American Fisheries Society

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WESTERN DIVISION

1982 ANNUAL MEETING

July 19-22, 1982
Tropicana Hotel
Las Vegas, Nevada

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Program & Abstracts

1982 Annual Meeting of the Western Division, American Fisheries Society

Program Chairman	Don Duff, Utah
Arrangements	Jack Dieringer, Nevada

Officers - Western Division

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The listed program and abstracts have been provided for your information and use at this 1982 annual meeting. The program reflects the status of the agenda as of June 1, 1982. Minor changes and deletions of some papers are possible and will be announced at the meeting sessions. Abstracts included herein are those received by the Program Chairman by this printing date.

The following candidates have been selected for ballot by the membership to the following positions. Winning candidates will be announced at the Business Meeting.

PRESIDENT-ELECT	SECRETARY-TREASURER	REPRESENTATIVE TO THE PARENT SOCIETY NOMINATING COMMITTEE
Stan Moberly, Alaska	Neil Armantrout, Oregon	Al Elser, Montana
Clair B. Stalnaker, Colorado	Tom Jackson, Colorado	Stan Smith, Washington

WDAFS ANNUAL MEETING
July 18-22, 1982
Tropicana Hotel
Las Vegas, Nevada

Tuesday, July 20, 1982

Fisheries Technical Session #1
(Monte Carlo Room A-B)

1:00-3:00 p.m. Panel - The Endangered Species Act and Its Implications for Fish and Wildlife Management and the World Community

Moderator: E. P. Pister, California Department of Fish and Game, Bishop, California

Panelists:

James E. Deacon, University of Nevada, Las Vegas
Paul and Anne Ehrlich, Stanford University, Palo Alto, California
Stephen J. Nicola, California Department of Fish and Game, Sacramento, California
Elliott A. Norse, Center for Environmental Education, Washington, D.C.
Jack Williams, U.S. Fish and Wildlife Service, Sacramento, California
Jack Woody, U.S. Fish and Wildlife Service, Albuquerque, New Mexico

3:00-3:15 p.m. Break

Concurrent Sessions

3:15-5:15 p.m. Culture and Management of Threatened and Endangered Species

Moderator: John Rinne, U.S. Forest Service, Rocky Mountain Forest and Range Experiment Station, Tempe, Arizona

Politics of Maintaining an Endangered Fish Rearing Facility
James E. Johnson, U.S. Fish and Wildlife Service, Albuquerque, New Mexico

Operational Management of the World's First Endangered Fish and Rearing Facility
Buddy Jensen, U.S. Fish and Wildlife Service, Dexter, New Mexico

Spawning and Rearing Razorback Suckers on a Production Basis
Theophilis Inslee, U.S. Fish and Wildlife Service, Dexter, New Mexico

Culturing Arizona Native Trout, Salmo apache
Roger Sorenson, Arizona Game and Fish Department, Page Springs, Arizona

The Influence of Temperature on Development and Hatching Success of Native Colorado River Fishes
Paul Marsh and Mark S. Pisano, Center for Environmental Studies, Arizona State University, Tempe, Arizona

The Hatchery Role in Recovery of the Cui-ui (Chasmistes cujus), and Endangered Species
Al Ruger, Pyramid Lake Tribal Enterprises, Sut-cliffen, Nevada

Review of Efforts to Establish and Maintain a Second Population of Devils Hole Pupfish (Cuprinodon diabolis) in the Hoover Dam Refugium
William Rinne and Gordon Mueller, U.S. Bureau of Reclamation, Boulder City, Nevada

Fisheries Technical Session #2
(Monte Carlo Room C)

Concurrent Session

3:15-5:00 p.m. Marine Fisheries Panel - Resource Data-Ammunition for the Political Gun

Moderator: Stan Moberly, Special Assistant to the Commissioner for External Affairs, Alaska Department of Fish and Game, Juneau, Alaska

Panelists:

Clem Tillion, Chairman of the North Pacific Fisheries and External Management Council, Director of International Affairs for Fisheries of Alaska, Anchorage, Alaska
Garnett Jones, Advisor for International and Intergovernmental Affairs, Pacific Region, Vancouver, B.C.
Bill Wilkerson, Assistant Director, Washington Department of Fisheries, Olympia, Washington
Bob Schoening, Department of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon
Charles Fullerton, Director, California Department of Fish and Game, Sacramento, California

Wednesday, July 21, 1982

Fisheries Technical Session #3
(Monte Carlo Room A-B)

1:00-3:00 p.m. Contributed Papers - Fisheries Management

Moderator: Ron Goede, Utah Division of Wildlife Resources, Logan, Utah

Morpholine Imprinting of Chinook and Coho Salmon in an Anadromous Fish Hatchery
Thomas Hassler, California Cooperative Fishery Research Unit, Fish and Wildlife Service, Humboldt State University, Arcata, California

Response of Flaming Gorge Tailwaters to Optimal Summer Reservoir Release Temperatures Resulting from Penstock Intake Modifications
Eric Larson, Bruce Schmidt, Bruce Bonebrake, James Johnson, Utah Division of Wildlife Resources

Effects of Stream Channel Alterations on Aquatic Insect Communities
Scott Reger, Arizona Game and Fish Department, Phoenix, Arizona

The Possibility of Losing the Ash Meadow Ecosystem
Don Sada, U.S. Fish and Wildlife Service, Reno, Nevada

In-reservoir Spawning of Striped Bass, Lake Powell, Arizona
A. Wayne Gustaveson and Thomas Pettengill, Utah Division of Wildlife Resources

Fisheries Technical Session #4
(Monte Carlo Room C)

Concurrent Session

1:00-3:00 p.m. Aquatic Habitat Management

Moderator: Neil Armantrout, U.S. Bureau of Land Management, Portland, Oregon

Streambank Stabilization Techniques
David W. Patterson, U.S. Soil Conservation Service, Red Bluff, California

Comparative Effects of Sheep and Cattle Grazing on an Anadromous Fish Stream in Central Idaho
Bruce May, U.S. Forest Service, Salmon National Forest, Salmon, Idaho

Riparian-Stream Habitat Conditions on Grazed and Ungrazed Streams Within the Great Basin, Nevada
Val Crispin and Osborne Casey, U.S. Bureau of Land Management, Nevada; Bill Platts and Rodger Nelson, U.S. Forest Service, Intermountain Forest and Range Experiment Station, Boise, Idaho

Cumulative Impacts of Logging Industry on Salmonid Habitats 1870-1970
Jim Sedell, U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon

Lake Rehabilitation Using Wind Powered Mechanical Water Circulators
Mark Shaw, U.S. Forest Service, Wasatch-Cache National Forest, Salt Lake City, Utah

Fish Distribution in Relation to Habitat Components in Western Oregon
Robert House and Neil Armantrout, U.S. Bureau of Land Management, Portland, Oregon

3:00-3:15 p.m. *Break*

3:15-5:15 p.m. *Western Division AFS Business Meeting (Monte Carlo Room A-B)*

Thursday, July 22, 1982

Fisheries Technical Session #5
(Monte Carlo Room A-B)

8:00-10:00 a.m. Energy Developments and Fisheries Management
Low Head Hydroelectric Projects

Moderator: John Turner, California Department of Fish and Game, Sacramento, California

Water: California's Most Sought after Resource
Gary Smith, California Department of Fish and Game, Sacramento, California

The Limnological Environment of Flaming Gorge Reservoir
David L. Wegner, USDI-Bureau of Reclamation, Salt Lake City, Utah

Bailey Creek Ranch Hydroelectric Project: A Grease-Under-The-Fingernails Description of Small Hydroelectric Development
Terence L. O'Rourke, Consolidated Hydroelectric, Inc., Redding, California

Some Effects of Power Peaking on Fish in the Hanford Reach of the Columbia River
Dale Becker, Battelle Pacific Northwest Laboratories, Richland, Washington

Management of Water for Fish and Hydropower
Dale R. Evans, National Marine Fisheries Service, Portland, Oregon

10:00-10:15 a.m. Break

Concurrent Sessions

10:15-12 noon Energy Development and Fisheries Management

Moderator: C. Dale Becker, Battelle Pacific Northwest Laboratories, Richland, Washington

An Ecosystem Approach to Monitoring Energy Related Impacts Within the Upper Colorado River Basin
Vincent Lamarra and John Carter, Ecosystem Research Institute, Logan, Utah

Power Plus Fish
Ronald Golus and Steven Jacubowics, USDI-Bureau of Reclamation, Boise, Idaho

The Colorado River Cutthroat Trout, Salmo clarki pleuriticus and Habitat Changes Associated with Industrial Development Within the Rocky Mountain Region
Bob Quinlan, Dames & Moore Consultants, Denver, Colorado

Reestablishment of Fish and Aquatic Invertebrate Populations in a Stream Severely Impacted by Acid Mine Drainage
Dudley Reiser and Mary Vitter, Camp Dresser and McKee, Inc., and Jeff Todd, AMAX Inc., Colorado

Local Movement and Distribution of Largemouth Bass and Catfish Species with Regard to Temperature in a Cooling Reservoir of a Coal-fired Power Plant in Northwest Arkansas
Marvin G. Galloway and Raj V. Kilambi, University of Arkansas, Fayetteville, Arkansas

Behaviorial Responses of Fathead Minnow (Pimephales promelas) and Rainbow Trout (Salmo gairdneri) to a Coal Liquid Water-Soluble Fraction
Dennis D. Dauble and Robert H. Gray, Battelle Northwest Laboratories, Richland, Washington

Fisheries Technical Session #6
(Monte Carlo Room D-E)

10:30-12 noon Contributed Papers - Fisheries Management

Moderator: Paul Cuplin, U.S. Bureau of Land Management, Denver, Colorado

Logging and Fish Habitat - A Long-Term Study of Five Olympic Peninsula, Washington Streams
Carl Samuelson, ITT Rayonier Inc., Shelton, Washington

Stream Improvement in Wyoming for Indigenous Cutthroat Trout
N. Allen Binns, Wyoming Game and Fish Department, Lander, Wyoming

Use of Color Infrared Photography in Stream Habitat Inventories
Wayne Elmore, Bureau of Land Management, Prineville, Oregon, and Paul Cuplin, Bureau of Land Management, Denver, Colorado

Comparative Diets of Planted Rainbow Trout and Speckled Dace in a Prairie Impoundment in North Central Idaho
James Johnson, Nez Perce Tribe of Idaho, Lapwai, Idaho

Status and Ecology of the Shoshone Sculpin
D. Daley, J. Griffity, and G. Beckman, Idaho State University, Pocatello, Idaho, and R. Wallace and P. Connolly, University of Idaho, Moscow, Idaho

An Integrated Wastewater Treatment, Wildlife Enhancement, and Aquaculture Project
George Allen and Robert Gearheart, Humboldt State University, Arcata, California

POSTER DISPLAYS

1. Aquatic Ecosystem Analysis Laboratory. Dr. Fred Mangum, USDA - Forest Service, Provo, Utah (Bonneville Chapter).

2. Comparative Diets of Planted Rainbow Trout (Salmo gairdneri) and Speckled Dace (Rhinichthys osculus) in a Prairie Impoundment in North Central Idaho. James H. Johnson, Nez Perce Tribe of Idaho (Idaho Chapter).

3. Marsh Creek Livestock Grazing and Fisheries Study, Idaho. Bruce May, USDA - Forest Service, Salmon National Forest, Idaho (Idaho Chapter).

4. Cutthroat Trout of the Intermountain Region, USDA - Forest Service, Don Duff, USDA - Forest Service, Ogden, Utah (Bonneville Chapter).

5. Interstate 70 - Clear Creek Canyon Project - Channel Changes with Fisheries Habitat and Channel Stability. John Leppenk and Dale Hepworth, Utah Division of Wildlife Resources, Cedar City, Utah (Bonneville Chapter).

6. Lake Rehabilitation Using Wind Powered Mechanical Water Circulators. Mark Shaw, USDA - Forest Service, Wasatch-Cache National Forest, Salt Lake City, Utah (Bonneville Chapter).

7. Bureau of Land Management, Rock Springs District, Aquatic Habitat Management Program. Bruce Smith, USDI - Bureau of Land Management, Rock Springs, Wyoming (Colorado-Wyoming Chapter).

8. Salt Creek Cooperative Stream Habitat Improvement Project, Lincoln County, Wyoming. USDA - Forest Service, Bridger-Teton National Forest and Wyoming Game and Fish Department (Colorado-Wyoming Chapter).

9. Riparian-Stream Habitat Conditions on Grazed and Ungrazed Streams Within the Great Basin, Nevada. Val Crispin and Osborne Casey, USDI - Bureau of Land Management, Nevada (California-Nevada Chapter).

10. Stream Improvement in Wyoming for Indigenous Cutthroat Trout. Allen Binns, Wyoming Game and Fish Department, Lander, Wyoming (Colorado-Wyoming Chapter).

11. Endangered Fish Studies of The Colorado River Fishery Project. Chuck McAda, USDI - Fish and Wildlife Service, Vernal, Utah (Bonneville Chapter).

12. Fishery Evaluation Program and Introduction. Leo D. Lentsch and Steve R. Culver, Colorado State University, Ft. Collins, Colorado (Colorado-Wyoming Chapter).

FISHERIES TECHNICAL SESSION #1

POLITICS OF MAINTAINING AND ENDANGERED FISHES REARING FACILITY IN NEW MEXICO

JAMES E. JOHNSON
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Dexter National Fish Hatchery in New Mexico is a U.S. Fish and Wildlife Service facility charged with rearing endangered fish species. Objectives for the endangered species program at Dexter include its use as a refugia for disappearing species of fish, as a production facility for reintroducing large numbers of native fish into historic habitats, and as a research center for southwestern fishes.

Before the decision was made to move fish out of their native habitats and into Dexter, several potential problems were addressed including prevention of escapement of species into the nearby Pecos River, prevention of the mixing of stocks, and the chances of reintroducing endangered species of fish back into historic habitats. Whereas, some setbacks have limited reintroduction efforts in the past, present reintroduction efforts involve the cooperation of several state and Federal agencies, and appear to be moving along in a very encouraging manner.

The unique services at Dexter are being incorporated into fish recovery plans throughout the Southwest, and the future of at least 18 species now seems more secure because of its existence. The Service is now evaluating Dexter with the possibility of creating similar facilities in other parts of the country.

OPERATION OF DEXTER NATIONAL FISH HATCHERY, AN ENDANGERED SPECIES FACILITY

BUDDY LEE JENSEN
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Dexter, NM 88230

Dexter National Fish Hatchery is located one mile east of Dexter in the Pecos River Valley of southeastern New Mexico. It was established in 1931 under legislative authority of the White Act. Originally established as a warm-water station to produce fingerling game fish to stock farm ponds in the Southwest, Dexter's mission changed following passage of the Endangered Species Act of 1973. Six species of endangered fish were brought to Dexter in 1974 to "test" the station as a potential endangered fishes holding and rearing facility. The fish thrived; consequently, additional species were brought to Dexter. The program at Dexter was implemented to assist in the recovery efforts for native southwestern fishes and to help prevent their extinction. With eighteen species of fish presently being held on the station and more introductions planned for the future, Dexter National Fish Hatchery has become the Service's priority facility for the maintenance and production of rare desert fishes.

SPAWNING AND HATCHING OF THE RAZORBACK SUCKER (*Xyrauchen texanus*)

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Razorback sucker (*Xyrauchen texanus*) broodstock was obtained from Lake Mohave in January 1981 and 1982. Fish that survived spawning in 1981 were held in a culture pond and spawned again in 1982. Spawning techniques tested in 1981 were: induced spawning with HCG and carp pituitary in circular or rectangular tanks, stripping, and pond spawning. Egg incubation was tested in McDonald hatching jars, Heath incubators, on gravel in circular tanks, and on nets suspended in culture tanks. Other facets studied were fungus control on incubating eggs, size of eggs, and techniques to hold larvae until swimup. In 1982, studies were oriented to determine the most efficient hormone rate, the best site of injuction, improved hatching techniques, egg enumeration, fry enumeration, fry holding techniques, fungus control, and to develop hatchery constants to enhance the culture of razorback suckers. One of the major objectives was to compare spawning success of brood fish procured from the wild versus brood fish held in culture ponds for one year.

The spawning method that showed the most promise in 1981 was hormone injections of HCG daily and stripping of eggs. The Heath incubator was the superior method for egg incubation. Formalin dip at 1:75 to 1:200 for ten minutes controlled fungus and did not kill developing embryos. In 1982, daily injections of HCG in the muscle at 100 IU/lb. of female weight was found to be the most effective hormone dosage. Egg viability at 96 hours was increased from 20$\pm$ 5% to 60$\pm$ 5% by stripping at 12-hour intervals after the start of egg ovulation, then enumerating

eggs and moving to incubator trays as soon as eggs had water hardened (from 45 to 60 minutes after fertilization). Fungus was controlled on incubating eggs with a ten-minute dip of 1:100 formalin in the Heath tray. Flow-through type treatment in a stack of eight trays was not successful due to the dilution of the chemical when it reached the lower trays. The gravimetric method of egg enumeration was believed to be more accurate than either water displacement or the von Bayer method. Sample counts and weights from 100 spawns resulted in a mean of 130 eggs per gram. Fry enumeration after hatching utilizing the water displacement method on 67 samples was found to be 233 fry/ml. The brood fish maintained for a year in a culture pond spawned as well or better than those obtained directly from Lake Mohave. They ripened about one month later which greatly enhances production. They were more predictable than wild fish, although the secondary sex characteristics were not as well developed. The greatest difference between these two lots of brood fish was the loss of brood fish from spawning. A loss of 49% of the females from Lake Mohave occurred, whereas all of the fish survived that were maintained for one year on the hatchery. A total of 7,366,565 eggs was obtained from 67 females for an average of 109,948 eggs per female. Mean egg viability at 96 hours was 27.3% or 2,013,910 expected fry.

CULTURING ARIZONA NATIVE TROUT (*Salmo apache*)

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In 1963, 82 *S. apache* were collected from Ord Creek on the headwaters of the White River. First spawn occurred in 1964 resulting in 99 fry which became future broodstock. The program continued with the same gene pool until 1974 when all fish were stolen. In 1975, 118 *S. apache* were collected from Soldier Creek on the headwaters of Black River and the program was again initiated. Problems associated with culture of *S. apache* are:

Poor egg and milt production - As year-two spawners, the males have very good milt production, but as year-three and -four spawners, milt is greatly reduced. Approximately 50% produce no milt and ripe males yield one milliliter per stripping. Two-year females produce few eggs and year-three and -four females do not produce eggs every spawning season.

Poor survivability of eggs and fry - During the 19 years of culturing *S. apache*, the egg mortality has averaged 69.7%. Survival of fish to stocking size or to broodstock is 11.8% of total egg production. When fry are placed in raceways, they exhibit a very strong territorial behavior and do not form aggregations or schools. There is a tremendous amount of harassment due to territorial defense resulting in only the dominant fish surviving.

Difficult to train fish to eat - It is extremely difficult to get the swim-up fry to accept artificial diets. Once a fish begins eating, the only problem is to present the food without being seen. *Salmo apache* are a very secretive and flighty fish. Only after they have been on feed for 3 to 5 weeks to they become accustomed to an individual feeding them.

Slow growth rate - After the fry have been on feed for 150 days, they have an average length of 2 inches. A 4-year-old broodfish will weigh an average 2.5 pounds.

Potential inbreeding - Initial broodstock harvested from the wild came from one population in a very small stream. Due to poor milt production by males, one ripe male might fertilize the eggs from three females which is not desirable. Because of limited space available, the egg lots and fry are mixed together which will eventually cause future brother-sister matings.

INFLUENCE OF TEMPERATURE ON DEVELOPMENT AND HATCHING SUCCESS OF NATIVE COLORADO RIVER FISHES

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Razorback sucker (Xyrauchen texanus), bonytail chub (Gila elegans), humpback chub (G. cypha), and Colorado squawfish (Ptychocheilus lucius) eggs were spawned and fertilized at 17C, and ova then incubated at 5, 10, 15, 20, 25, and 30C. Total mortality of all ova occurred in 12-96 hours at 5, 10, and 30C, and in 48-60 hours at 15C for P. lucius only. Survival and percentage hatch was highest at 15-20C (G. elegans) or 20C (all others). Hatched prolarvae were 0.2-1.3mm TL longer at 20C than at 15 or 25C. Spinal or other anomalies were more frequent at 15 and 25C than at 20C. Development rates were similar for all species, 4.4-6.1 (15C), 8.4-9.9 (20C), and 12.4-18.8 (25C). Development rate (V): temperature (T) relationships, defined as $V = mT + b$, were similar for all species. All were highly significant ($r^2 = 0.77$-0.99) and indicated a "zero development" temperature range of 8.6C (G. elegans) to 12.2C (P. lucius). Because of lower survival and significantly higher incidence of anomalies at 15 and 20C, the optimal temperature for development and hatching of these species is probably near 20C. This suggests that reproduction may be limited by low water temperatures throughout much of the Colorado River, although successful hatching is certainly not precluded. Other hypotheses to explain the real or apparent demise of these fishes in the river, such as predation upon young, should be examined.

THE HATCHERY ROLE IN RECOVERY OF THE CUI-UI, AN ENDANGERED SPECIES

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The endangered status of the Cui-ui (Chasmistes cujus) is primarily attributed to the loss of spawning habitat caused by diversions from the Truckee River. The Cui-ui is the only representative of the genus and is endemic to Pyramid Lake, Nevada. Historically, this fish played a significant role in the culture of the Pyramid Lake Paiute Tribe, the ancestral name being Ku-yu-wi-kut-teh (Harmann 1973) meaning "sucker eaters." The fish are now netted between March and May near the river delta and spawned. The eggs are incubated in two closed system hatcheries in egg jars, and held until swim-up. The majority of fry are then planted in the river and lake, an average of over 2 million per year. Success in raising the Cui-ui to fingerling size is apparently limited by development of a suitable diet.

REVIEW OF EFFORTS TO ESTABLISH AND MAINTAIN A SECOND POPULATION OF DEVIL'S HOLE PUPFISH (CYPRINODON DIABOLIS) IN THE HOOVER DAM REFUGIUM

WILLIAM E. RINNE and GORDON MULLER
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The Devil's Hole pupfish (Cyprinodon diabolis) was listed as a Federal Endangered Species in 1967. Concern increased for this species when the water level of Devil's Hole delined because of ground water pumping from a nearby agricultural development. One measure initiated to preserve this species if catastropy eliminated the only population at Devil's Hole, was to establish a second population in the artificially created Hoover Dam Refugium. The refugium population was established from a transplant of 27 adult Devil's Hole pupfish in 1972. Population numbers increased to a maximum of about 200 in 1974 then declined to about 60 in the fall of 1975. Since that time, population levels have ranged from about 50 (February) to 70 (October) each year. Management efforts have been directed towards annual population inventories. One indepth investigation (1975-1977) was completed on population structure and characteristics of the refugium population. The water supply delivery system to the refugium has been a continued maintenance concern. Funding for additional, investigation maintenance of the refugium, population monitoring, and future uses and management of the refugium have been the principal administrative activities associated with the refugium. The use of Devil's Hole pupfish in the refugium for experimental purposes or as a backup population is presently being evaluated by biologists on the Eastern Mohave Desert Recovery Team.

CONCERNS AND SUGGESTIONS REGARDING RE-INTRODUCTION OF HATCHERY PRODUCED ENDANGERED FISHES.

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To restore a species of fish to its historical range is a goal of the highest order in fishery management. With it comes the responsibility to do no harm. While hatcheries can be an effective tool for re-establishing populations of endangered fish, care must be taken to protect the genetic diversity and integrity of each species, subspecies and strain. Mistakes of the past need to be avoided such as the spreading of disease organism and exotic fish from one watershed to another.

FISHERIES TECHNICAL SESSION #3

MORPHOLINE IMPRINTING OF CHINOOK (*ONCORHYNCHUS TSHAWYTSCHA*) AND COHO SALMON (*O. KISUTCH*) IN AN ANADROMOUS FISH HATCHERY

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California Cooperative Fishery Research Unit[1]
Humboldt State University, Arcata, CA 95521

The possibility of significantly increasing the returns of chinook and coho salmon with the artificial attractant morpholine to Mad River Hatchery by imprinting juvenile salmon, and later attracting them when they return to fresh water was studied. Coho salmon from the Mad River (California) Hatchery of the 1977 and 1978 brood years, and of the 1977 and 1979 brood years chinook salmon were each divided into two groups -- treated and control. The treated groups were exposed to 5×10^{-5} mg/l of morpholine for at least 17 days before release. Fish of both groups were fin clipped or nose tagged. Later during the spawning migrations of 1979, 1980, and 1981 morpholine was metered into the hatchery's fish ladder and returns to the hatchery were monitored. Among the returns in both of the experiments involving coho salmon, imprinted fish made up a significantly higher percentage than control fish. There was no significant difference between returns of treated and control chinook salmon.

[1]Cooperating agencies are the Humboldt State University, the California Department of Fish and Game, and the U.S. Fish and Wildlife Service.

RESPONSE OF FLAMING GORGE TAILWATERS TO OPTIMAL SUMMER RESERVOIR RELEASE TEMPERATURES RESULTING FROM PENSTOCK INTAKE MODIFICATION

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JAMES JOHNSON
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The construction of Flaming Gorge Dam in 1962 created an excellent trout fishery in the Green River from the dam to the Colorado border, a distance of 45 river kilometers. As the reservoir filled, however, water was released from increasingly deeper and colder strata. By the late 1960's, mean discharge temperatures peaked late in the growing season and seldom exceeded 9 C., resulting in poor growth and survival of stocked rainbow and cutthroat trout fingerlings and a decline in the tailwater fishery. In a cooperative effort by the Utah Division of Wildlife Resources and the U.S. Bureau of Reclamation, the outlet works of Flaming Gorge Dam were modified to allow the selective release of epilimnetic waters to the tailwaters during the summer growing season. Peak river temperatures rose to 13.5 C., and temperatures exceeded 11.5 C. from June through October. Monthly growth of trout fingerlings during their first summer in the river more than tripled, and annual growth more than doubled. Currently, trout fingerlings stocked in May or June enter the creel during their first summer in the river, whereas, previous to penstock modification, two growing seasons were required to reach acceptable size. As a result of warmer tailwater temperatures, the Green River fishery experienced record levels of angling pressure, total harvest and yield during the 1981 angling season.

EFFECTS OF STREAM CHANNEL ALTERATIONS ON AQUATIC INSECT COMMUNITIES

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Stream alterations have been alleged to have detrimental effects on the flora and fauna of the lotic ecosystem. The Logan River system study evaluated effects of channel alterations on flood plain areas where the situation was complicated by agricultural usage of the stream. Four sites were compared: (1) a control-unaltered; (2) an area bull-dozed in 1971 that had since remained relatively constant; (3) an area dredged twice by backhoe in 1975; and (4) an area bull-dozed in 1971 and again in 1975. Samples were collected monthly by two methods and organisms sorted by size and taxa; subsampling was used when justified.

Community composition was changed for a relatively short period of time by recent alterations--fewer taxa were found and diversity decreased belatedly (as a function of faster recolonization by more mobile taxa such as baetids, chironomids, and simuliids). Alterations greatly reduced macroinvertebrate density and standing crop for a short time. There was some evidence that dredging produced slightly longer-lasting effects--apparently due to greater substrate (habitat) instability. The duration of the impact on the benthic community was largely dependent on the time required for the return of substrate stability. Other factors apparently controlling the recovery of macroinvertebrates were time of year of the alteration and the rate of return of a flood base.

Mean standing crop and production were highest at the site bull-dozed in 1971, but diversity was the lowest. This is attributed to the uniformity of substrate (lack of habitat heterogeneity). The control site had the second

highest mean standing crop and production, and the highest diversity. The areas bull-dozed and dredged in 1975 were third and fourth, respectively, in mean standing crop and production, and second and third in diversity. As turnover ratios were very similar, the mean annual standing crop estimate proved to be as useful as production for comparison--perhaps more so as confidence intervals could be calculated for standing crops. Differences in standing crop and production were correlated to substrate stability (lack of movement) in contrast to fish production which was correlated to other habitat changes, particularly the removal of pools.

Similar seasonal patterns were found in all sites, although recent alterations overrode "normal" seasonal differences. A low water year in 1976, an introduction of a toxicant (by irrigation return?) in 1975, and differences in flow patterns between the sites were confounding variables.

IN-RESERVOIR SPAWNING OF STRIPED BASS

LAKE POWELL, UTAH - ARIZONA

A. WAYNE GUSTAVESON and THOMAS D. PETTENGILL
Utah Division of Wildlife Resources
P.O. Box 1446, Page, AZ 86040

JAMES R. WAHL
Utah Division of Wildlife Resources
Star Rt. 1, Box 1-G, Bullfrog Basin, Hanksville, UT 84734

Striped bass traditionally spawn in swift, turbulent current of major rivers where their eggs must remain suspended for approximately 48 hours before hatching. Striped bass, introduced into Lake Powell in 1974, naturally reproduced in 1979. Reproduction was attributed to fish ascending the Colorado River and spawning in the traditional manner, although evidence of in-reservoir spawning was detected in 1979.

In 1981, spawning striped bass were collected in the lower reservoir near the dam. Larval and fingerling striped bass were subsequently collected there with mid-water trawl and seine, some 300 km downlake from the Colorado River inflow. The overflow density current proved to be too weak to transport young-of-the-year striped bass the length of the reservoir. Striped bass had successfully spawned within Lake Powell without the aid of turbulent current.

Subsequent standardized gill netting confirmed the production of a strong 1981 year class of striped bass, with relative abundance highest on the extreme ends of the reservoir. Young-of-the-year near the inflow were presumed to be the result of traditional river spawning, while those found near the dam were spawned within the reservoir. Young fish were found at midlake stations, but in lower numbers than the stations at opposite ends of the reservoir.

FISHERIES TECHNICAL SESSION #4

STREAMBANK STABILIZATION TECHNIQUES USED BY THE SOIL CONSERVATION SERVICE IN CALIFORNIA

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The response of resource agencies and the public to Soil Conservation Service (SCS) Streambank Protection Projects has often been emotional. Streambank protection techniques developed over years of trial, error, and success are presented. SCS is aware of its responsibility to design conservation practices which are sound both environmentally and from an engineering standpoint. To that end, SCS has developed designs and techniques incorporating both physical protection and vegetative plantings which serve as a standard for streambank protection work. General principles are presented supporting the need for proper land use planning on land containing waterways and consideration of hydrologic forces within waterways. Practical examples of streambank protection design are presented using both diagrams and before and after pictures. The need for incorporating vegetative plantings and placement of instream rock for improved aesthetics and fish and wildlife habitat is emphasized as well as allowing time after project completion for the development of planned vegetative plantings. Cost data for various protection methods is presented.

COMPARATIVE EFFECTS OF SHEEP AND CATTLE GRAZING ON AN ANADROMOUS FISH STREAM IN CENTRAL IDAHO

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Comparative effects of sheep and cattle grazing were studied on Marsh Creek in the headwaters of the Middle Fork of the Salmon River. Habitat data were primarily related to stream bank conditions and characteristics. Stream bank conditions on areas grazed by sheep were considerably more stable and of higher quality than stream bank conditions in the cattle-use area. Vegetative stream cover resulting from grasses and willows was also greater in the sheep-use area. Results of the study indicated that class of livestock as well as management prescription can have a strong influence on the relative compatibility of grazing and aquatic resources.

RIPARIAN-STREAM HABITAT CONDITIONS ON TABOR CREEK, NEVADA, UNDERGRAZED AND UNGRAZED CONDITIONS

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A previously grazed riparian-stream habitat improved in many environmental conditions when changed from continuous grazing to complete rest. The most dramatic improvements were observed in the water column, streambank, and riparian vegetation, with a trend delected towards improvement of the channel morphology. The past seasonal continuous grazing strategy is considered detrimental to this riparian-stream habitat. The plan to evaluate a more modern grazing strategy (late deferred rest) on this same habitat is discussed.

LAKE REHABILITATION

USING WIND POWERED MECHANICAL WATER CIRCULATORS

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Complete utilization of the dissolved oxygen in ice covered lakes has resulted in fish winter kills in several high alpine lakes of the Uinta Mountains. The problem originated from an excess accumulation of organic materials in the form of 1) excessive macrophyte growth from construction of small dams on natural lakes which created large shallow littoral zones, 2) organic materials carried in by runoff from the drainage area surrounding the lake, 3) no constant inflow-outflow of water to the lake, and 4) extended complete volume turnover times of four years or more.

To alleviate this problem, wind powered water circulators were installed in three lakes in an attempt to artificially destratify the lakes during the normal summer thermal stratification period, thereby increasing the rate of oxidation of accumulated organic materials, and reducing the dissolved oxygen demand during the ice covered months.

Over a period of two to three years after installation, all three lakes have shown an improvement in the dissolved oxygen levels during the ice covered months. The degree of change after one summer of circulation varied according to the singular characteristics of the lake from slight improvement to an acceleration of the complete utilization of the dissolved oxygen. Long term effects have been favorable, and the amount of habitable summer lake water has been substantially increased in one of the lakes.

FISH DISTRIBUTION IN RELATION TO HABITAT COMPONENTS IN WESTERN OREGON

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A series of detailed measurements were made of habitat components in several western Oregon streams. Included were channel configuration and stability, substrates, cover types and physical characteristics. Fish were sampled at the same locations, with fish lengths and population levels recorded. Coho salmon, steelhead trout, cutthroat trout and sculpins were the main fish species sampled. The distribution of fish was compared to the specific habitat components. This paper summarizes some of the results of this analysis.

FISHERIES TECHNICAL SESSION #5

SOME EFFECTS OF POWER PEAKING ON FISH IN THE HANFORD REACH OF THE COLUMBIA RIVER

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Atypical fluctuations in water level occur in the flowing Hanford Reach of the central Columbia River from a peaking mode of hydropower generation at an upriver dam. Water level and temperature regimes were monitored, and observations on fish stranding and bass spawning were made, in selected locations with the objective of identifying major impacts. Daily and weekly fluctuations were more extreme in a high-flow year, but water temperatures remained lower, compared to the following low-flow year. Losses of fish in shoreline areas were due primarily to stranding, entrapment (with and without complete dewatering), and predation. Juvenile fish were more susceptible to entrapment than adult fish. Since relatively few fish known to be isolated in pools could be subsequently accounted for, estimates of stranding losses based on foot surveys were conservative. The most serious ecological impacts resulting from water level fluctuations in the Hanford Reach were impairment of adult smallmouth bass spawning success and losses of chinook salmon fry during spring and early summer. The extent to which other riverine fish species are affected depends on their use of shoreline areas for spawning and inshore presence of young. Few of these relationships are completely known or understood. Extreme low flows during winter have the potential to dewater intergravel chinook salmon eggs.

MANAGEMENT OF WATER FOR FISH AND HYDROPOWER

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Fishery managers are faced with complex problems resulting from hydroelectric developments and power system operations. Coordinated energy systems have integrated the capabilities of hydro and thermal generation for efficient daily and weekly peaking operations. Regional systems are being tied together to exchange energy on a seasonal basis. When the operation of several energy sources is managed as a system, impacts of individual hydroelectric developments on fishery resources may change, become more significant, and more difficult to resolve than project specific impacts.

In practice, the management of fish habitat in many river systems and impoundments depends largely on the decisions of agencies managing water for other purposes. In order for fish habitat managers to effectively participate in these decisionmaking processes, they need the expertise to deal competently with regulatory and technical matters in the arena of other traditional project purposes such as hydropower, flood control, irrigation, and navigation.

Procedures for coping with the administrative and technical burden of reviewing large numbers of Federal Energy Regulatory Commission preliminary permit applications are discussed. Problems likely to be encountered when proposing a broadened interpretation of multiple use management to water and power managers are outlined and a strategy for securing a place for fishery interests in long-term water resource planning and day-to-day decisionmaking with other water managers is presented.

THE COLORADO RIVER CUTTHROAT TROUT (SALMO CLARKI PLEURITICUS) IMPACTS ASSOCIATED WITH INDUSTRIAL DEVELOPMENT WITHIN THE ROCKY MOUNTAIN REGION

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Increasing development of water resources within the Rocky Mountain Region has generated concern over various fish species and their ability to recover from associated impacts. One such specie is the Colorado River cutthroat trout (Salmo clarki pleuriticus) inhabiting the North Fork of the Little Snake River in south-central Wyoming. The Colorado River cutthroat has been classified as endangered in Utah, threatened in Colorado, and sensitive in Wyoming. The reproductive potential of this pure strain population is apparently low, thereby indicating the possible lack of ability to recover from the increased fishing pressure.

A municipal water project has withdrawn water from this drainage for the past 19 years with additional withdrawals anticipated in the near future. If access is increased due to the construction and operation of additional diversion structures, a substantial increase in angling pressure can be expected.

Future fish management programs implemented by the Regional Fishery Manager will need to consider the existing and projected harvest of the Colorado River cutthroat within the North Fork of the Little Snake River drainage and the low reproduction potential of the species. Several options are available for the management and preservation of this unique fishery: (1) reduced creel limits, perhaps as low as two fish per day, (2) catch and release regulations could be applied to the entire drainage, and (3) the drainage could be officially designated as a preserve for the Colorado River cutthroat and closed to fishing.

RE-ESTABLISHMENT OF FISH AND AQUATIC INVERTEBRATE POPULATIONS IN A STREAM SEVERELY IMPACTED BY ACID MINE DRAINAGE

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Acid mine drainage from an abandoned mine has entered Coal Creek, a small stream in western Colorado since about 1955. As a result of water quality degradation, the reach of Coal Creek extending from just below the drainage outfall to its confluence with the Slate River (approximately 8.0 km) has been essentially devoid of aquatic life. Viable brook and brown trout populations exist above and below this section of stream. The pH of Coal Creek during this time ranged from 3-5; five heavy metal concentrations (Cd, Cu, Fe, Pb, Zn) exceeded the Colorado guidelines for cold water biota. Thick deposits of ferric hydroxide blanketed the stream substrate.

In May 1981, AMAX, Inc., a mining company with interests in developing an area adjacent to Coal Creek, commenced the operation of a heavy metals treatment plant designed to reduce the water quality problems of the acid drainage. Since then, the water quality of Coal Creek has greatly improved, with pH values of 6.5-7.5 and heavy metals concentrations near or below acceptance levels.

Within one month following plant operation, aquatic invertebrates (predominantly dipterans and trichopterans) were observed in the stream and within 2-3 months, fish were recovered throughout the stream reach. Fish populations

based on electrofishing data collected (after 4 months of treatment plant operation) from an upper, middle, and lower site within the affected reach were estimated at 967, 6,165, and 2,142 brook trout/hectare, respectively. The lower site also had an estimated brown trout population of 218/hectare. Benthic invertebrates sampled within the same study sites were composed primarily of dipterans (85%). Ephemeropterans became an increasingly important component of the invertebrate community in the lower study site.

The re-establishment of aquatic communities in Coal Creek has occurred rapidly, attesting to the improved water quality conditions and the resiliency and opportunistic nature of fish and aquatic invertebrates. The reclamation of Coal Creek represents a milestone in the recovery of streams impacted by acid mine drainage.

LOCAL MOVEMENT AND DISTRIBUTION OF LARGEMOUTH BASS (*Micropterus salmoides*) AND CATFISH SPECIES WITH REGARD TO TEMPERATURE IN A COOLING RESERVOIR OF A COAL-FIRED POWER PLANT IN NORTHWEST ARKANSAS

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Mark and recapture methods were used to study largemouth bass in Flint Creek Reservoir, a 530-acre cooling reservoir for a fossil fuel power plant. Tag recoveries indicate high mobility of individual bass. Catch-per-unit-effort from electroshocking indicated a general migration of largemouth bass during the period of September 1981 to February 1982. Largemouth bass were concentrated in the fall (September to November) at the dam where make-up water is received from another lake. In the winter (December to February) the bass moved to other areas in the reservoir and were found near, but not directly in the thermal plume of the hot water outlet.

Temperature profiles during the fall-winter time period reveal a thermal gradient between the warmer upper end of the reservoir and down near the dam. The largemouth bass appear to have a preferred temperature between 20 and 30° C., as indicated by internal (dorsal epaxial muscle) temperature, water temperature profiles, and catch-per-unit-effort data.

Channel catfish and black bullhead did not exhibit the migration pattern of largemouth bass. The catfish species were taken most often in the warmer regions, especially near and even in the thermal plume.

Population dynamics of the Flint Creek Reservoir fishes are in progress.

BEHAVIORAL REACTIONS OF FATHEAD MINNOW (PIMEPHALES PROMELAS) AND RAINBOW TROUT (SALMO GAIRDNERI) TO A COAL LIQUID WATER-SOLUBLE FRACTION

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Laboratory avoidance tests were conducted with toxic concentrations of a coal liquid (solvent refined coal-II[1]) water-soluble fraction (WSF) using fathead minnow and rainbow trout in a multi-chamber test apparatus. The coal liquid WSF consisted almost entirely of phenolic compounds, mainly cresol and substituted phenols. Adult fathead minnow avoided acutely toxic concentrations > 3.5 mg/ℓ phenols. However, minnow avoidance was not detectable at concentrations that inhibited growth (0.7-1.5 mg/ℓ phenols). Juvenile rainbow trout did not avoid acutely toxic concentrations (3.0-7.0 mg/ℓ phenols) and may be attracted to the WSF. Species responses in the laboratory were complicated by other behavioral mechanism, including schooling and territoriality.

[1]A 2.9:1 blend of middle to heavy distillate obtained from a pilot plant at Fort Lewis, Washington.

FISHERIES TECHNICAL SESSION #6

LOGGING AND FISH HABITAT

A LONG TERM STUDY OF FIVE OLYMPIC PENINSULA, WASHINGTON STREAMS

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Field investigations on the effects of logging and road building on salmon and trout habitat were conducted from 1972-1979. Studies were designed to represent real-life logging situations. Areas were harvested under the requirements of Best Management Practices within the guidelines of the Washington Forest Practices Act. Five headwater streams on ITT Rayonier lands on the west slope of Washington State's Olympic Peninsula were studied. The summer low stream flow period, June to September, was investigated. Each area was sampled for a minimum of three summers prior and three summers after logging. In addition, upstream uncut areas were sampled throughout the study.

Parameters measured included: spawning gravel composition, stream temperature, surface and intergravel dissolved oxygen, turbidity, pH, conductivity, color, fish standing crops and riffle benthos dynamics.

Only temperature and riffle benthos populations showed overall trends of change after logging. Temperature levels and diurnal fluctuations will be above background for several years. Riffle organism production was increased. Other parameters did not show overall trends of change. Logging did not result in decreases in fish populations or changes in their composition.

Logging has a potential to be detrimental to fish habitat. However, this study indicates that current logging and road building practices, properly conducted and supervised, are compatible with fisheries production.

STREAM IMPROVEMENT IN WYOMING FOR INDIGENOUS CUTTHROAT TROUT

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While several subspecies of cutthroat trout (Salmo clarki) are native to Wyoming, their abundance has declined due to the degradation of fluvial habitat. Livestock overgrazing, herbicide use on streamside vegetation and stream channel alteration for flood control and road construction have adversely affected native trout stocks. To reverse this downward trend and increase populations of native cutthroat trout, stream improvement techniques are being used on several streams by State and Federal agencies.

Once believed extinct in Wyoming, remnant populations of Bonneville cutthroat trout (S.c. utah) persist in the Bear River drainage. These streams often feature warm water, much silt, and serious downcutting. Several joint State-Federal stream improvement projects are underway to improve habitat conditions for this fish. Selected stream bottoms have been fenced to exclude cattle. Additional holding areas for trout are being provided by log overpours, rock plunges, wedge dams, gabion check-dams, and trash catchers. Eroding stream banks are being treated with tree retards and rock riprap. While habitat and fishery recovery will likely be a slow, long-term process, preliminary data indicate a favorable response is already occurring. Bonneville cutthroat trout increased 69% from 1976 to 1980 in one 2-acre enclosure. Also, habitat and macroinvertebrate samples point to improved stream health in treated stream sections.

Colorado River cutthroat trout (S.c. pleuriticus) stocks have also suffered from habitat deterioration. However, success of this trout is tied more closely

to beaver ponds than are the other species, so primary restoration activities have centered on providing reproductive isolation with fish barriers. Some eutrophic beaver ponds have been removed with dynamite to improve spawning opportunity for S.c. pleuriticus.

Streams occupied by the Snake River cutthroat trout (S.c. subsp.) have been damaged in some areas by intensive farming practices and stream alteration for flood control. Instream structures are generally impractical due to stream size, so efforts have been directed towards improving spawning success in small, spring-fed tributaries. Using a backhoe, spawning gravel and deep pools have been provided. Large trees have been anchored in the spring flowages as overhead shelter for spawning cutthroat trout. On the lower Salt River, tree retards and tree blocks are being systematically applied to stabilize all eroding stream banks. Previous spot treatments were too scattered to cure the widespread habitat damage. Goal of the present large-scale project is the total stabilization of the lower Salt River, and the eventual recovery of the Snake River cutthroat trout fishery. Spring-fed spawning tributaries in the upper drainage have also been renovated. Boulder clusters have been installed in the Greys River to provide pocket pools in swift water areas.

USE OF COLOR INFRARED PHOTOGRAPHY IN STREAM HABITAT INVENTORIES

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The use of low level color infrared photography was used to inventory 192 miles of riparian and aquatic habitat on the John Day and Deschutes Rivers in central Oregon. Photos were taken at a scale of 1" = 2000" (1" = 166.6 ft.) and were overexposed 1/2 f stop to obtain water penetration. The aerial coverage was contracted through the Environmental Protection Agency for $15,000.00 or a cost of $78.13 per mile.

Ten ground truthing plots were selected prior to the aerial photography and consisted of 1/10-mile stream segments which were classified for riparian and stream habitat. Riparian vegetation was sampled on a 200-foot long transect with four 11.7-foot-radius plots. Trees and shrubs were identified and classified by condition, age, height, crown densitu, and percent ground cover. Target sheets 2' x 10' were placed at the start of each 200-foot transect to aid in photo scale determination and plot location.

Stream habitat was classified by evaluating percent shade, stream-bottom sediment, bank condition, riparian vegetation, and channel stability.

Analysis of photos revealed an accurate assessment of riparian condition, total riparian habitat acreage, stream condition, and base data for future trend. Overexposing the film for water penetration allowed analysis and mapping of spawning areas and bottom composition.

COMPARATIVE DIETS OF PLANTED RAINBOW TROUT (*SALMO GAIRDNERI*) AND SPECKLED DACE (*RHINICHTHYS OSCULUS*) IN A PRAIRIE IMPOUNDMENT IN NORTH CENTRAL IDAHO

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The diets of planted rainbow trout (*Salmo gairdneri*) and speckled dace (*Rhinichthys osculus*) were examined from Talmaks Lake, a small 5 hectare impoundment on the Nez Perce Indian Reservation. Yearling rainbow trout (n=92) were grouped into three size categories (i.e., < 250 mm, 250-289 mm, ≥ 290 mm) based on apparent differences in diet composition. Chironomid larvae were generally the principal prey of trout (25-53%) although speckled dace (32%) were the major dietary component of trout ≥ 290 mm. The prey taxa coenagrionid nymphs (7-10%), phryganid larvae (2-15%), corixids (4-9%) and fish (0-32%) increased in importance with the size of trout while cladocerans (11-1%) and baetid nymphs (19-5%) decreased in importance.

Speckled dace (n=285) were grouped into four size categories (i.e., < 70 mm, 70-79 mm, 80-89 mm, ≥ 90 mm). Chironomid larvae (67-92%) were the chief prey of speckled dace and were followed in importance by baetid nymphs (3-15%). Coenagrionid nymphs (2-12%) were consumed by the two largest size groups of dace, whereas corixids (7%) were utilized only by the largest dace.

Intra- and interspecific similarity in diet was determined using Horn's measure of overlap. For trout, dietary overlap was greatest between fish < 250 mm and 250-289 mm (0.981) and lowest between fish < 250 mm and ≥ 290 mm (0.474). Because of minor dietary variation among the size groups of speckled dace

STATUS AND ECOLOGY OF THE SHOSHONE SCULPIN (*COTTUS GREENEI*)

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The Shoshone sculpin (*Cottus greenei*) is a candidate for Federal threatened/endangered listing, largely because of its limited distribution. We worked with this previously unstudied species during 1980-82 to assess its distribution, abundance, habitat preference, and life history. *C. greenei* was found, with few exceptions, only in the constant temperature springs of the Thousand Springs Formation entering a 42-km section of the Snake River in Gooding and Twin Falls counties, Idaho. About two dozen populations, ranging in size from a few individuals to as many as 20,000, were identified. Individuals were patchily distributed, with higher densities (up to 11 fish/m^2) being associated with low water velocities and abundant rubble and aquatic plant cover. Mottled sculpin (*C. bairdi*) were found with some Shoshone sculpin populations but maintained different microhabitats.

Dietary preferences of *C. greenei* were examined by obtaining stomach contents through a combination of stomach flushing and administration of an emetic. This technique proved totally effective on 95% of the fish tested and resulted in few mortalities. We investigated feeding periodicity and dietary overlap between *C. greenei* and *C. bairdi* by sampling at 4-h intervals through a 24-h period in both allopatric and sympatric situations.

In the laboratory we conducted temperature, dissolved oxygen, and ammonia bioassays to assess the ability of the Shoshone sculpin to survive the habitat alterations (construction of trout hatcheries and hydropower projects) that are rapidly proceeding in the area. Live-cages holding sculpin were also placed in a number of altered habitats to evaluate survival.

overlap values were high, ranging from 0.931 to 0.998. Interspecific dietary overlap values were determined for all size groups of trout and dace examined. Values ranged from 0.439 (trout ≥ 290 mm - dace < 70 mm) to 0.969 (trout 250-289 mm - dace ≥ 90 mm). Overall, the largest dace had the most similar diet to that of three size groups of trout ($\bar{x}$=0.826) while the smallest dace had the least similar diet ($\bar{x}$=0.708).

AN INTEGRATED WASTEWATER TREATMENT WILDLIFE ENHANCEMENT AND AQUACULTURE PROJECT CURRENT STATUS OF THE ARCATA EXPERIENCE

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In 1963, the City of Arcata approved the use of part of an oxidation pond used for sewage treatment for aquaculture. By 1980, four major elements in an expanded wastewater treatment and reclamation scheme have been completed or in operation. These elements include: 1) An upgraded wastewater treatment system based primarily on lagooning that is the only wastewater treatment system on Humboldt Bay meeting Federal water quality standards. The system provides a major freshwater habitat for waterfowl on Humboldt Bay; 2) A California Coastal Conservancy project completed in 1981 that converted a degraded salt marsh and an abandoned landfill dump into three freshwater marshes and a recreational lake complex; 3) A 12-cell pilot project marsh to establish the ability of wetlands to produce tertiary treated domestic wastewaters; and 4) aquaculture ponds that use domestic wastewater and seawater mixtures for rearing of juvenile salmonids to smolt stages.

Along with describing the four elements mentioned, the paper will give the current status of the proposed system which envisions the treated wastewater flowing through the marsh-lake complex to provide a source of water for operating a fishway and adult salmon holding and spawning ponds.

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