olaf P. Jenkins edition, Death Valley sheet: California Div. of Mines and Geology, scale 1:250,000
- Loeltz, O. J., 1960, Sources of water issuing from springs in Ash Meadows Valley, Nye County, Nevada (abs.): Geol Soc. America Bull., v.71, no. 12, pt. 2, p. 1917-1918

- Longwell, C. R., Pampeyan, E. H., Bowyer, Ben, and Roberts, R. M., 1965, Geology and mineral deposits of Clark County, Nevada: Nevada Bur. Mines Bull. 62, 218 p.
- Malmberg, G. T., 1967, Hydrology of the valley fill and carbonate rock reservoirs, Pahrump Valley, Nevada-California: U.S. Geol. Survey, Water-Supply Paper 1832, 47 p.
- Malmberg, G. T. and Eakin, T. E., 1962, Ground-water appraisal of Sarcobatus Flat and Oasis Valley, Nye and Esmeralda Counties, Nevada: Nevada Dept. Conserv. and Nat. Resources, Ground Water Resources -- Recon. Ser. Rept. 10, 39 p.
- Maxey, G. B. and Jameson, C. H., 1948, Geology and water resources of Las Vegas, Pahrump, and Indian Springs Valleys, Clark and Nye Counties, Nevada State Engineer Water Resources Bull. 5, 121 p., app. 1, 128 p., 2, 43 p.
- Maxey, G. B. and Mifflin, M. D., 1966, Occurrence and movement of ground water in carbonate rocks of Nevada, in, Moore, G. W., ed., Limestone hydrology -- a symposium with discussion: Natl. Speleol. Soc. Bull., v. 28, no. 3, p. 141-157
- Miller, R. R., 1946, Correlation between fish distribution and Pleistocene hydrography in eastern California and southwestern Nevada, with a map of the Pleistocene waters: Jour. Geology, v. 54, no. 1, p. 43-53.
- \_\_\_\_\_, 1948, The Cyprinodont fishes of the Death Valley system of eastern California and southwestern Nevada: Univ. of Michigan, Misc. Publ., Museum of Zoology, no. 68
- Pistrang, M. A., and Kunkel, Fred, 1964, A brief geologic and hydrologic reconnaissance of the Furnace Creek Wash area, Death Valley National Monument, California: U. S. Geol. Survey Water-Supply Paper 1779-Y, 35 p.
- Quiring, R. F., 1965, Annual precipitation amount as a function of elevation in Nevada south of 38 1/2 degrees latitude: U. S. Weather Bur. Research Sta., Las Vegas, Nev., mimeographed report, 14 p.
- Roberts, R. J., 1964, Paleozoic rocks, in, Mineral and water resources of Nevada: U. S. Geol. Survey and Nevada Bur. Mines, p. 22-25, fig. 7
- Schoff, S. L. and Moore, J. E., 1964, Chemistry and movement of ground water, Nevada Test Site: U. S. Geol. Survey, open-file report, TEI-838, 75 p.
- Thordarson, William, Young, R. A., and Winograd, I. J., Records of wells and test holes in the Nevada Test Site and vicinity (through December 1966); U. S. Geol. Survey, open-file report, TEI-872, 26 p.
- Tschanz, C. M., and Pampeyan, E. H., 1961, Preliminary geologic map of Lincoln County, Nevada: U. S. Geol. Survey, Mineral Inv. Field Studies Map MF-206

- Walker, G. E., and Eakin, T. E., 1963, Geology and ground water at Amargosa Desert, Nevada-California: Nevada Dept. Conserv. and Nat. Resources, Ground-Water Resources -- Recon. Ser. Rept. no. 14, 45 p.
- Winograd, I. J., 1962, Interbasin movement of ground water at the Nevada Test Site; U. S. Geol. Survey Prof. Paper 450-C, p. C108-C111
- \_\_\_\_\_, 1963, A summary of the ground-water hydrology of the area between the Las Vegas Valley and the Amargosa Desert, Nevada, with special reference to the effects of possible new withdrawals of ground water, in, U. S. Congress, Nevada Test Site Community hearings before the Joint Committee on Atomic Energy: U. S. 88th Cong., 1st sess., Sept. and Oct. 1963, p. 197-226 (also U. S. Geol. Survey, open-file report TEI-840, 79 p.)
- Winograd, I. J., 1971, Origin of major springs in the Amargosa Desert of Nevada and Death Valley, California: Ph.D. dissertation, Univ. of Arizona, Tucson (in review; release expected by February 1, 1971)
- Winograd, I. J., and Eakin, T. E., 1965, Interbasin movement of ground water in south-central Nevada -- The evidence, in, Abstracts for 1964: Geol. Soc. America, Special Paper 82, p. 227
- Winograd, I. J., and Thordarson, William, 1968, Structural control of ground-water movement in miogeosynclinal rocks of south-central Nevada, in, Nevada Test Site, E. B. Eckel, ed.: Geol. Soc. America Memoir 110, p. 35-48
- Winograd, I. J., and Friedman, Irving, 1969, Delineation of regional ground water flow systems using deuterium, eastern Great Basin, Nevada: Geol. Soc. America, Abstracts with Programs for 1969, Part 7, p. 239-240
- Winograd, I. J., Thordarson, William, and Young, R. A., 1971, Hydrology of the Nevada Test Site and vicinity: U. S. Geol. Survey Prof. Paper (in review; release to open-file expected during first quarter 1971)
- Worts, G. F., 1963, Effect of ground-water development on the pool level in Devils Hole, Death Valley National Monument, Nye County, Nevada: U. S. Geol. Survey, open-file report, 27 p.

## APPENDIX B

### A Proposal for Preservation of Endangered Fishes of the Death Valley System

Date: 17 and 18 November 1970

To : Members, Second Annual Symposium on Endangered Fish of Death Valley  
at Furnace Creek, California

Some of the gentlemen gathered here I know are familiar with the existence of a sizeable number of talented amateur aquarists throughout the country. Certain of these aquarists are especially interested in and devoted to the care, maintenance and reproduction of Cyprinodontid fishes. In 1961 a small number of us formed the American Killifish Association, an organization of expert aquarists, many with formal scientific training, all with considerable practical knowledge of the skills needed to reproduce fish in home aquaria. The AKA now has nearly 1000 members in the U.S.A. with an additional 50 or so foreign members in Europe, South America, Africa and Asia. With all due respect to the professional scientists in this audience, permit me to remind you that it often happens that amateur animal keepers possess more skill than professionals in providing conditions for healthy survival of captive animals and in the case of fish many of these non-professionals are better at inducing animals to reproduce than are many ichthyologists. I suggest that the talents of certain members of the AKA be called on to aid in the preservation of endangered cyprinodontids of the Death Valley System, in a manner analogous to practices now in common useage with endangered mammals and birds in zoos throughout the world.

I have had a hand in the formation of the AKA and know personally or through intragroup scuttlebut who are the most skilled and dedicated hobbyists. My proposal to this group today is in its essentials exceedingly simple. I suggest that I be charged with the responsibility of distributing to selected AKA people a few pairs of the various species in question with the understanding that they are to make every effort to maintain reproducing populations in their possession. I would keep track of who has what and periodically require of them a status report. Such a plan has much to recommend it. All that would argue against it is low natural numbers of some species, e.g. C. diabolis, E. latos. Even with some of these species a very few individuals in the hands of our best aquarists stand a good chance of survival and reproduction.

Should this idea find favor with members of this symposium body I suggest the following sequence of implementation.

1. A short article outlining the problem and the proposal to be prepared for publication as soon as possible in Killie Notes, the monthly of the AKA. This would call for volunteers to contact me, giving me information relative to their degree of skill and experience with aquarium fish culture, particularly of cyprinodontids, as well as assurance of possible long term commitment to the project.

2. Information sheets, prepared from the literature and unpublished data from sources such as Drs. Deacon, Miller, Brown, Liu, Walters, etc., giving temperature ranges, pH, water hardness, electrical conductivity, etc., as well as essentials of reproductive and social behavior, would be disseminated for each species to selected AKA members. This would allow aquarists to prepare suitable aquaria.

3. Field collections of limited numbers of specimens would then be undertaken. These would be returned to my facilities at Fresno State and from there would be sent by air mail special delivery to aquarists. Cost for shipment to be borne by participant. I am knowledgeable in the techniques for shipping small fish through the mails.

4. Separate collections and mailings would be made for each species.

5. At regular intervals feedback would be required of the participants on a standard prepared form giving the status of the fish in their possession.

I envisage the idea as being eminently possible and workable with much to be gained if successful and nothing more to be lost than is currently being lost should it fail. Since those with whom I suggest we work are expert aquarists, I think the opportunities for success are excellent. I solicit your commentary and suggestions.

Richard Haas, Ph.D.  
Department of Biology  
Fresno State College  
Fresno, CA 93710

APPENDIX C

ROSTER

1970 PUPFISH SYMPOSIUM

Phil Pister	Fishery Biologist California Fish & Game	407 W. Line Street Bishop, California
Charles G. Hansen	Research Biologist National Park Service	P.O. Box 156 Death Valley, California
Leon Berggren	Natural Resource Specialist Bureau of Land Management	800 Truxtun Ave. Rm. 311 Bakersfield, California
Jim Blaisdell	Regional Biologist National Park Service	296 Verde Mesa Danville, California
Clark Hubbs	Professor University of Texas	Department of Zoology University of Texas
O. L. Wallis	Aquatic Research Biologist National Park Service	Washington, D.C. 20240
Dennis Williams	Geohydrologist Los Angeles Department of Water and Power	P.O. Box 111 Rm. 1411 Los Angeles, California
Bruce Kuebler	Staff Engineer Los Angeles Department of Water and Power	P.O. Box 111 Rm. 1411 Los Angeles, California
Earl T. Walker	Division River Basin Studies Bureau of Sport Fisheries & Wildlife	Department of the Interior Washington, D.C.
Robert L. Borovicka	Fisheries Biologist Bureau of Land Management	710 N. E. Holladay St. Portland, Oregon
Tilly Barling	Natural Resources Management Naval Weapons Center	525 A Nimitz China Lake, California
Bob Barling	Real Estate Management Naval Weapons Center	525 A Nimitz China Lake, California
Ron Lambertson	Attorney Department of the Interior	7981 Riggs Road Adelphi, Maryland
Louis A. Boll	Biologist Bureau of Land Management	7703 Arlen Street Annandale, Virginia

Martin R. Brittan	Biologist Sacramento State College	600 J Street Sacramento, California
Alan M. McCready	Research Analyst Private	2510 Rogue River Drive Sacramento, California
Leonard Fisk	Senior Fisheries Biologist California Fish and Game	1416 Ninth Street Sacramento, California
Edwin W. Reed	Hydraulic Engineer National Park Service	Washington, D.C.
Thomas R.C. Wilson	Attorney Spring Meadows, Inc.	60 Court Street Reno, Nevada
William W. Dudley, Jr.	Research Hydrologist U.S. Geological Survey	Denver Federal Center Building 25, Denver, Colo.
Dale V. Lockard	Regional Biologist Nevada Fish & Game	4747 Vegas Drive Las Vegas, Nevada
Robert D. Montgomery	Regional Manager R5 California Fish & Game	350 Golden Shore Long Beach, California
Paul A. Fodor	Park Ranger National Park Service	Death Valley, California
John Rapier, III	Park Ranger National Park Service	Death Valley, California
Edward C. Kinney	Bureau of Sport Fisheries & Wildlife	Washington, D.C. Department of the Interior
Larry Cenotto	Administrative Assistant Assemblyman Chappie's Office	State Capitol Sacramento, California
Jack Hemphill	Assistant Regional Director Bureau of Sport Fisheries & Wildlife	P.O. Box 3737 Portland, Oregon
Bill White	Chief, Division of River Basin Studies Bureau of Sport Fisheries & Wildlife	Department of the Interior Washington, D.C.
James D. Carson	Fish & Wildlife Biologist Bureau of Sport Fisheries & Wildlife	Sacramento, California
Paul Z. Zellmer	Junior Aquatic Biologist California Fish and Game	Blythe, California

Minckley	Student University of Nevada	Las Vegas, Nevada
st R. Miller	Professor of Zoology University of Michigan	Ann Arbor, Michigan
Jenkins	Fishery Biologist Bureau of Sport Fisheries & Wildlife	Convict Creek, California
ge B. Maxey	Director Center for Water Resources Research - Desert Research Institute	Reno, Nevada
. Worts	District Chief U.S. Geological Survey	Federal Building Carson City, Nevada
s T. McBroom	Assistant Director Bureau of Sport Fisheries & Wildlife	Washington, D.C.
Joakum	Wildlife Specialist Bureau of Land Management	Reno, Nevada
i L. Soltz	Graduate student U.C.L.A.	Department of Zoology U.C.L.A.
ard Haas	Assistant Professor Fresno State College	Fresno, California
Lilliston	Reporter Los Angeles Times	Los Angeles, California
Tower	Area Manager Bureau of Land Management	Las Vegas, Nevada
T. Burridge	Sierra Club	14762 Carfax Drive Tustin, California
is King	Chief, Division Fishery Service	Washington, D.C.
ard R. Meyer	Associate Solicitor Department of the Interior	Washington, D.C.
iam J. Newman	Groundwater Engineer Division of Water Resources	201 S. Fall Street Carson City, Nevada
St. Amant	Associate Fishery Biologist California Fish and Game	350 Golden Shore Long Beach, California

ine Nappe	Foresta Institute	Box 620, Rt. 1 Carson City, Nevada
d Brown	Graduate Student University of Southern California	2217 Veteran Ave. Los Angeles, California
H. Brown	Assistant Professor U.C.L.A.	Department of Zoology Los Angeles, California
t Feldmeth	Assistant Professor Claremont Colleges	Joint Science Department Claremont, California
Fiero	Research Associate University of Nevada	4624 Maryland Parkway So. Las Vegas, Nevada
d Meyer	Water Resources Division U.S. Geological Survey	Washington, D.C.
Burandt	Fish and Game Warden California Fish & Game	Lone Pine, California
aiman	Student U.C.L.A.	Department of Zoology Los Angeles, California
Calhoun	Chief, Inland Fish. Br. California Fish & Game	1416 9th Street Sacramento, California
t Liu	Assistant Resources Path. Department of Pathology	Los Angeles, California U. C. L. A.
G. Sanchez	Chief Park Naturalist National Park Service	Death Valley, California
H. Myers	Wildlife Specialist Bureau of Land Management	Las Vegas, Nevada
undy	Observer Carson City, Nevada	514 W. Robinson
P. Leach	Chief Park Ranger National Park Service	Death Valley, California
t J. Murphy	Superintendent National Park Service	Death Valley, California
th S. Croker	Conservation Chairman Orange County Group Sierra Club	2783 Mendoza Drive Costa Mesa, California
P. Alley	Assistant Professor-Zoology California State, L. A.	5151 State College Drive Los Angeles, California

E. Crawford	Wildlife Biologist Bureau of Land Management	3200 Louraine Circle Santa Fe, New Mexico
W. Klishevich	Student California State College at Los Angeles	4080 Redwood Los Angeles, California
ton H. Lostetter	Coordinator Rare and Endangered Species, BSW	P.O. Box 3737 Portland, Oregon
E. Kroonemeyer	Fishery Biologist Bureau of Sport Fisheries & Wildlife	2800 Cottage Way Sacramento, California
. Deacon	Professor University of Nevada	University of Nevada Las Vegas, Nevada
Aho	Field Solicitor Department of the Interior	Room 2004, Federal Building Reno, Nevada
l McClaren	Chief, Project Studies Bureau of Reclamation	Boulder City, Nevada
ht T. Warren	Retiree National Park Service	Death Valley, California
. Jonez	Recreation & Wildlife Specialist Bureau of Reclamation	Boulder City, Nevada
rt E. Brown, Jr.	Student U.C.L.A.	3291 Sepulveda #3 Los Angeles, California
Gillilan	Information Officer California Fish & Game	350 Golden Shore Long Beach, California
r B. Moyle	Assistant Professor Fresno State College	Fresno State College Fresno, California
s B. Hoy	Research Entomologist United States Department of Agriculture	5544 Air Terminal Drive Fresno, California
ld G. Stewart	Hydraulic Engineer Fish & Wildlife Service	P.O. Box 3737 Portland, Oregon
imir Walters	Associate Professor U.C.L.A.	Department of Zoology Los Angeles, California

as J. Trelease	Chief of Fisheries Nevada Department of Fish & Game	P.O. Box 10678 Reno, Nevada
sh E. Doctor	Administrative Assistant Senator Howard Way	P.O. Box 724 Exeter, California
ling Bunnell	Nature Conservancy	32 Millwood Mill Valley, California
an Herkenham	National Park Service	San Francisco

## PREFACE

The naturalist looks upon every species of animal and plant now living as the individual letters which go to make up one of the volumes of our earth's history; and, as a few lost letters may make a sentence unintelligible, so the extinction of the numerous forms of life which the progress of cultivation invariably entails will necessarily render obscure this invaluable record of the past. It is therefore an important object to preserve them. If this is not done, future ages will certainly look back upon us as a people so immersed in the pursuit of wealth as to be blind to higher considerations. They will charge us with having culpably allowed the destruction of some of those records of creation which we had it in our power to preserve, and while professing to regard all living things as the direct handiwork and best evidence of a Creator, yet, with a strange inconsistency, seeing many of them perish irrecoverably from the earth, uncared for and unknown."

A. R. Wallace, 1863.  
Journal of the  
Royal Geographic Society

## FOREWORD

Allace's prefatory statement describes pretty well what this is all about--our battle to save the Death Valley System fishes from extinction. For what we are attempting to do here is, in many ways, to save the unknown--to save this resource for future generations which, hopefully, will be more understanding and better able to appreciate and utilize it than we are. From my personal standpoint, I am trying to save, along with the Death Valley fishes, my own self respect and conscience. For I realize that, if man destroys this resource, it will be because I have not worked hard enough to save it; and if I do not work hard enough to save it, probably no one else will either.

We are at a very critical point now in the evolution of the "ecology ethic." We have seen, almost overnight, man's reverence and respect for Nature turn to gross indifference. He has viewed the bountiful gifts bestowed upon him by an Almighty Creator simply as the raw materials to be utilized for his own selfish economic gain, and with scarcely a thought of the needs of future generations of Americans.

Now he is beginning to see the light and, suddenly, is waking up to the fact that this type of misuse cannot go on forever and ultimately will defeat him--probably within his own lifetime if allowed to proceed unchecked.

Now we have a few adherents to our cause from among the American public and are gaining more all the time as the basic laws governing the universe become increasingly apparent.

But we do not have much time to sit back and philosophize. We are fighting a battle against time--time measured not in years anymore, but in months, hours and minutes. We have already lost Epiplatys merriami, and we may be too late to save Cyprinodon diabolis. Others have passed on unheralded before these. Water levels throughout the upper Amargosa Basin continue to drop, and we continue to fight a complex and obscure enemy comprising big business, tax laws, development-oriented state government, local tax revenues, conflicting policies and philosophies of governmental agencies, an American public which is just now waking up to the facts of life and, paradoxically, the "American Dream" which has been repeated so many times that we view it as blasphemous to question the desirability and need of clearing and "developing" land.

However, sometimes the night seems darkest just before the dawn. Although we still have a long way to go before we win this battle, we have a lot going for us that we did not have two years ago, or two months ago, for that matter. And, in the words of John Paul Jones: "We have not yet begun to fight."

For what we have in the Ash Meadows area, and throughout the Death Valley system, is far more than a few pupfish and a declining water table. We have in this system a tiny microcosm which reflects, basically, the same problems which the entire Earth faces, or soon will face. In the Ash Meadows area we

ive some fish species which are facing extinction because of needless encroachment on their habitat by man simply for economic gain. This is essentially the basis of the world's environmental problems today.

opefully, in our battle to save the desert fishes, we can set up guidelines and procedures which will be valuable in solving similar problems elsewhere. an must begin, sooner or later, to decide where the line must be drawn between environmental preservation and economic development. In many cases, f he is prudent, he can eat his cake and have it, too. Perhaps we can elp guide him.

obert Louis Stevenson once said: "You cannot run away from weakness; you ust sometime fight it out or perish; and if that be so, why not now, and here you stand?"

his is where we stand, and this is why we are fighting.

Bishop, California  
August 1, 1971

## ACKNOWLEDGMENTS

The writer gratefully acknowledges the assistance of Miss Linda Balatti, of the National Park Service, for her accurate notes of the various panel discussions. Dale Lockard, of the Nevada Department of Fish and Game, recorded the all-important session relating to the preparation of the 1971 work plan. Robert Brown and David Soltz, graduate students at U.C.L.A. and summer employees of the California Department of Fish and Game, reviewed the tape recordings and prepared comprehensive notes of the entire proceedings. Mr. Brown also made valuable suggestions concerning preparation of the text. The U. S. National Park Service made available its facilities at the Furnace Creek Visitors' Center throughout the symposium. The manuscript was typed by Madelyn Turner, of the Inyo National Forest. Finally, special thanks are due the members of the Department of the Interior's Pupfish Task Force and the Desert Fishes Council Advisory Group for their support and enthusiasm in the entire preservation effort.

## INTRODUCTION

e Symposium was followed on November 23, 1970, by a press release issued Ward Gillilan, Information Officer of the California Department of Fish and Game's southern region. This release is printed verbatim as an abstract of the proceedings of the meeting.

November 23, 1970  
For Immediate Release

### Rare Desert Fishes Gain Temporary Lease on Life

A nationwide blend of state, federal and university scientists and resource specialists, formally organized last week as the Desert Fishes Council, can point with pride to its past year's accomplishments while viewing with alarm the continuing habitat changes which necessitated the group's first meeting a year ago.

The purpose of the council is to preserve the vanishing native fishes of the Southwestern Desert.

In the past year the group has temporarily saved from extinction the tiny pupfish of Devils Hole in Nevada, a detached portion of Death Valley National Monument, where the nearby pumping of new wells for private land development apparently is lowering the water table.

But whether the Pahrump killifish, Devils Hole pupfish and eight other rare and endangered fish species unique to the Death Valley drainage system in Nevada and California can be saved over the long haul remains in doubt.

The answer, says the council, will be determined by the outcome of its battle to restore and preserve the springs and waterholes which have sustained the little-known fishes since the Pleistocene ice age.

These facts surfaced last week at Death Valley National Monument headquarters during a two-day (Nov. 17-18) workshop meeting of 81 of the nation's leading biologists, geologists, hydrologists, ecologists, resource managers, public land and water administrators and conservationists.

They came from California, Nevada, New Mexico, Texas, Colorado, Michigan, Maryland, Virginia and Washington, D.C.

Coordinated by California's Department of Fish and Game, it was the second annual meeting of the group which formed itself into the Desert Fishes Council, elected California DFG biologist Phil Pister as the council's chairman, and updated work plans and priorities for the coming year.

Topping the list of the 10 most endangered species is the Pahrump killifish, whose entire population exists in an isolated spring in Nevada's Pahrump Valley. The species is not expected to survive another 10 years, although attempts are being made to transplant it to other areas.

Snatched from the brink of doom by emergency action resulting from the group's first meeting a year ago, the colorful, inch-long Devils Hole pupfish, which began evolving thousands of years ago in the limestone sink bearing its name, is still in big trouble and remains at No. 2 on the council's list of the 10 most endangered desert fish species.

A drop in the Devils Hole water level has shut out sunlight needed to grow the fish's food. The lowering water level is also exposing a shallow, underwater ledge which, through the ages, has provided the fish's only suitable spawning area.

As an emergency measure, the biologists installed an artificial spawning shelf last May 7. A bank of electric lights, to promote food growth, was installed July 17. Since then the fish have reproduced well and seem to be at least holding their own.

As added insurance against total disaster, the biologists on August 14 transplanted 24 of the Devils Hole pupfish into a remote desert spring in California's nearby Inyo County.

The carefully-selected transplant spring closely matches the 92-degree temperature and chemical makeup of the water in Devils Hole, and the fish apparently are surviving there.

But the biologists warn that long-term living in an artificial or new environment would inevitably change the fish themselves, and the species that nature has produced would be lost.

The workshop consensus was that the Devils Hole pupfish and the other endangered fishes in the Ash Meadows area of the Amargosa River Basin can be saved only if the springs in which the fishes evolved are quickly restored to and maintained in their pre-pumping condition.

And this, it was agreed, can happen only if the land developers who own the critical water rights convert to a surface-flow catchment system for most of their irrigation water and limit their pumping to those areas where it will not adversely affect the home springs of the endangered fishes.

Meanwhile, the U.S. Department of the Interior is taking these additional emergency actions: (1) The Bureau of Land Management is re-classifying public lands in the area so that further irrigation development can be limited, and (2) under direction of a special task force, a geologic study is being made to clarify the relationship between pumping and the area's waterhole levels and spring discharges.

Identified by the Desert Fishes Council as their priority list of Death Valley drainage system fishes threatened with extinction are:

(1) Pahrump killifish, Nevada; (2) Devils Hole pupfish, Nevada; (3) Tecopa pupfish, California; (4) Ash Meadows speckled dace, Nevada; (5) Owens River speckled dace, California; (6) Owens River chub, California; (7) Ash Meadows pupfish, Nevada; (8) Warm Spring pupfish, Nevada; (9) Mohave chub, California; and (10) Owens pupfish, California.

Positive action taken by DFG biologists in constructing refuges and making transplants to more secure water sources has materially strengthened the position of the Owens pupfish and Mohave chub. Although these fishes are still considered endangered, the possibility of their becoming extinct has been materially lessened.

## SUMMARY OF PROCEEDINGS

esday, November 17

bert Murphy, Superintendent of Death Valley National Monument, presented brief introduction and welcome. His remarks, though brief, emphasized the fact that the potential problems of yesterday are the actual problems of today. This philosophy applies to such critical items of Park and Monument administration as indiscriminate vehicle use, crowd control, vandalism of natural habitat and recreational facilities, and law enforcement. The lesson is clear: We should begin now to estimate and predict our future problems and prepare for them in whatever way we can.

Following Superintendent Murphy's introductory remarks, Mr. Pister gave a brief "Introduction to the Pupfish" and reviewed developments since the first symposium held on November 18-19, 1969. He emphasized the key role played by the Department of the Interior's Pupfish Task Force. Since its formation by Commissioner Charles Meacham and Secretary Walter Hickel in 1970, the Task Force has taken a leading and very effective role in coordinating various preservation programs for the desert fishes. Strong and enthusiastic leadership for the Task Force has been provided by Chairman James T. McBroom of the Washington Office, Bureau of Sport Fisheries and Wildlife.

Mr. Pister then summarized the current status of the various endangered species. Their status is treated in detail in the following section.

SESSION I - Progress report on species preservation assignments made in November, 1969.

Chairman: O. L. Wallis, U.S. National Park Service,  
Washington, D.C.

Pahrump killifish, Empetrichthys latos.

Dr. Deacon, Mr. Lockard, and Mr. Myers.

On June 4, 1970, 31 individuals were collected from Manse Spring, all in good condition, and taken by a helicopter provided by the Bureau of Reclamation to a spring area adjacent to Lake Mohave. Two springs were planted, with approximately half of the fish in each one. Spring temperatures were 70°F. and 78°F. The current status of the transplant is unknown, but fish were still alive about two months thereafter. Dr. Deacon estimated a population of about 200 E. latos in Manse Spring. Goldfish are still present there.

Devils Hole pupfish, Cyprinodon diabolis.

Mr. Sanchez, Dr. Deacon, Mr. Lockard, Mr. Fisk, and  
Mr. Pister.

Devils Hole has experienced unprecedented declines in water levels during recent months. Because of this, an artificial shelf was installed during the summer of 1970 in an attempt to compensate for the natural limestone feeding and spawning shelf from which the water is receding. The artificial shelf was constructed from fiberglass roofing material and suspended from styrofoam floats. Shortly thereafter the Park Service installed electric lights above the shelf to stimulate algae growth which would naturally diminish from increasing darkness as the water level dropped. Both the shelf and lights appear to be functioning satisfactorily.

Two transplant attempts were made during the past year. On August 17, 1970, 24 C. diabolis were collected at Devils Hole and transplanted into Upper Warm Spring in Saline Valley, Inyo County, California. The current status of these fish is not known, although four fish were seen there in mid-September. This transplant was covered by CBS-TV and was released shortly thereafter in southern California.

Another transplant attempt was made into an artificial pond dug near Point of Rocks Spring by Spring Meadows, Inc. Although the area above the pond was chemically treated prior to the introduction, contamination by C. n. mionectes has apparently occurred already. This points out the necessity of insuring that genetically pure populations of rare or endangered fishes are not contaminated by transplants of other rare or endangered fishes.

Owens pupfish, Cyprinodon radiosus.

Dr. Miller, Mr. Berggren, Mr. Pister

On June 30, 1970, 428 fish were introduced into the Owens Valley Native Fish Sanctuary in Fish Slough, Mono County, located about ten miles north of Bishop, California. These fish have reproduced very successfully to their current level of several thousand. To date no other endemic fishes have been introduced into the sanctuary.

An additional introduction of 39 fish was made from the Fish Slough population into the Warm Springs Sanctuary, located about eight miles south of Bishop on October 28, 1970. This should provide ideal habitat for C. radiosus.

A third sanctuary is currently under construction at BLM Spring, located on the east side of Fish Slough. Considerable planning is being devoted to this project, inasmuch as Indian artifacts are located nearby, and the entire concept lends itself ideally to a study area and a public interpretive site. This project is endorsed by the Inter-agency Committee on Owens Valley Land and Wildlife and is being constructed with funds provided by the John Muir Institute, Bureau of Land Management, and California Department of Fish and Game.

A paper by Miller and Pister pertaining to the management of the Owens pupfish will be published during the coming year in the Transactions of the American Fisheries Society.

2. Ash Meadows pupfish, Cyprinodon nevadensis mionectes.

Mr. Lockard, Dr. Miller, Mr. Myers

Crystal Spring, Jackrabbit Spring, and Forest Spring had all experienced complete eradication of their C. n. mionectes populations. However, this subspecies still exists in several springs in the Ash Meadows area. Lew Myers briefly reviewed the rare and endangered species program conducted by BLM and discussed their 1968 habitat management plan for Jackrabbit Spring. At that time the main problem there was the presence of exotic fishes. An attempt was made to obtain the concurrence of Spring Meadows, Inc., in fencing the spring and creating public viewing areas. However, no reply was received. On July 26, 1969 a pump was discovered in the spring, and the populations of both C. n. mionectes and Rhinichthys sp. were destroyed. By January, 1970 a cooperative agreement to pump only from a pumping pit was signed, and the pump was removed from the spring. During the summer of 1970 the spring was maintained at 1 - 2 feet below the normal outflow level; but there was much fluctuation, and the water increased in temperature and turbidity. Dr. James Brown announced that the spring at Fairbanks Ranch was completely dry.

Although no representative of the Nature Conservancy was present, a telegram from Keith Artz of the Conservancy's San Francisco office revealed that negotiations for the purchase of Big Spring are proceeding satisfactorily.

3. Mohave chub, Gila mohavensis.

Mr. St. Amant

The only known genetically pure population of Mohave chubs in recent years was at Zzyzx Spring near Baker, California. On December 18, 1969, 150 G. mohavensis from Zzyzx were transplanted into Piute Spring, northwest of Needles, California. However, this is considered temporary because of the likelihood of flash floods. A total of 140 chubs was sent in January, 1970 to the South Coast Botanical Gardens near Los Angeles. In July, 1970 they were very abundant and three size classes were present.

Transplant sites at One-hole and Two-hole Springs, San Bernardino County, California, were reviewed. Two-hole Spring was fenced, and an introduction was made using fish smaller than four inches in length.

The California Department of Fish and Game announced its intent, in cooperation with the Department of the Navy, to introduce G. mohavensis into Lark Seep Lagoon, on the China Lake Naval Weapons Center near Ridgecrest, California.

3. Tecopa pupfish, Cyprinodon nevadensis calidae.

Dr. Miller

It is felt that the species is probably extinct. However, Dr. Miller wants to check additional collections to see if they are C. n. amargosae or C. n. calidae.

Warm Spring pupfish, Cyprinodon nevadensis pectoralis.

Mr. Myers, Dr. Deacon, Mr. Lockard,  
Dr. Miller

Mr. Myers described the habitat management plan for School Spring. In June, 1969 a one-acre enclosure was built around the spring, with a "viewers' pond" constructed below in an attempt to get public support for this type of project. During the spring of 1970 the flow appeared to be seriously reduced, resulting in a well being drilled on June 30, 1970 to provide supplementary water to School Spring. A pumping test of this well showed no adverse effect either on School Spring or Devils Hole. Dr. Miller reported that two 1967 collections from Scruggs Spring were identical with the School Spring fish and thus were C. n. pectoralis.

SESSION II - The Department of the Interior's Pupfish Task Force - its origin, purpose, and future.

Mr. James T. McBroom, Task Force Chairman

The Department of the Interior's Pupfish Task Force was established in May, 1970 at the direction of Deputy Assistant Secretary Charles Meacham. James T. McBroom was appointed as Task Force Chairman. It was noted that 33 Interior employees were present at the symposium.

The agencies within Interior currently represented on the Task Force are: Bureau of Land Management, Geological Survey, National Park Service, Office of the Solicitor, Bureau of Sport Fisheries and Wildlife, and Bureau of Reclamation. The basic purpose of the Task Force will be to organize communications and provide high level endorsement of pupfish preservation.

The Task Force determined that the primary and most urgent need at this time was a groundwater study of the Ash Meadows area. Financing in the amount of \$50,000 has been provided for this study.

The primary activities of the Task Force to date may be summarized as follows:

1. Cooperative efforts with the Nevada Department of Fish and Game and University of Nevada, Las Vegas, have resulted in the positive action described earlier at Devils Hole.
2. A Task Force decision and recommendation led to the new well at School Spring.
3. The Ash Meadows groundwater study has been financed by Interior and is being conducted by William Dudley of the Denver office, U.S. Geological Survey.

- . Attempts are being made to obtain an Office of Water Resources Research grant to supplement the U.S.G.S. study.
- . The critical habitat areas in Ash Meadows are checked, reported to Washington, and the reports disseminated to Task Force members on a weekly basis.
- . Formal requests have been made to the Nevada State Engineer to place a moratorium on granting any and all new permits for the use of Ash Meadows water until the groundwater study is completed.
- . Dale Lockard (Nevada Department of Fish and Game) and Clinton Lostetter (Bureau of Sport Fisheries and Wildlife) have completed a habitat evaluation study of surface waters in Ash Meadows.
- . The pamphlet, "Let's Save the Desert Pupfish" has been published and given wide circulation.
- . Considerable quantities of mail in favor of saving the pupfish have been received and answered.
- . Interior has reclassified all remaining lands in Ash Meadows so that they are no longer available for exchange.

SESSION III - Consideration of proposal to establish a "Desert Fishes Protective Council" and a Pupfish Advisory Committee to work with Interior's Pupfish Task Force.

Mr. Pister.

Considerable group discussion was held concerning this item, and the Desert Fishes Council was formed by unanimous vote. Phil Pister was selected as chairman, and he was given the assignment of preparing a constitution and by-laws, as well as appointing committees and "getting the Council off the ground." Also involved here would be setting up advisory groups, designating procedures requisite to administering the affairs of the Council, and assisting the Task Force in the solution of technical problems. Formal discussion and adoption of the constitution, etc., was set for the November 16-17, 1971 symposium.

SESSION IV - The ecology and research value of the Death Valley System fishes.

Dr. James Brown

Dr. Brown gave a brief narration on why biologists are interested in pupfish. He reviewed Pleistocene events and the reduction of aquatic habitats since that time, resulting in "islands of water in a sea of sand."

He stated that biologists are currently asking two basic questions:

1. Evolutionary - how much divergence has occurred in isolated populations, and

2. Ecological - how have pupfish been so successful in so many different environments? There exists here a series of natural experiments.

k to date may be summarized as follows:

1. a. Dr. Miller worked out the morphological differences.  
b. Dr. Uyeno is currently studying the chromosome karyotypes.  
c. Dr. Liu has studied the behavioral divergences.  
d. Mr. Turner is studying enzyme differentiation.
2. Studies of behavioral energetics and populational response to environmental variation are in progress at the University of Nevada (Las Vegas), U.C.L.A., and Arizona State University (Tempe).

In addition, Dr. Brown cited several examples of physiological and populational response of Cyprinodon to environmental parameters based on current or completed research. The response of pupfish dependence on their habitat was mentioned with regard to:

1. Temperature. Drs. Brown and Feldmeth found that Devils Hole pupfish (C. diabolis) can tolerate, on a short term basis, temperatures from 32°F. to 108°F.
  2. Salinity, both in unusual overall concentrations and in ionic composition. Pupfish have been observed in concentrations ranging from nearly distilled water to several times that of sea water.
  3. Absolute differences in habitat size (example given was from Mexican Spring to the Amargosa River near Tecopa). Populational homeostasis was emphasized, wherein populations are adjusted to habitats of various sizes. In Jackrabbit Spring an introduction of 100 C. n. mionectes increased to over 3,000 in about three months, but in Mexican Spring the population never exceeded 50 fish in a full year's observations.
  4. Seasonal variation in habitat size (example: annual recolonization of Salt Creek and the Amargosa River within Death Valley National Monument from the source springs area).
  5. Productivity (example: Devils Hole has little sunlight and very low productivity, whereas essentially the opposite is true at Big Spring).
- . Brown's suggestions (made as an ecologist rather than an ichthyologist) are to:

1. Preserve the original habitats in a natural condition. Each population of pupfish is unique and irreplaceable, and an alteration of their habitats can alter the populations, making them different and less interesting. "Man cannot improve upon Nature."

2. Be careful about introducing pupfish into waters that have never had fish. The communities of endemic invertebrates are unique in their own right and just as worthy of protection as the fish species we are trying to preserve.

Editor's Note: We must exercise keen judgment in our enthusiasm to preserve the desert fishes, inasmuch as we might well undo much of the inherent good in our overall program by neglecting other portions of the biota which may be damaged or destroyed through our preservation efforts. We are, in fact, dealing with communities of exceedingly complex interactions, of which we have a woefully inadequate understanding.

3. Further research must be encouraged, but we must likewise exercise restraint so that our research efforts do not adversely affect the very delicate populations we are studying. Dr. Brown's implicit point was that the very research which is too often viewed with disdain may well provide the information necessary to both understand and preserve the pupfish.

In reply to the question: "Will not these populations eventually become extinct through natural processes anyway?", Dr. Brown stated that natural extinctions are certainly tolerable, but man-caused extinction can never be justified. We must plan programs that will solve the problems of species preservation, not just prolong the time to extinction.

SESSION V - Review of current research on Death Valley System fishes, and additional research necessary for species preservation.

Chairman: Dr. James Deacon, University of Nevada, Las Vegas.

Dr. Walters, Dr. King, Dr. Miller, Dr. Brown

Dr. Walters described current research being conducted by three graduate students at U.C.L.A.

- a. Bruce Turner is conducting electrophoretic studies of polymorphism and the degree of genetic divergence that has taken place between the various populations.
- b. Robert Brown is studying environmentally controlled behavioral changes in C. radiosus and C. salinus.
- c. Robert Naiman is beginning a study of feeding and food habits of various Cyprinodon populations.
- d. David Soltz is conducting research on the effect of behavioral and environmental variables on life history features and dispersal rates of pupfish populations in small springs.

Dr. King described the hydrologic study being conducted by U.S.G.S. in Ash Meadows. He also pledged the support of the Task Force and Bureau of Sport Fisheries and Wildlife in the research effort on desert fishes and indicated that efforts would be made to place a BSFW biologist in the desert area to assist in the overall preservation effort.

Dr. Miller commented on the importance of chromosome study in elucidating the degree of evolutionary divergence. The work which he and Dr. Teruya Uyeno are doing (karyological analysis of Cyprinodon) has revealed that all 13 forms studied have the same number (48). A form from El Potosi showed a male count of 47 and a female count of 48. This is the only known case in fishes where a sexual dimorphism in chromosome numbers has been encountered.

All American minnows, including the Death Valley forms, have 50 chromosomes. The catostomids apparently arose by polyploidy from the cyprinids. All those studied (most species) have 100 chromosomes and twice the amount of DNA.

Dr. Brown discussed his research (in collaboration with Dr. Feldmeth and Mr. Soltz) at "Tecopa Bore," a well (water temperature 48°C.) flowing down to a marsh near the Amargosa River. Studies of the pupfish population living in this gradient showed that they live right at their lethal temperature (42°C.). This illustrates the precision of behavioral and ecological interactions.

Comparisons are also being made of the size and structure for a constant (Big Spring) population and a fluctuating (Amargosa River) population. Mr. Soltz is collaborating on some of the above areas.

Mrs. Astrid Brown (Dr. Brown's wife) is studying the effects of environment on behavior at Big Spring.

Dr. Feldmeth commented at this point that the lethal temperature extreme study directed toward determining how and why different pupfish populations can tolerate a wide range of temperature (all through acclimation) indicates little genetic change. He also stated that little is known of ionic and osmotic regulation: how, for instance, Cottonball Marsh fish can adapt to a concentration of 80 p.p.m. of boron, a level which had previously been considered lethal to both plants and animals.

Dr. Deacon described the work of his students at the University of Nevada (Las Vegas) in reviewing previously acquired data in an attempt to trace energy flow patterns through the Saratoga Springs ecosystem, and to determine how much energy is removed from the system.

#### SION VI - The hydrogeology of the Ash Meadows area and Amargosa River System.

Chairman: Dr. G. B. Maxey, Desert Research Institute.

Mr. Dudley, Mr. Winograd

c. Maxey was asked by the Department of the Interior to prepare a preliminary report on the Ash Meadows problem. This has been completed, but no further reference was made to it.

the consultant hydrogeologist retained by Spring Meadows, Inc., erred in his data interpretation and grossly overestimated (perhaps by as much as three times) the amount of water available and, therefore, the amount of land which could be irrigated. The amount of water discharged from the basin (17-24,000 c.f. annually) is all that is legally and feasibly available for development. d. Maxey was of the opinion that Spring Meadows, Inc., was simply a victim of poor technical advice, both from the standpoint of available water and impending damage to desert fish habitat.

e. Maxey's proposed plan is in two phases: (1) to develop a water management system for Ash Meadows, and (2) to apply this generalized system to "areas of much more extensive concern."

f. The U.S. Geological Survey will produce the data for this plan which, Dr. Maxey hopes, will allow both Spring Meadows, Inc., and the pupfish to survive.

g. William Dudley, of the Denver Office, U.S. Geological Survey, stated that the basic purpose of his study is to determine why the water level within Devils Hole has been dropping and why the discharge of other springs in the Ash Meadows area has been decreasing. His working hypothesis is that pumping in the area is the cause of both situations.

h. The primary consideration in this study will be to quantitatively determine the proportion of pumped water originating from various sources: (1) how much is simply robbing spring discharge and (2) how much is removing water from storage in the alluvial and carbonate aquifers.

i. Other objectives of the study will be to determine which of the present pumping centers are causing the greatest damage to pupfish habitats. The hydrogeology of the aquifers and faults will be studied and described as a basis for understanding the mechanics of the connections of the present pumping centers to the pupfish habitats. The approach to this problem will be essentially as follows:

1. Had the water level of Devils Hole ever been below the level of the shelf? Divers went to a depth of about 90 feet and found no evidence that it had.
2. Complete historical records and continue taking records of water levels and spring discharges. All major springs and some minor ones are currently giving continuous records.
3. A correlation of nuclear and seismic activity with spring flows has been partially completed. To date no relationship has been indicated.
4. A correlation of spring flows with climatic records likewise showed no relationship.

The chemical composition of well and spring water is now being monitored in an attempt to understand the present hydrology of groundwater. Water is carried through carbonate aquifers, and how it discharges in Ash Meadows is not understood.

Pump tests will be run during the 1970-71 winter to determine effects on both Devils Hole water levels and spring discharges within Ash Meadows.

The lowest recorded level in Devils Hole between 1956-67 was approximately 5 feet below the copper index washer. In 1968 the low dropped to 1.7 feet below the washer, in 1969 to 2.3 feet and, on August 28, 1970 to 3.08 feet. The low in 1970 exposed approximately 55 percent of the crucial limestone shelf. Hence the reason for the study and our concern.

The following flow figures from various springs in the Ash Meadows area summarize the general decrease in groundwater levels during the past decade:

<u>Spring</u>	<u>1960 flow (c.f.s.)</u>	<u>1970 flow (c.f.s.)</u>
Fairbanks	3.8	3.2
Soda	0.2	dry
Longstreet	2.6	2.3
Crystal	6.6	5.8
Point of Rocks	0.9	0.7
Jackrabbit	1.4	0 to 0.4
Big Spring	2.4	2.0
Scruggs	No data	
School	No data	

The current study will not cover water quality, although this is an essential consideration in a long-term irrigation project.

In the discussion which followed, Dr. Clark Hubbs emphasized that mining of fossil water beyond renewable amounts is a problem in many areas. Dr. Maxey replied that the policy of the Nevada State Engineer precludes allowing the mining of groundwater. (Editor's note: Current policy of the Nevada State Engineer is to allow a "reasonable annual drawdown," which was not specifically defined.)

Dr. Maxey pointed out the problem of ultimate needs for water in southwestern desert areas. It was his opinion that the City of Las Vegas will eventually propose to export groundwater from the Amargosa Basin and will probably be successful.

Dr. Maxey referred to a paper prepared specifically for the symposium by Ike Vinograd of the University of Arizona. This paper relates to the hydrogeology of the Amargosa system and is reproduced in the appendix of the symposium summary.

This session of the symposium was punctuated by a lively exchange concerning a fact which is painfully apparent to all of us: all professions exhibit

practitioners with varying degrees of competence. It is only natural, therefore, that some glaring examples of incompetence will occasionally occur. Another fact was indisputable: the professions of hydrogeology and biology unquestionably produce practitioners with both quick minds and quick tempers.

SESSION VII - Landownership in key areas - progress report on property acquisition.

Clinton Lostetter, Bureau of Sport Fisheries and Wildlife,  
Portland, Oregon.

Mr. Lostetter reviewed activities of his office which, at the request of the Pupfish Task Force, acquired information on land holdings in the Ash Meadows area. He stated that approximately 85,000 acres is leased government land, and 15,000 acres is in private ownership. A total of 5,000 acres of Spring Meadows, Inc., land was acquired through exchange from the Bureau of Land Management. There are 34 private landowners in the Ash Meadows area. Negotiations by the Nature Conservancy to purchase Big Spring are proceeding slowly.

SESSION VIII - Studies and plans relating to land development in the Death Valley System.

Chairman: Robert L. Borovicka, Bureau of Land Management,  
Portland, Oregon

Mr. Kuebler, Mr. Wilson, Mr. Tower, Mr. McClaren

Bruce Kuebler, of the Los Angeles Department of Water and Power, reviewed the history of the Los Angeles land acquisition and water export program in the Owens Valley. Over 300,000 acres of land in the Owens and Mono basins were purchased for the protection of the Los Angeles water supply. The activities of the Inter-agency Committee on Owens Valley Land and Wildlife were outlined, and the wildlife preservation programs conducted by the Los Angeles Department of Water and Power were discussed. The history and development of the Owens Valley Native Fish Sanctuary at Fish Slough, north of Bishop, were described in some detail. The majority of Fish Slough is owned by the City of Los Angeles and will remain withdrawn for preservation purposes.

Dr. Dennis Williams, geohydrologist with the Los Angeles Department of Water and Power, estimated the safe yield of ground water in the Owens Valley to be approximately 220 c.f.s.

Mr. Thomas R. C. Wilson III, attorney for Spring Meadows, Inc., (although he appeared at the symposium as a private attorney) summarized the activities for Spring Meadows, Inc., in the Ash Meadows area. To date SMI has invested 5-6 million dollars in their ranching operation. Their present method of pumping from wells is the most economical way to procure water for their agricultural ventures.

Mr. Wilson felt that the most obvious answer to our current problem is to use surface flow (spring discharge) supplemented by those wells which do not

fect pupfish habitat. He outlined the many benevolent gestures offered voluntarily by SMI (well monitoring, Point of Rocks Sanctuary, etc.,) as evidence of the corporation's concern for the environment.

Considerable discussion followed Mr. Wilson's presentation. Mr. McBroom requested that SMI withdraw their current applications for well permits, to which Mr. Wilson replied that eight pending applications are for operating wells and that permit applications for new wells could be withdrawn. He offered to consult with his client concerning a moratorium on pumping and new well drilling and gave no concrete answers when questioned about long-range development plans of SMI.

James Brown posed a rather perplexing question concerning to what extent SMI was responsible for lowering the water level in Devils Hole, which in turn reduces the value to the American people of one of their national monuments.

Art Tower, of the Las Vegas office of the Bureau of Land Management, reviewed the land status in Ash Meadows. He stated that on December 23, 1970 BLM will lose their authority to sell land.

September, 1966 Spring Meadows, Inc., applied to exchange about 13,000 acres of land (in an unstated location) for a similar acreage in Ash Meadows to complement approximately 5,000 acres purchased from the Nye County Land Company. Over 5,000 acres were transferred in October, 1969; other lands in the area were encumbered by mining claims, etc. On September 3, 1970 the classification of other land applied for was revoked by BLM, and on October 23, 1970 an exchange application was rejected.

In other positive actions by BLM, 56 acres were classified for the protection of Jackrabbit Spring, and 60 acres were classified to protect School Spring. An additional 2,020 acres of land in the Devils Hole area are proposed for reclassification.

Fiero brought up the point that, if the initial land exchange had not been made, there most likely would not have resulted so serious a threat to the pupfish. This statement was followed by some rather lively discussion.

Editor's note: This is a classic example of barndoor and escaped horses. The important point here is that we have all learned many lessons from our experience with the pupfish in the Death Valley System. We recognize our mistakes and, hopefully, are now engaged in a coordinated effort to save the resource.)

Cecil McClaren, Chief of Project Studies for the Bureau of Reclamation's Boulder City, Nevada office, briefly described the proposed Amargosa River Basin Project. The Bureau is now beginning a feasibility study for a project designed for "turning thousands of acres of desert into fertile farm land." The Bureau will attempt to design the project with a "positive" impact upon the environment. The exact meaning of this last statement was not fully clarified.

Considerable discussion followed Mr. McClaren's presentation, but nothing really constructive was accomplished. Although the Bureau's goal of a "positive" environmental impact is indeed admirable, this statement (and the project in general) was received somewhat cynically by those in attendance. As Congressman Johnson of California's Second District stated in a recent newsletter to his constituents: "We shall withhold judgment on the Amargosa Project until all facts are available." Hopefully, he will do exactly this.

#### SESSION IX - The current legal situation.

Chairman: Mr. Leonard Fisk, California Department of Fish and Game, Sacramento.

Mr. Newman, Mr. Aho, Mr. Lostetter

In summarizing current Nevada water law, Mr. Newman stated that there had been no new developments in this respect. The doctrine of prior appropriation is followed, and "beneficial use" is the measure and criterion for evaluating new water applications.

There are two ways to acquire water within Nevada:

1. By adjudication - beneficial use prior to current law;
2. By permit to develop to a beneficial use.

An application is published for four weeks, after which 30 days are allowed for protests to be filed. After this a permit may be issued. A certificate of beneficial use is processed, and the water right is then made a perfected water right.

Any decision made by the State Engineer relative to a water right may be appealed within 30 days.

"Water mining" is illegal in Nevada; however, in critical areas (Pahrump Valley, for example), a certain amount of overdraft for "successful" agricultural development is permitted (i.e., if economic demands require).

Water law may have to be changed to allow for developments such as the Amargosa Valley Project, to allow for a drawdown of the water table of as much as 100 feet. (Editor's note: This statement is extremely significant from the standpoint of the preservation of desert spring habitats. We should attach full significance to it in our thinking and long-range planning.)

Mr. Aho explained the controversy between Federal and State water law. All western states claim that water belongs to the state, and application must be made to the state. The question then arises concerning the use of water by the Federal government on Federal public lands. The Federal government contends that it has not given over its water rights to the states, and that it must not accede to state jurisdiction. The priority of the Federal government to the water in Devils Hole was established in 1952!!

nton Lostetter reviewed various rare and endangered species laws and  
borated on the Endangered Species Conservation Act of December 9, 1969.  
s is a more comprehensive act than the one previously in force and spells  
the various protected species. A total of 189 species of vertebrates  
currently listed in the Secretary of the Interior's "Redbook."

SION X - The role of the news media in rare and endangered species  
preservation, with specific reference to the pupfish problem.

seems to be typically American to be mowing the lawn while the house burns  
n. But news is news, and the culmination of the 30-day climb up the face  
El Capitan in Yosemite National Park at the time of the symposium precluded  
attendance of the panel Chairman and several panelists.

ever, the subject was reviewed, and some film clips of the C. diabolis  
nsplant from Devils Hole to Upper Warm Spring in Saline Valley, which was  
wn throughout southern California by CBS television in Los Angeles, were  
e available for our use at the symposium. This was typical of the ex-  
lent coverage given the desert fishes problem by the media, and it was  
erally agreed that good publicity is one of the most effective weapons we  
muster in our battle to save the desert fishes from extinction. We shall  
k actively to assure the continuation of this type of coverage.

SION Xa - Discussion of general preservation problems in the Ash Meadows  
area.

Chairman: Mr. Pister

lowing the abbreviated session concerning the role of the news media in  
e and endangered species preservation, a general discussion was held rela-  
e to the operations of Spring Meadows, Inc., and how they might be altered  
allow for the preservation of the endemic fishes. The primary participants  
e were Tom Wilson and Jim McBroom.

became immediately apparent that very little could be decided, or even  
commended, without first conducting a hydrological study of the Ash Meadows  
a. Mr. Wilson suggested that Interior might carry the burden of the study  
also cover the investment made by Spring Meadows, Inc., in their under-  
ground water system. It was generally felt, however, that the hydrological  
dy was necessary before this could even be considered by Interior.

suggestion was made by several participants that a moratorium be placed  
well drilling until such time as the groundwater study is completed.  
re was also considerable discussion of the suggestion that Spring Meadows,  
., switch to the use of surface water supplemented, perhaps, by wells  
at do not influence spring flows. No commitments were made by SMI on  
her of these points, and it was admitted by both sides that little could  
decided without more data, and this could be acquired only through the  
undwater study.

Deacon made the very good, but generally unknown, point that we are  
ing to preserve only the last remnants of the Ash Meadows fish populations,  
l we cannot afford to sacrifice anything more.

Wednesday, November 18.

Between 8:00 A.M. and 12:00 Noon the entire group toured the problem areas in Ash Meadows in order to gain a better picture of habitat degradation and resultant species preservation problems. Leading this field trip were Dr. Deacon, Mr. Sanchez, Mr. Myers, and Mr. Lockard.

SESSION XI - Review of possible transplant locations.

Chairman: Dale Lockard, Nevada Department of Fish and Game.

Mr. Lockard briefly reviewed the general subject. However, inasmuch as transplant locations would be a significant part of the preparation of the action plan, discussion was temporarily held in abeyance.

SESSION XII - Reassignment of priorities for species preservation.

Chairman: Dr. Robert R. Miller, University of Michigan.

Dr. Miller conducted a general discussion of the various species involved, and priorities for species preservation were reassigned as follows:

1. Pahump killifish, *Eupetrichthys latos*
2. Devils Hole pupfish, *Cyprinodon diabolis*
3. Tecopa pupfish, *Cyprinodon nevadensis calidae*
4. Ash Meadows speckled dace, *Rhinichthys osculus nevadensis*
5. Owens River speckled dace, *Rhinichthys osculus ssp.*
6. Owens River chub, *Gila sp.*
7. Ash Meadows pupfish, *Cyprinodon nevadensis mionectes*
8. Warm Spring pupfish, *Cyprinodon nevadensis pectoralis*
9. Mohave chub, *Gila mohavensis*
10. Owens pupfish, *Cyprinodon radiosus*

General discussions of the various species were held as priorities were reassigned. Pertinent comments are listed below.

Relative to the habitat of *Eupetrichthys latos*, if predictions made by several knowledgeable individuals are correct, there may not be any surface water left in Manse Spring by the end of the decade.

The Bureau of Reclamation suggested that a good transplant site for *C. diabolis* exists below Hoover Dam. Some discussion was also held concerning the possible contamination by *C. n. mionectes* of the new Point of Rocks "sanctuary." Dr. Liu commented that numbers of fish transplanted to a new location should be kept as large as feasible.

sible transplant locations around the newly acquired Scotty's Ranch properties were also discussed. Some in attendance questioned whether or not introduction within Death Valley National Monument of exotic species (Note: specific to a specific drainage area within the Monument), even though rare and endangered, is within National Park Service policy. This question was left unanswered, pending further consideration. Although all in attendance were generally sympathetic with the intent of the policy, it was the group consensus that it would be tragic if, after a thorough analysis of the individual situation showed that no harm would be done by such a transplant, a species became extinct because of an inflexible policy.

diabolis has been neither reared nor introduced successfully outside of its native habitat. Any waters selected as transplant sites for this species should therefore approach as closely as possible those conditions existing within Devils Hole.

The Owens River speckled dace, Rhinichthys osculus ssp., may well be one of our most seriously endangered species. A total of 18 were collected during the summer of 1970 at Mathieu's Ranch, five and one-half miles south of Benton, Mono County, California, and were transplanted into the Warm Springs Sanctuary near Big Pine, Inyo County. However, none have been seen since, and we have been unable to locate additional specimens.

The only known stocks of the Owens River chub, Gila sp., have been located below Crowley Dam, Mono County, California. Those above and below this area have apparently hybridized with exotic forms.

Miller commented that Rhinichthys osculus ssp. once occurred in Forestburg and that the forms of R. O. ssp. in the Amargosa River, Ash Meadows, and near Beatty, Nevada are all distinct.

A telegram was received from Keith Artz, of the Nature Conservancy's San Francisco office, that negotiations of the Conservancy to purchase Big Spring are proceeding satisfactorily.

ossible chemical treatment to remove exotic fishes from Big Spring in Ash Meadows was discussed, but no decision was reached.

It was suggested that Corn Creek, on the Desert Game Range in Nevada, would be a suitable location for the Pahrnagat bonytail chub, Gila robusta jordani, Empetrichthys latos.

The problem of the exotic mosquitofish, Gambusia affinis, within Furnace Creek was discussed, and it was generally agreed that they should be removed.

Dick Haas, of Fresno State College, presented a proposal whereby certain members of the American Killifish Association would be allowed to conduct breeding experiments with the various endangered fishes. This suggestion was well received, and it was suggested that Dr. Haas work up a formal proposal for further consideration by the Task Force and Desert Fishes Council.

SSION XIIa - Preparation of action plan for 1970-71.

An action plan for species preservation was then prepared, in the hope that most assignments would be completed prior to the next annual symposium.

Chairmen: Mr. Lockard  
Mr. Pister

The species and protective measures planned for them in 1971 are listed below, in order of the priority assigned to them at the symposium.

1. Pahrump killifish, Empetrichthys latos

- a. The Nevada Department of Fish and Game will check initial introductions in Lake Mead Recreation Area and will add additional fish to pond, if needed. Assignment of responsibility: Lockard.
- b. A letter will be sent to the Nevada State Director of the Bureau of Land Management requesting that every effort be made to procure funding for the construction of refugia at Shoshone, Spring Valley, White Pines County, Nevada. This is currently recommended as having the best potential of any known transplant site for this species. Assignment of responsibility: Pister and Miller.
- c. The California Department of Fish and Game and U.S. National Park Service will evaluate potential transplant sites at Tecopa, Inyo County, California. Assignment of responsibility: Pister and Sanchez.

2. Devils Hole pupfish, Cyprinodon diabolis

- a. The Bureau of Reclamation will evaluate the feasibility of constructing refugia below Hoover Dam. Assignment of responsibility: Jonez.
- b. The Nevada Department of Fish and Game will construct refugia in northern Nevada. Assignment of responsibility: Trelease and Lockard.
- c. Five or six specimens will be sent to Bob Miller for karyotyping. Assignment of responsibility: Miller, Lockard and Deacon.

Since Bob Miller's estimate of November 18 and letter of November 22, several independently conducted counts have been made at Devils Hole and all indicate that the population has now dropped to less than 300 individuals. This number approximates that which is thought to occur there normally at this time of the year, according to both Pete Sanchez and Jim Deacon.

Consequently, we feel that no fish should be taken for any purpose until another count is made after the population begins to build up again in 1971. At that time we shall reevaluate our needs and decide how best to utilize any fish which might be available for transplanting.

Tecopa pupfish, Cyprinodon nevadensis calidae

California Department of Fish and Game and U.S. National Park Service will evaluate possible spring areas near Tecopa and will collect material for Bob Miller's investigation. Assignment of responsibility: Pister and Sanchez.

Ash Meadows speckled dace, Rhinichthys osculus nevadensis

Nevada Department of Fish and Game will attempt to remove exotic species from Big Spring, Ash Meadows, Nye County, install a suitable barrier downstream from the spring, and reintroduce populations of R. o. nevadensis and n. mionectes. Assignment of responsibility: Lockard.

Owens River speckled dace, Rhinichthys osculus ssp. and

Owens River chub, Gila sp.

Total of 16 dace were transplanted into the Warm Springs Sanctuary near Pine (Inyo County) on September 7, 1970. These fish were initially collected near Benton (Mono County) and were held within a live cage in the Owens Valley Native Fish Sanctuary at Fish Slough for several weeks prior to the transplant. The California Department of Fish and Game will attempt to locate additional dace populations and will transplant these fish plus Owens River chubs collected below Crowley Lake dam into existing refugia within the Owens Valley during the spring and summer of 1971. Assignment of responsibility: Pister.

Ash Meadows pupfish, Cyprinodon nevadensis mionectes

This is included in the action plan designated for the Ash Meadows speckled dace, already discussed under number 4.

Warm Spring pupfish, Cyprinodon nevadensis pectoralis

Miller will forward to Dale Lockard a list of potential transplant sites in northern Nevada, and the Nevada Department of Fish and Game will determine their suitability. Assignment of responsibility: Miller and Lockard.

Mohave chub, Gila mohavensis

Deacon and Dale Lockard will investigate an existing population at Paradise Spa, Las Vegas, Nevada; and an additional transplant is planned by the California Department of Fish and Game into Lark Seep Lagoon on the China Lake Naval Weapons Center (Kern and Inyo counties, California), probably in February, 1971. The Mohave chub was transplanted to several locations during 1970.

Owens pupfish, Cyprinodon radiosus

Although the Owens pupfish has been introduced into two refugia in the Owens Valley, we still feel it advisable to extend the range to other refugia and,

ventually, to other suitable areas within the Owens Valley. Consequently, refuge will soon be constructed at BLM Spring on the east side of Fish Slough in a cooperative venture involving the Bureau of Land Management, California Department of Fish and Game, Los Angeles Department of Water and Power, and California Division of Forestry. Additional investigations of refuge sites and transplant areas will be pursued vigorously. Assignment of responsibility: Berggren and Pister.

Finally, refugia are planned for the Naval Weapons Center at China Lake. The selection of species will depend upon a post-construction analysis of the habitats. Assignment of responsibility: Barling and Pister.

The 1970 symposium was then dismissed, with the agreement that the third annual symposium would be held at Furnace Creek, as usual, on November 16-17, 1971.