Publications

of the

U. S. Fish and Wildlife Service

Fish Technology Centers

1966-June 1999

Title: Publications of the U. S. Fish and Wildlife Service Fish Technology Centers, 1966-June 1999

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Forward

The following is an updated list of reference materials produced by personnel and partners of U. S. Fish and Wildlife Service Division of Fisheries' Fish Technology Centers. The list contains some background on the Centers and published articles and station leaflets produced by the Centers. References that resulted from collaborative efforts among Technology Centers are listed under each Center.

The references are grouped by Center and copies of the individual articles may be obtained by writing the Director of the appropriate facility. A list of addresses is provided at the back of this publication.

Technology transfer is one of the primary missions of all Centers.

U. S. Fish and Wildlife Service
Fish Technology Centers

Fish Technology Centers were established to provide leadership and guidance to the fish culture community. Over the years, fish culture studies focused on reducing costs, enhancing fish quality, and improving overall fish culture operations. The importance of Fish Technology Centers became clear as fishery managers were increasingly aware of the need to produce fish that are healthy, genetically diverse, and well-adapted to fishery management objectives.

Correspondingly, Fish Technology Center roles and responsibilities have grown, and areas of specialty have expanded to include technical support to fishery resource programs such as inter-jurisdictional fishes, estuarine and riverine fishes, non-indigenous aquatic nuisance species, threatened and endangered species, and other high priority aquatic resource issues. To accomplish their work, each Fish Technology Center now maintains at least two areas of technical expertise. Functioning as a cohesive system, each Fish Technology Center strengthens the others, taking full advantage of various geographic differences to ensure that study results will successfully support a broad range of users. Through their partnership role with other Service programs and federal agencies, States, tribes, the private sector and international cooperation, Fish Technology Centers provide a vital link in the Service's commitment to conservation of our Nation's aquatic resources.

Sustaining the Nation's Fisheries

The United States has an unparalleled richness and diversity of natural resources, including our valuable fishery resources. Unfortunately, human pressures on fish and their habitats have increased to the point where many stocks of fish are being depleted, with some listed and others considered for listing under the Endangered Species Act. Many once-thriving fisheries are no longer commercially or recreationally viable, straining the economic, social, and cultural fabric of the Nation.

In order to restore depleted stocks, the health of the aquatic systems that fish (and humans) depend on must be restored and maintained. To achieve this goal, the U. S. Fish and Wildlife Service adopted an ecosystem-based approach to fishery restoration. This approach is based on scientific management, conservation of natural diversity, effective partnerships, and enhanced public awareness and stewardship.

A key element in fishery restoration and management is technology development. The Service's Fish Technology Centers provide cutting-edge technology and scientific information to fish hatcheries and fishery managers – knowledge critical to their ability to continue to manage fishery resources. The Fish Technology Centers comprise a national network, each complementing the other in an effort to conserve and restore the Nation's fisheries.

Serving the Fish Culture Community

Fish Technology Centers developed fish culture techniques and fish diets now used around the world, including the dry, long-lasting feeds that revolutionized the fish-rearing industry. Technology development by Fish Technology Centers provided the foundation of the aquaculture industry, which contributes millions of dollars annually to the United States economy.

Today, the Service's Fish Technology Centers continue to support the National Fish Hatchery System and

the fish culture community with emphases on:

- Improving the quality, genetic diversity, and post-release survival of captive reared fishes
- Identifying and reducing ant detrimental effects of hatchery releases on wild fish populations
- Developing technologies to reduce water consumption and pollution in hatcheries
- Developing and improving diets to meet nutritional requirements of captive reared fishes.

Recovering Endangered Species

The roles and responsibilities of Fish Technology Centers have grown to include the recovery of endangered, threatened, and declining fish populations. The Fish Technology Centers develop culture techniques and diets for endangered and threatened species, maintain captive populations and brood stocks, and assist in monitoring the success of re-introductions. A database of the genetic fingerprints of many wild stocks is being assembled and used as a baseline for characterizing and comparing wild and hatchery stocks. Cryogenic techniques to safeguard the genetic material of threatened and endangered fishes are also being developed to assist fisheries managers and hatchery managers in recovery and habitat restoration efforts.

Fish Technology Center History

The Fish Hatchery Development Center Program was created in 1965 to utilize fishery research information in developing improved methods of fish husbandry. The Fish Hatchery Manual, Section 1535, defined the responsibilities of five Fish Culture Development Centers as adapting basic research information to cultural methods, systems, facilities, and equipment for increased production of fish.

Over the years the name was altered to Fish Technology Centers and roles expanded. While the main emphasis of the Centers was directed at fish culture technologies and methodologies, the scope of the effort expanded to integrate other applied technologies like water quality, bioengineering, genetics, physiology, nutrition, and fish health. In the 1990s, Fish Technology Centers broadened their role to assist Fisheries Managers and the Division of Ecological Services with threatened and endangered species and hatchery product evaluations.

The original five Fish Cultural Development Centers were Abernathy, Washington; Bozeman, Montana; Lamar, Pennsylvania; Marion, Alabama; and McKenny, South Dakota. A San Marcos, Texas, facility became a Fish Technology Center in 1975. In 1984, Abernathy become the Abernathy Salmon Technology Center, Washington; and the Spearfish Diet Testing Development Center, South Dakota evolved into the Beulah Fish Technology Center, Wyoming. In 1986, Beulah Fish Technology Center was phased out; the remaining work and files were transferred to the Bozeman Fish Technology Center.

The six current Fish Technology Centers are: Abernathy, Washington; Bozeman, Montana; Southwestern Fisheries Technology Center [Dexter, New Mexico and Mora, New Mexico]; Northeast (Lamar), Pennsylvania; San Marcos, Texas; and Warm Springs, Georgia (including field station Bear's Bluff, South Carolina).

Abernathy Salmon Culture Technology Center

Background

Part of the Abernathy National Fish Hatchery, the Abernathy Salmon Culture Technology Center was established in 1972. The Center develops new salmon culture techniques, equipment, and feeds; develops techniques to improve the quality of hatchery-reared salmon; and evaluates the effects of various rearing and disease control techniques on the survival of hatchery-reared salmon in the wild. In the future there will be an increasing emphasis on studying the genetics of wild salmon and interactions between wild and hatchery fish. Abernathy Salmon Culture Technology Center provides advice and technical assistance in fish culture and disease diagnosis to fish biologists and aquaculturists in the public and private sectors. The Center also oversees quality control of fish feeds used the National Fish Hatchery System.

The station was established originally as a National Fish Hatchery under the provisions of the Mitchell Act (52 Stat. 345) on May 11, 1938 as amended August 8, 1956 (60 Stat. 932). The purpose of that Act is to provide for the "conservation of fishery resources of the Columbia River". The Act authorized and directed the Secretary of the Interior "to establish, operate, and maintain" fishery facilities to help compensate for the fish losses in the Columbia River Basin resulting from the effects of constructing mainstream dams and the impacts of other human activities.

The site for the Abernathy facility was chosen in 1956 by the U. S. Fish and Wildlife Service with the goal of contributing to the restoration of chum, pink, coho, and fall chinook salmon runs in the Columbia River Basin. Abernathy Creek offered a desirable location for a hatchery of this type because of its proximity to the mouth of the Columbia River and its convenient location. Construction occurred primarily in 1959. Fish culture began in 1960.

In 1961, the Division of Fishery Research activities at the Salmon Culture Laboratory in Entiat, Washington were transferred to Abernathy National Fish Hatchery to facilitate expansion of the laboratory's research program to include fall chinook salmon. The station functioned as a part of the Research Division until April 1972, when it was transferred to the Division of Fish Hatcheries and designated the Abernathy Salmon Cultural Development Center. Responsibilities of the Center were defined as (1) continued fish production for restoration of fish runs under the Mitchell Act, and (2) development of culturing methods, systems, facilities, and equipment for increased production of fish. The name of the station was changed to the Abernathy Salmon Culture Technology Center in 1984.

Objectives /Emphasis

- Studies to aid restoration of Columbia River salmon, steelhead, and sturgeon populations
- Fish culture methods, systems, facilities, and equipment development to enhance efficient production of healthy/quality fish.
- Federal leadership in scientifically based management of national fishery resources through assessment and development of methodology for the evaluation of hatchery products
- Develop fish food quality assurance programs and diets to maintain the nutritional value of feeds purchased for fish culture
- Federal leadership in population genetics and evaluating the interactions between hatchery and wild fish populations.

Station Mission

The Center's mission is to: (1) produce fish for restoration of Columbia River salmon and steelhead runs under the Mitchell Act, (2) develop culturing methods, systems, facilities, and equipment for increased and efficient production of fish, and (3) provide Federal leadership in scientifically based management of National fishery resources and anadromous fish propagation by developing new concepts and improved technologies as well as solving specific problems in fisheries management and hatchery operations. In addition, the Center conducts a fish food quality assurance program to maintain and improve the nutritional quality of feeds purchased for salmon and steelhead culture. The facility also provides technical advice and assistance to the fisheries community in addition to reporting findings in scientific journals, special Center publications, workshops, scientific meetings, and training schools.

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Recent Activities

Program Overview: The Center's program has three major facets: (1) fish production, (2) investigations and development, and (3) technical assistance. Approximately 30% of the station's funding and FTE's are devoted to fish production. Investigations and development work account for about 60% of program funding and human resources, while approximately 10% is expended in providing technical advice and assistance to a wide variety of federal, state, tribal, and private entities involved with fish culture or fisheries management.

Fish Production: The Center is currently rearing primarily fall chinook salmon on a production basis. Our annual maximum capacity is about 1,500,000 smolts weighing about 45-50,000 pounds. During the last ten years the Center has produced an average of 1,670,000 fish weighing 39,800 pounds. Smolt size has averaged about 10.8 grams (42 fish/lb.).

The Center has also provided space, water, and operational help for stream-side, gravel incubator boxes used by the Washington Department of Fisheries to produce chum salmon for a project to restore that species in the lower Columbia River. As part of this program, the Center reared approximately 158,000 chum salmon smolts in FY 1991 and released them into Abernathy Creek.

Investigations and Development: The Center's investigational and developmental efforts are presently concentrating on three aspects of artificial propagation: (1) nutrition, (2) hatchery techniques, and (3) fish health. During the past four years these subject areas included the following projects:

A. Nutrition:
1. Nutrition/Osmoregulation, Relationships
2. Effects of Vitamin Nutrition on Immune Response of Hatchery-Reared Salmonids

3. Nutrient Losses During Feed Storage and Manufacture
4. Mineral Studies

B. Hatchery Techniques:
1. Pond Loading Studies
2. Oxygen Supplementation
3. Pathology of Microtagging
4. New Feeding Methods (Fish Behavior)

C. Fish Health:
1. Egg Disinfection Procedures
2. Non-nutritive Feed Components vs Fish Health
3. Removal of Drugs and Chemicals from Effluents
4. Fungus Infections in Fish and Eggs

Fish Feed Quality Control: The Center is responsible for conducting a fish food quality assurance program for diets purchased by the Service to feed to Pacific salmon and steelhead trout. The formulations and manufacturing requirements for the two commonly used open-formula feeds, Oregon Pellets and Abernathy Diet, are based on results of nutrition research conducted by the Service and other government agencies or universities. The Center updates those specifications semiannually to incorporate recent findings and advances in nutrition and feed manufacturing. Also, operations at each feed manufacturing plant are inspected at least once per quarter to insure that contract specifications are being met. At the same time samples of feeds and ingredients are regularly sampled and chemically analyzed (in house or commercially) to make sure that products are wholesome and contain required levels of nutrients. After the feeds reach the field, Center staff are available to "trouble shoot" suspected nutritional problems. In the event that poor quality feeds are found, either at the manufacturing plants or in the field, the Center has the lead role in implementing steps for their replacement.

Histopathology Services: The Center provides histological services to various Federal and State hatchery biologists in the Northwest concerning disease diagnosis and confirmation.

Extension Services: Each year, Center personnel fill a large number of requests, from State, Federal, Tribal, and private fish culturists and fishery biologists, for advice, information, and guidance on all aspects of artificial propagation. Advice on statistical methods and assistance to Service biologists with statistical analyses of data is furnished as needed.

Bozeman Fish Technology Center

Background

The Bozeman Fish Technology Center has operated as a Federal facility for over 100 years. Originally established as a fish hatchery in 1892, it was designated a Fish Culture Development Center in 1966. As research needs expanded, the facility became the Bozeman Fish Technology Center in 1983. The work of the Center focuses on developing and refining rearing techniques for cold- and cool-water fish (both sport fish and species of special concern), improving hatchery fish quality, and maintaining the genetic diversity of captive-reared grayling and sturgeon. Areas of staff expertise include fish culture, management, nutrition, health, reproduction, water management, drug registration, and water chemistry.

In 1966, The Bozeman National Fish Hatchery was designated a Fish Culture Development Center. A small staff was employed and began investigations related to salmonid fish culture. Investigations addressed primarily: water treatment systems, water reuse, hatchery effluent treatment, carrying capacity and rearing indices, trout diets, trout broodstock, trout strain field evaluations, and other projects related to salmonid fish culture.

In 1983, the Center was given a new title, Bozeman Fish Technology Center. Since 1983, very little operational fish production has been assigned to the Center. Fish are produced as part of specific investigations. In 1986, the Beulah Fish Technology Center was closed and its staff and function which included diet development and testing programs for salmonids and cool-water species were transferred to Bozeman. This action, plus the hiring of a nutritionist, doubled the workload at the Center and increased the staff by four individuals at that time. A reproduction physiologist was also added to the staff in 1989.

In 1994 the Center was designated as the FWS's National Investigational New Animal Drug Office. Three additional biologists were hired to work with federal, state, and private aquaculture facilities to supply the Food and Drug Administration with the necessary data for registering drugs and chemicals used in fisheries resource work. Currently there are 14 full time permanent staff members at the Center.

In addition to development investigations, Center activities include a Technical Assistance Program for federal and state agencies as well as for the private sector, in fish health, fish culture, fish management, fish nutrition, drug registration, and fish reproduction.

The Center is unique in having extensive feed manufacturing capabilities, a fish histopathology laboratory as well as six water sources; two cold springs, a warm spring (70 degree F), two warm water wells, and Bridger Creek. The Containment Building, construction completed in 1996, is also unique in that it allows staff to bring non-native fish species into this building for research because effluent water is filtered, ground up, and ozonated to prevent fish escapement. This building also houses three water reuse systems to conserve valuable disease-free spring water.

Close proximity to Montana State University, the Cooperative Fishery Research Unit, the Montana Veterinary Molecular Biology Laboratory, the Bozeman Fish Health Center, the Wild Trout Laboratory, MT Department of Fish, Wildlife & Park's Region 3 Headquarters, and the State Veterinary Diagnostic Laboratory assure readily available sources for cooperative studies and special laboratory assistance. Center staff serve on graduate committees and many students complete all or part of their work at the Center.
Publication of the results of development investigations is an important aspect of the Center's program.

Such investigations have resulted in numerous publications in professional journals. Staff members also publish in cooperation with other agencies and programs. In 1975, the Bozeman Information Leaflet Series was initiated. This Series provides current information on development investigations.

Objectives/Emphasis

- Development of feeds, health management, and propagation/maintenance systems and techniques for high priority species.
- Develop and test new and alternative fish culture systems and techniques to improve the quality and efficiency of fish propagation.
- Operate the National Investigational New Animal Drug (INAD) Office for the Fish and Wildlife Service. Test efficacy of new therapeutic drugs for fish.
- Provide scientific support and technical assistance to operational and field programs, including recovery/restoration programs for sturgeon, salmonid, castostomid, and cyprinid fishes.
- Develop and test new feed formulations to meet special needs for larval fish nutrition, imperiled species, and pollution abatement.
- Provide fish disease diagnostic and health management services for Federal, State, and private sector cooperators.

Station Mission

The Center's mission is to: (1) conduct diet testing, feed development, histopathology, reproductive physiology, broodstock management, and fish culture enhancement programs for threatened & endangered fish species and species of special concern;(2) test alternative culture practices and assessment techniques to improve quality of hatchery produced fish and enhance cost effectiveness of hatchery operations; (3) cooperate with the Montana Fluvial Arctic Grayling Workgroup by maintaining broodstock and providing fry and fingerlings to native streams in Montana as requested; (4) maintain fish feed quality control program and assist fish culture facilities with hatchery effluent monitoring and pollution reduction programs; (5) appraise various fisheries management techniques such as electroshocking, and evaluate different strains of salmonids to determine benefits of growth and survival; (6) strive to register chemotherapeutants for use in all fishery resource programs with the establishment of the Center's Investigational New Animal Drug (INAD) Office; (7) develop procedures and strategies to better manage and lessen the effects of whirling disease on native fish populations; (8) work with other agencies in educating the public and surveying non-native aquatic mussels; (9) assist with the development of a database for the Service’s Region 6 fish passage program; (10) investigate new water management and disinfection techniques; and (11) provide assistance in all areas of expertise to Federal and State agencies and to the private sector by disseminating technical information through scientific journals, information leaflets, and by making presentations at professional meetings and workshops.

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89. Bart, A. N., G. A. Kindschi, H. Ahmed, J. Clark, J. Young, and Y. Zohar. 1999. Enhanced diffusion of calcein into rainbow trout larvae using cavitation level ultrasound.

88. Welch, E. B., E. L. Anderson, J. M. Jacoby, B.F. Biggs, J. M. Quinn, and G. A. Kindschi. 1998. Invertebrate grazing of filamentous green algae in outdoor channels.

87. Bowker, J. D., and L. Telles. 1997. Results from a Chloramine-T clinical efficacy trial to control mortality among fall chum salmon caused by bacterial gill disease.

86. Barrows, F. T., and W. A. Lellis. 1997. Prevention of fin erosion in rainbow trout, Onchorynchus mykiss, by dietary modification.

85. Bowker, J. D., and D. A. Erdahl. August, 1997. Observations on the efficacy of chloramine-T treatment to control mortality in a variety of salmonids.

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Recent Activities

Restoration efforts for the fluvial (river-dwelling) Arctic grayling, a species of special concern, by holding the genetically diverse broodstock continues to be a prime function of the Center. This is a cooperative effort with the Montana Department of Fish, Wildlife and Parks, Forest Service, Bureau of Land Management, Trout Unlimited, and the Nature Conservancy. This fluvial population in the Big Hole River, Montana is the only one remaining in the lower 48 states.

Nutrition studies continue to test alternate sources of protein as replacements for fish meal for use in fish feeds. Fish meal is usually imported and is not only costly, but is in short supply as well. Larval and broodstock diets have been and continue to be developed for endangered species including pallid, lake, Atlantic, white, and Gulf sturgeons as well as delta smelt and bull trout.

There has been very little work done on the development of broodstock diets for trout species. Current studies are designed to test feeds differing in protein and energy content and ratios for various trout broodstock programs for less expensive feeds which maintain high gamete quality.

The Center is involved with the Department of Agriculture's funded Western Regional Aquaculture Center by working cooperatively on sturgeon and low pollution diet projects. Staff members serve as Work Group chairmen and as members on the Research Technical Committee.

Feeds for early life stages of hard-to-raise larval threatened and endangered fishes such as Colorado squawfish and razorback suckers are currently being developed and tested.

Research on the susceptibility of various fish species to whirling disease continues, as well as, investigations on the tubificid worm life cycle, methods to sample the free floating stage (tams) in the wild, evaluating birds as possible vectors, and conducting research on fumagillin treatment to prevent infection.

Strides are being made in developing diets for the prevention of fin erosion in salmonids which is a serious problem at most trout production facilities.

The Service's National INAD Office is located at the Center striving to obtain fisheries use registrations for a number of chemicals not currently cleared through the U.S. Food and Drug Administration for use on fish. Currently this office is in the process of completing an INAD "piggy-backing" mechanism whereby state, tribal, and private aquaculture facilities can sign on to Service administered INADs.

Temperature requirement research for bull trout, brook trout, and west slope cutthroat trout is ongoing to provide valuable data to environmental agencies for establishing stream temperature criteria.

The non-indigenous species introduction program continues to be a part of the Center's program through public outreach, agency advocacy, and working with the Montana Department of Fish, Wildlife and Parks to be proactive in addressing this problem.

The Center has been designated as Region 6's fish passage representative in this national initiative to record in a database the locations of all waterway fish barriers.

Cavitation level ultrasound research is ongoing to develop equipment and protocols for the transdermal delivery of calcein for marking calcified tissue and vaccines for disease prevention in fish. This is a cooperative project with the University of Maryland and the U.S. Naval Surface Warfare Center.

Over the past 6 years over $5 million in construction projects have been completed at the Center. This includes replacing old underground steel piping, rehabilitating a mobile home for the INAD office, constructing a 5,500 sq. ft. feed development laboratory and 11,700 sq. ft. containment building, installing a 1500 gallons per minute raceway water reuse system and 400 sq. ft. pump house, installing a mini-water reuse system for Arctic grayling broodstock, and constructing a fish barrier at the cold spring water source.

Plans for the new 16,700 sq. ft. laboratory/administration building are being developed for possible construction in the years 2001 or 2002.

The Center currently hosts several community events throughout the year. The main event is the Annual Fishing Derby for kids 6 years old and younger who are allowed to catch 2 rainbow trout each. In June, 1998 769 kids registered for this popular event. Another annual event includes the Bridger Environmental Education Program (BEEP) a 3-day outdoor classroom that involves about 100 students in grades 6 through 8 from schools in areas surrounding Bozeman. Students study back country survival skills, orientation, aquatic invertebrates, fish, photography, soils and birds, just to name a few subjects. Emily Dickinson Days is hosted in October each year for area 5th graders interested in environmental education, the Community Watershed Festival is held the 3rd Saturday in May put on by the Bridger Outdoor Science School (BOSS) to educate young and old alike on how important watersheds are, and bowhunter education

classes are held during the summer on the Center's grounds.

The Gallatin County Summer Fair is held in July and the Center staff sets up a booth each year in the display building. Staff members rotate their schedules during the 5 days of the Fair to answer questions by the public. Aquaria are set up and fishes such as shovelnose sturgeon, trout, grayling, sauger, catfish, walleye, and goldeyes are displayed. This is a real attraction and brochures, handouts, information leaflets, and photo albums from the old days, the 1992 Center Centennial Celebration, and from past Fishing Derbies are available for all to see. This is great exposure for the Center as thousands of people attend this Fair each year.

Past Activities

Development of a greenback cutthroat trout broodstock from Colorado was begun in 1976. Fry and fingerling trout were returned to their native streams in Colorado. The recovery goal for the greenback is 20 stable populations. The Center discontinued involvement in this program in 1993 but is credited with the success of this supplementation program.

Feed formulas for use in manufacturing fish feeds on a production scale were developed for trout and coolwater species, primarily walleye and musky. These feeds are used by many state, federal and private hatcheries throughout the United States.

A cooperative study for the development of water recirculation systems with the U.S. Army Corps of Engineers and a private engineering firm, resulted in system design data that is used in the development of water recycle systems in aquaculture facilities today.

Development of methods and formulas for determining the carrying capacities of fish hatcheries were completed at the Center. These formulas are used by many state, federal and private fishery facilities in determining the carrying capacities of their hatcheries, as well as aiding in the design of new hatcheries.

In cooperation with Montana State University's Fisheries Bioassay Laboratory, Center personnel assisted in conducting the only life cycle studies on rainbow trout ever completed to determine the minimum and maximum ammonia levels that trout are able to tolerate. These data, as well as acute toxicity data, resulted in the development of standard ammonia criteria currently being used by the Environmental Protection Agency.

Studies were conducted to determine efficient methods for injecting oxygen into hatchery water supplies and thus increase fish production or improve water quality at these facilities. Studies also tested the effect of excess oxygen levels on the health and well being of fish.

Evaluation of various strains of fish, both wild and domesticated, have been completed at the Center as well as in the wild in cooperation with the Montana Department of Fish Wildlife and Parks and the Montana Fish and Wildlife Management Assistance Office.

The Center took a leadership role in working cooperatively through the Federal Aid program with the States of Arkansas, Iowa, Illinois, Missouri, Nebraska, North Dakota, South Dakota and Wisconsin in the development and testing of feeds and culture methods for coolwater species, primarily walleye. Due to this role quality walleye fingerlings are now successfully reared intensively.

Northeast Fishery Center

Lamar Fish Technology Center

Background

The Lamar Fish Technology Center, established in 1965, is part of the Northeast Fishery Center, which also includes the Lamar National Fish Hatchery and the Lamar Fish Health Unit. The Lamar Fish Technology Center provides fisheries information and technical assistance to Federal, State and Tribal agencies, private sector aquaculture, and foreign governments. Applied research at the Tech Center deals primarily with the development and improvement of culture techniques for Atlantic salmon, landlocked salmon, Atlantic sturgeon and American shad, with hatchery product evaluation and population assessments, and with trouble-shooting problems at federal field facilities. The Lamar Fish Technology Center also works to clear drugs and chemicals for use in fish husbandry and oversees quality control of fish feeds used in the region's fish hatcheries. Areas of staff expertise include fish culture, population ecology, biometrics, and water chemistry.

Objectives/Emphasis

- Develop culture and management techniques for threatened, endangered, and other imperilled aquatic species and ensure functional and genetic compatibility of propagated species with existing wild populations.
- Develop and provide technological assistance for implementation of approved management plans for inter-jurisdictional fisheries, including development of methods to evaluate hatchery products through population dynamics, stock identification, and stock assessment.
- Develop and test alternative fish cultural and management techniques to improve the quality and quantity of fishes produced at federal hatcheries and to enhance field capability of fishery management assistance offices.
- Determine the cause of production problems occurring at federal hatcheries and recommend solutions.

Station Mission

The Center's mission is to: 1) develop and test alternate methods of cultural and management techniques to improve the quality of hatchery products; 2) provide technical assistance to Federal, State, Tribal, and private entities in the areas of fish culture, hatchery product evaluation, and population assessment to promote recovery of depleted fish populations; 3) evaluate experimental techniques related to fish culture to determine suitability on a production scale; 4) develop culture techniques for threatened, endangered, and imperilled species; and 5) resolve cultural problems at Federal field stations in Region 5.

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Technology Center Transfer Series: 1983-1998

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Recent Activities

Fish Feed Inspections: The Technology Center is responsible for quality control of all production fish diets in Region 5. The quality of the open formula feed manufactured by a commercial mill was very poor in 1997 and 1998, resulting in instances of rancid feed and generally poor growth and condition of hatchery fish. Feed problems were addressed by the Technology Center and solutions to the problem reached by consensus of Project Leaders at a meeting lead by the Technology Center.

Atlantic Sturgeon Status Review: A member of the Technology Center staff served on the Status Review Team to determine if Atlantic sturgeon should be listed as a threatened or endangered species under the Endangered Species Act. Technology Center staff wrote three sections of the Endangered Species Act Status Review document - culture, disease, contaminants and interspecific competition. The Review Team recommended that the Atlantic sturgeon not be listed as endangered and the two agencies involved (Fish and Wildlife Service and National Marine Fisheries Service) agreed and published their decision in the Federal Register.

Atlantic Sturgeon Culture: The Technology Center continued to develop culture technology for this species, concluding studies on rearing densities for fry and fingerlings and diet trials. Results of the density studies are expected to be published in 1999. The Technology Center also continued to monitor adult and juvenile sturgeon captured in the wild for sexual maturation. Juvenile sturgeon captured in 1991 were successfully brought to spermiation using hormones. This is the first time wild juvenile Atlantic sturgeon have been held in captivity and reared to sexual maturity. Technology Center staff were also successful in capturing, tagging and releasing over 90 adult sturgeon in the Hudson River in 1998.

LC50 Determinations for Atlantic Sturgeon: Studies have been initiated to determine LC50 levels for three therapeutic chemicals. The chemicals being tested are chloramine-T, formalin, and sodium chloride.

Atlantic Sturgeon Genetics: The Technology Center cooperated with commercial fishermen, the States of New York, New Jersey, Delaware and Pennsylvania to obtain tissue samples from Hudson and Delaware River Atlantic sturgeon for use in genetic characterization of these stocks. The Technology Center cooperated with U. S. Geological Survey, Biological Research Division to develop a Quick Response research proposal to fund this genetics project. Genetic sampling has since been extended to the Chesapeake Bay and the James River.

Atlantic Salmon Hatchery product Evaluation: A study will be conducted in cooperation with the office of the Maine Anadromous Fisheries Coordinator to assess mortality rates of Atlantic salmon fry stocked in the Pleasant River, Penobscot drainage, Maine. The objective will be to estimate the survival, through the pre-smolt life stages, of hatchery-origin Atlantic salmon fry stocked into the Pleasant River, and to evaluate gross movement patterns of stocked fish. Field work will begin in May, 1999.

Egg Quality: The Technology Center was asked by Project Leaders to determine the cause of poor egg survival in Atlantic salmon, landlocked salmon, and rainbow trout (national broodstock station). Nutritional, disease, and density studies were performed at six federal fish hatcheries, and additional

studies were conducted at Lamar. As a result, changes in transport techniques were recommended, as were egg loading densities in incubation units. Nutritional studies were inconclusive, and disease studies continue.

Evaluation of the Toxicity of Iodophor to Eggs of Atlantic Salmon: The recommended rate for water hardening Atlantic salmon eggs in polyvinylpyrrolidone iodine compound is 100 mg/L of active iodine for 30-60 minutes at a Ph of 7.0 or above. Many Project Leaders believed that the toxicity of water hardening Atlantic salmon eggs in 100 mg/L iodophor had not been adequately tested. A study was conducted at Lamar where salmon eggs were water hardened in 50, 100, and 150 mg/L iodine for 30, 60, and 90 minutes. Results showed no difference in egg survival among any of the treatments, so it was concluded that water hardening eggs in iodophor at recommended rates was safe.

American Shad: The recovery of American shad populations in the Susquehanna River is a major restoration effort involving the Fish and Wildlife Service and the States of Pennsylvania and Maryland. The recovery effort relies primarily on hatchery stockings. Stripping of shad eggs is normally done at night on the river banks, a time consuming and difficult task. Pennsylvania provided $25,000 to the Technology Center to develop tank spawning technology for this species. The Technology Center developed a system which included four large spawning tanks, water recirculation and heating, ultraviolet light treatment, and degassing. Hormones were used to induce spawning and the first year of operating the system was a moderate success.

Chemical Marking of Salmon and Eels: The number one research need identified by Atlantic salmon biologists is a mark for non-feeding fry that can be non-lethally detected in parr, smolts, or adults. The Technology Center used a chemical, calcein, to create a fluorescent mark in fin tissue that can be easily detected by clipping a piece of fin and placing it under a fluorescing microscope. This same chemical was used to mark glass eels at the request of Law Enforcement personnel who needed a mark, undetectable by human eye, to help them stem the illegal trade in elvers. The Technology Center also cooperated with U. S. Geological Survey, Biological Research Division in the development of a highly promising immuno-mark using bovine albumin.

Dissolved Gas System: The Electrical Power Research Institute provided the Technology Center with $90,000 to design and build a system that would allow researchers to control oxygen and nitrogen levels and temperature levels in a closed system, and then to assess the impact of fluctuating oxygen levels on the growth and mortality of salmonid fishes. These experimental conditions would simulate environmental changes experienced by fish below hydroelectric dams. The system is operational and the first test with rainbow trout has been completed.

Horseshoe Crabs: A major issue involving several mid-Atlantic states is the perceived decline in horseshoe crab populations. These crabs are a major food source for migratory birds, are important in human medicine, and are used for bait by commercial fishermen. The Technology Center is involved in advising the Atlantic States Marine Fisheries Commission Technical Committee and Management Board of the current status of the horseshoe crab population. Whether to close the crab season is highly controversial politically and information to make that decision is scant. A member of the Technology Center staff is co-chair of a workshop designed to develop scientifically valid crab surveys for presentation to the Management Board in the hope that future population assessments will be based on sound scientific method.

San Marcos National Fish Hatchery and Fish Technology Center

Background

The original San Marcos National Fish Hatchery, the first warmwater hatchery west of the Mississippi River, began operations around 1900 and was located near the headwaters of the San Marcos River. During the 1960's, the U.S. Fish and Wildlife Service donated the aging hatchery to Southwest Texas State University which, in turn, donated 116 acres south of the city of San Marcos to the Service for the development of a new National Fish Hatchery and Cultural Development Center. The Center, located at the intersection of Interstate Highway 35 and McCarty Lane, was dedicated in 1976 and the name was changed in 1983 to the National Fish Hatchery and Technology Center.

Historically, the Center developed and demonstrated practical techniques for fish propagation, management, and monitoring; formulated solutions to hatchery and management problems; produced fishes to meet high priority needs; and developed strategies for monitoring, protecting, and managing high priority aquatic species, with emphasis on threatened, endangered, and inter-jurisdictional species.

Objectives/Emphasis

- Collecting, maintaining, and propagating Texas wild rice, salamanders, and fishes as outlined in the Service's San Marcos/Comal/Edwards Aquifer Rare, Threatened, and Endangered Species Contingency Plan
- Conducting research on life history, ecological requirements, genetics, and culture of Edwards Aquifer organisms
- Conducting research on restocking refugium species
- Collecting biological information on the region's aquatic biological resources
- Troubleshooting problems at other hatcheries
- Training hatchery personnel

Station Mission

The primary mission of the Center is to provide refugia for Texas wild rice, Texas blind salamanders, San Marcos salamanders, fountain darters, and, if found, San Marcos gambusia. Culture-related activities for these species are inherent to this mission. Major consideration is placed on assessment of biological issues related to the Edwards Aquifer and San Marcos and Comal springs. The Center also provides genetically diverse largemouth bass broodstock to several national fish hatcheries.

Peer Reviewed Publications

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Recent Activities

Since 1996, the San Marcos National Fish Hatchery and Technology Center has devoted nearly all its resources to refugium-related work for species listed in the San Marcos/Comal/Edwards Aquifer Rare, Threatened, and Endangered Species Contingency Plan. Center staff provided technical assistance in the development of this Contingency Plan and continue to refine it. Center staff also collect genetically diverse organisms from the wild and maintain them in refugium with the following target numbers: 950 fountain darters, 160 San Marcos salamanders, 160 Texas blind salamanders, and 160 Comal Springs salamanders, 88 Texas wild rice plants, and an unspecified number of Comal Springs riffle beetles.

Offspring from refugium organisms have been used in projects on toxicity (fountain darter, Comal Springs salamander), gas saturation (fountain darter), parasite/fish relations (fountain darter), restoration (Texas wild rice), seed banks (Texas wild rice), and backup refugium (Texas wild rice). Adults have been used for studies on genetics (fountain darter, San Marcos salamander, Texas wild rice), reproduction (fountain darter, San Marcos salamander), temperature effects (fountain darter, San Marcos salamander), food habits (fountain darter), and flow preference (San Marcos salamander).

Other work includes: development of procedure manuals for culture of the species in refugia, developing specifications for a new salamander refugium and research building, developing specifications for a new Texas wild rice refugium and research building, fry feeding for an endangered darter surrogate, effects of a parasite on west Texas fishes of concern, development of culture techniques for the Devil's River minnow (species of concern), development of a new warmwater fish culture short course, and enhancing station habitat for monarch butterfly use.

Southwestern Fisheries Technology Center

- **Dexter National Fish Hatchery and Technology Center**
- **Mora National Fish Hatchery and Technology Center**

The Southwest Fisheries Technology Center, composed of facilities at Dexter and Mora, New Mexico, was established for the production of threatened and endangered fishes and development of state-of-the-art fish cultural methods and facilities.

The Mora National Fish Hatchery and Technology Center and it's sister facility, Dexter National Fish Hatchery and Technology Center make up the Southwestern Fisheries Technology Center of the U. S. Department of the Interior, Fish And Wildlife Service. The Mora facility is the newest station of the Fish and Wildlife Service and the Dexter station is the only facility to solely address needs of threatened and endangered species. The Mora facility is located near the Sangre de Cristo Southern Rocky Mountains, about 2 miles north of Mora NM. The Dexter facility is located about 1 mile east of Dexter NM in the northern fringes of the Chihuahuan desert.

Dexter Fish Technology Center

Background

Associated with Dexter National Fish Hatchery, Dexter Fish Technology Center is the hub of the Service's efforts to preserve the imperiled native fishes of the Colorado River Basin, such as the Colorado squawfish, razorback sucker, and bonytail chub.

The waters of the Southwest have changed dramatically in the last hundred years. Rivers have been dammed and diverted to meet the demands of human settlement and development of this arid region. In the process, scores of unique freshwater ecosystems have been altered or destroyed and many organisms dependent upon these habitats have declined in both numbers and area of historic occurrence. The near disappearance of fishes native to these waters is a case in point, and their decline has occurred unintentionally and almost unknowingly by man.

After Congress passed the Endangered Species Act of 1973, the U.S. Fish and Wildlife Service (Service) was charged with the responsibility of identifying and protecting threatened and endangered species of wildlife. During this process the Service began searching for a facility to work with imperiled fishes of the American Southwest including northern Mexico. Of the 600 freshwater fish species found in the United States, 45 are presently listed as threatened or endangered. Seventeen of these species are currently being held and cultured at the facility selected to carry out this important work, Dexter National Fish Hatchery and Technology Center, Dexter, New Mexico.

On property acquired by the Service in 1931, the Dexter hatchery was constructed in 1931 and 1932, and produced warmwater game fish for stocking federal and state waters throughout the Southwest. With other Service facilities in Texas and Oklahoma fulfilling the federal commitments for Dexter produced game fish and the added responsibility for endangered fishes, the mission of the Dexter facility changed in 1978. No other place in the world has such a concentration of rare and endangered fishes at a single locality nor the responsibility to maintain and develop culture techniques for such an array of unique native fish species. Additional information is contained in Tables 1 and 2.

Objectives/Emphasis

- Maintain captive populations of native threatened and endangered fishes from Western America, including Chihuahua and Sonora Mexico.
- Genetically identify and characterize all Southwestern native threatened and endangered fishes.
- Develop cryopreservation technology for native threatened and endangered species management.
- Develop genetics management methods and culture techniques to minimize captive propagation influence on post-stocking/re-introduction behavior of native threatened and endangered species.

Station Mission

The Technology Center's mission is to help maintain the genetic diversity of these and other species, develop culture techniques for them and conduct biological studies to increase our understanding of these unique native fishes. Dexter FTC works with many Federal and State agencies, Universities, Indian Tribes, and several Mexican states. An ongoing expansion of laboratory facilities will increase the Technology Center's research capabilities. The Technology Center serves as a Refuge and Development Facility for Endangered Southwestern Fishes

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Recent Activities

The Technology Center is involved in many projects. One major project is rebuilding the razorback sucker broodfish population. Each year offspring from paired mating of wild razorback suckers from Lake Mohave, on the Colorado River, are brought to Dexter for grow-out, ultimately replacing the current broodfish, which are getting very old.

Another project involves development of a Regional genetics laboratory at the Technology Center. The Game and Fish Department of The State of New Mexico, New Mexico State University, the U. S. Geological Survey, Biological Research Division, and private interests all are partnering in this effort.

Colorado squawfish (now pikeminnow) population status was determined by Technology Center personnel and it is anticipate that the Center will need to develop more broodfish populations– for the Colorado and Green River populations of Colorado pikeminnow.

The Center is producing advanced fingerling bonytail for recovery efforts in the Colorado River. Fish are spawned at the facility and some are retained and grown out. Others are transferred to the Service facility at Willow Beach on the Colorado River.

Other refugium populations are being maintained for various species. The number of species maintained at Dexter changes frequently, depending upon need, and despite some successes, Dexter is not meant as a final solution to saving endangered fishes. The Endangered Species Act also calls for the protection of the habitat on which listed species depend for their continued existence. Although human activities have tremendously impacted the aquatic ecosystems of the Southwest, these activities played an important role in the economic development of the region. The goal of the U. S. Fish and Wildlife Service is to coordinate development with the needs of fish and wildlife. Hindsight, it is often said, is the best teacher. We can see some of the mistakes we have made in the past and hopefully learn from them. With careful and intelligent planning, loss of our natural resources, including the elimination of species, need not be the price for modern progress.

List and status of species held at Dexter NFH & TC. Species (Acronym), Scientific name Federal status [E = Endangered; T = Threatened P = Proposed for listing in Federal Register.

Family Catostomidae: Razorback sucker (RBS) Xyrauchen texanus T; Lost River sucker (LRS) Deltistes luxatus E; Shortnose sucker (SNS) Ghasmistes brevirostris E; Warner sucker (WAS) Catostomus warnerensis E.

Family Cyprinidae: Colorado squawfish (CSF) Ptychocheilus lucius E; Bonytail chub (BTC) Gila elegans E; Chihuahua chub (CCH) Gila nigrescens T; Pahranagat roundtail chub (PRG) Gila robusta jordani E; Virgin River roundtail chub (VRC) Gila robusta seminuda E; Woundfin (WDF) Plagopterus argentissimus E; Guzman beautiful shiner (GBS) Notropis f. formosus T.

Family Ictaluridae: Yaqui catfish (YCF) Ictalurus pricei T.

Family Cyprinodontidae: Leon Springs pupfish (LSP) Cyprinodon bovinus E; Desert pupfish (DEP) Cyprindon macularius E.

Family Poeciliidae: Gila topminnow (GTM) Poeciliopsis o. occidentalis E; Big Bend Gambusia (BBG) Gambusia gaigei E.

Mora Fish Technology Center

Background

The Mora Fish Technology Center is the newest Fish Technology Center in the Service and is presently in final construction phase. When operational, the Fish Technology Center will investigate high density fish production using water conservation methods. Water treatment systems will be flexible, reliable, and reasonable in cost, and will be capable of producing and developing technology for cold-and-coolwater species of sport fish and threatened and endangered species. Mora Fish Technology Center will initially rear Rio Grande cutthroat trout and the endangered Gila trout.

The Mora Fish Technology Center will investigate, develop, and demonstrate high density fish production using water conservation methods. Water treatment systems have been designed to be flexible, reliable, reasonable in cost, and will be capable of producing, and developing technology for cold, cool, and warm water species of sport, threatened, and endangered fish.

The Mora Fish Technology Center is designed to: develop fish culture technology for aquatic fauna of national significance; develop water conservation technology; developing new genetic initiatives; maintain threatened and endangered species; serve as a wetland recovery demonstration project; and provide local training and employment in the Mora Valley.

The facility will promote conservation of water quality and quantity for human and natural resource benefits and develop technologies to conserve water. Such conservation technologies and development are critical with the limited water resources in the desert Southwest and in areas of poor water quality and pollution. Mora will focus on improving recirculation and reuse technologies of fish culture water such that water may be used more than 20 times. Techniques will be tested on pilot and production scales to develop economic, safe, and efficient water cleansing for use in other fish culture facilities. Associated with water management will be the development of technology for high density fish production.

With completion of the Mora NFH&TC, the U. S. Fish and Wildlife Service will gain important fish culture expertise in and production of cold water fish culture. To test the water treatment and conservation systems, rainbow trout and other fish will be used as models for high density fish production with limited water and will be produced and made available to meet Service fish stocking demands. Focus will be placed on developing study protocols that address fish physiology, genetics, and behavior necessary for survival after release. Mora will concentrate efforts on sport and endangered fish production for high desert and mountain watersheds.

The Service will also gain important threatened and endangered fish culture expertise in and production of both cool water and cold water fish culture. Focus will be placed on developing study protocols that address fish physiology, genetics, and behavior necessary for survival after release. Mora will concentrate efforts on sport and endangered fish production for high desert and mountain watersheds.

Objectives/Emphasis

- Evaluating national and international fish culture, aquaculture technology, and propagation techniques.
- Conserving genetic resources through genetic initiatives, management guidelines, and protocols.
- Developing national and international water conservation technology; developing procedures and

techniques for high density fish production with limited water resources.

Station Mission

Technology development complements the Service "Action Plan for Fisheries Resources and Aquatic Ecosystems". The Mora project mission and purposes established goals in: ecosystem conservation; restoration and mitigation; water management, quantity, and quality; aquaculture; genetic policy evaluation for hatchery fishes; fish fauna genetic management; threatened and endangered fishes; drug and chemical management and fish health; effluent management; hatchery product evaluations; sustainable development; and wild and cultured fish interactions. The facility will address ecosystem management goals of biodiversity, water quality and quantity, natural resource oriented recreation, and public outreach. Technology developed by the Mora facility will involve partners, public education and outreach.

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Recent Activities

Construction activities have consumed much staff time over the last years. Three water reuse systems are now in place at the facility. Up to 50,000 pounds of cold-water fish may be reared on site. The recirculating systems are unique to the facility and should allow maintenance of sport and threatened and endangered fishes. Plans call for the rearing of Rio grande cutthroat trout in the Spring of 1999. Over 25,000 were hatched and reared to first feeding larvae in Spring 1998. Partnerships for fish culture, management, and genetic studies of Rio Grande cutthroat trout are being developed with the State of New Mexico, U. S. Geological Survey, Biological Research Division, Dexter Fish Technology Center, U. S. Bureau of Land Management, U. S. Department of Agriculture, Forest Service, and New Mexico State University.

Gila trout are scheduled for Spring of 1999. The facility will likely be a refugium for broodfish and will produce Spruce Creek strain Gila trout with the States of New Mexico and Arizona, the Forest Service, Mescalero National Fish Hatchery, and the Gila trout Recovery Team.

Technology Center personnel assisted Willow Beach National Fish Hatchery develop recirculating systems for razorback suckers and bonytail. The systems use solar heat and horizontal bed biofilters. Willow Beach National Fish Hatchery has successfully expanded it's mission to include endangered fishes as well as sport fish. Also, Technology Center personnel assisted Mescalero National Fish Hatchery in development of water recirculating systems to soften and reuse water for endangered Gila trout culture. Small systems were studied and installed at Tishomingo National Fish Hatchery for controlled incubation of paddlefish eggs.

Razorback sucker reproductive studies at Willow Beach National Fish Hatchery continue to be an annual Spring activity for Technology Center Personnel. Wild fish are caught and spawned at the hatchery before being returned to the Colorado River. Males and females do not time spawning well at the reduced temperatures of the Colorado River (due to Hoover Dam) so studies with sperm storage and cryogenics and hormone injection of females and males are ongoing. This year hatchery and Technology Center personnel successfully spawned several dozen riverine razorback suckers and obtained well over 200,000 hatched eggs.

Station personnel are busy preparing permit applications for Spring of 1999 when it is anticipated that full operations of the facility will commence.

Warm Springs Regional Fisheries Center

Background

The Warm Springs Fish Technology Center is part of the Warm Springs Regional Fisheries Center (RFC) which was organized in 1990 to establish a more cohesive and stronger Regional fisheries program. The Regional Fisheries Center is located within the city limits of Warm Springs, Georgia, on U. S. Highway 27A and Georgia Highway 41. The Center is approximately 35 miles northeast of Columbus, Georgia, and 70 miles southwest of Atlanta, Georgia. The Center's geographic location is ideal for Regional support.

Since 1990, the Region has moved in a deliberate fashion, taking advantage of discretionary monies to improve the Center. The Warm Springs Regional Fisheries Center (RFC) was organized in 1990 to establish a more cohesive and stronger Regional fisheries program. The Center staff remains committed to developing the expertise and technologies needed within the Region to advance U. S. Fish and Wildlife Service leadership in fisheries science and aquatic resource management.

RFC Program Components

The Warm Springs Regional Fisheries Center presently consolidates four programmatic components. Nineteen full-time employees provide program support. The program components are as follows:

1) The Warm Springs Fish Technology Center: 7 full-time employees; Administrative office; Wet lab building; Broodstock/spawning facilities; Water treatment system; Library/Conference room

2) The Bears Bluff National Fish Hatchery (Unit of Fish Tech Center): 3 full-time employees; Thirty-one acre site on South Carolina coast south of Charleston; Administrative Office; Freshwater & saltwater capabilities; Broodstock holding/spawning facilities; Laboratory & pier.

3) The Warm Springs National Fish Hatchery: 5 full-time employees; Site with 56 acres; 40 ponds at 18.23 acres; Three separate spring water supplies; Holding house; Public aquarium & visitor's area; Residence & Office; Various shop/garage/storage buildings

4) The Warm Springs Fish Health Laboratory: 4 full-time employees; Virology, bacteriology, parasitology labs; Water chemistry & fish sample prep labs; Diagnostics and microscopy; Office areas; Triploid grass carp program support through work at Warm Springs as a one-person satellite office in Stuttgart, Arkansas to handle triploid work in the Ecosystem Unit I.

Warm Springs Fish Technology Center

Fish Technology Centers were established in 1965 to provide leadership and guidance to the fish culture community. Over the years fish culture studies focused on reducing costs, enhancing fish quality, and improving overall fish culture operations. The importance of Fish Technology Centers became clear as fisheries program managers became increasingly aware of the need to produce fish that were healthy, genetically diverse, and well-adapted to fisheries management objectives. As the Service expanded its vision under the umbrella of ecosystem management, Fish Technology Center roles have correspondingly grown. Areas of specialty now include technical support for fisheries resource programs such as inter-jurisdictional fishes, estuarine and riverine fishes, non-indigenous aquatic nuisance species, threatened and endangered species, and other emerging high priority aquatic resource needs. To

accomplish their work, each Fish Technology Center maintains at least two areas of technical expertise. Functioning as a cohesive system, each Fish Technology Center strengthens the others, taking full advantage of various geographic differences to ensure that study results will successfully support a broad array of users. Through their partnership role with other Service arms and federal agencies, states, tribes, and the private sector, Fish Technology Centers provide a vital link in the Service's commitment to conservation of our nation's aquatic resources.

The Warm Springs Fish Technology Center (FTC) was established in 1993, to strengthen technology development within Region 4 and support other program areas through outreach from the Warm Springs Regional Fisheries Center. Since its inception, the FTC has continued to support the wide array of aquatic resource needs in the Southeast Region. The scope of the operations expanded in 1995 and the Center was charged with strengthening Service capabilities in coastal and riverine fisheries programs. Along with this charge came the responsibility and resources to develop the Bears Bluff NFH, South Carolina, as a unit of the Fish Technology Center. Accordingly, the role of the Fish Technology Center expanded and now includes program development targeted at inter-jurisdictional riverine and estuarine fisheries.

Objectives/Emphasis

The technical focus areas of the Technology Center continued to expanded in 1998, advancing new technologies (i.e., cryogenics and water conditioning systems). The repertoire of capabilities continues to advance, and Fish Technology Center staff continue to envision the following three major focus areas, and high priority targeted sub-areas, to be the strength of their program through the 90's and into the new century:

1) Fish Culture/Aquatic Species Development
- inter-jurisdictional coastal/riverine fishes
- native fishes
- imperiled species
-other Regional high-priority species

2) Technology Transfer
- reproductive biology
- cryogenics
- species handling & transport
- triploidy (grass carp, shortnose sturgeon, et al.)

3) Fisheries Evaluation
- alternatives to drugs & chemicals in the treatment and control of aquatic diseases
- fish quality indicators
- hatchery product evaluation

The Bears Bluff NFH (Unit of the Fish Technology Center)

Background

The Bears Bluff National Fish Hatchery was acquired by the Service from the U. S. Environmental Protection Agency in 1981. It is located on Wadmalaw Island, South Carolina (20 miles south of Charleston, SC). The hatchery consists of ten buildings, including two fish holding/spawning buildings, a

pier, two freshwater wells, one salt water pump and four ponds, all located on 31 acres of land. Buildings at Bears Bluff include a combination lab-dormitory-conference room, and an office building currently shared with three Ecological Service biologists from the Charleston Field Office. Other buildings include two older storage buildings, a newly constructed shop building, two power supply sheds, a filtration and pump shed, and two residences (mobile homes, one added in FY 1997).

Bears Bluff NFH, Wadmalaw Island, SC, was complexed with the Warm Springs NFH in October, 1993, and in April 1995 placed under the supervision of the Fish Technology Center. In August 1995, Kent Ware was transferred from the Bo Ginn National Fish Hatchery to Bears Bluff National Fish Hatchery as hatchery manager.

Fish production facilities at Bears Bluff include one broodstock holding building, a spawning building/egg hatching room and three outside tanks consisting of a 12-ft circular tank, a 20-ft circular tank and a 20-ft raceway. Both the broodstock building and the spawning building contain recirculating broodstock conditioning systems with water temperature control devices and biofilters used to condition shortnose broodstock for spawning. Water to the facility is supplied by two freshwater wells and a salt water pump located on a pier extending into the North Edisto River. Other structures at Bears Bluff include a pier, water supply lines, two water storage towers, observation deck, boat dock, entrance sign and two residences.

Bears Bluff staff and Warm Springs personnel working at Bears Bluff are primarily involved in the study and production of shortnose sturgeon. Significant progress has been made in refining egg handling & hatching and fry culture techniques for shortnose sturgeon. The new hatchery facility and wet-lab has given the staff increased capacity to condition and induce ovulation of the broodstock. This gives the Service another management tool (captive propagation of large numbers of juvenile sturgeon) for population Recovery and/or Restoration, providing a very attractive approach if we can continue to assure that the genetic integrity of the species can be maintained.

Finally, the Service continued to invest in the future of Bears Bluff's unique fishery resource potential. Construction of a new maintenance building was completed in 1997 and an emergency power generator was installed in 1997 to strengthen the facility.

Warm Springs National Fish Hatchery

Background

Warm Springs National Fish Hatchery (NFH) was established by act of Congress on July 1, 1898, as authorized by Appropriation Act 30 Stat. 612, to produce fish for farm pond stocking. The initial land acquisition was on February 14, 1899. The first recorded production was in 1903. Over the years the focus of the production changed from farm pond stocking to alternative program stockings. More recently, all the fish have been produced for National priority needs. Accordingly, the hatchery became an integral part of the Warm Springs Regional Fisheries Center (RFC). The Regional Fisheries Center now consists of the Warm Springs National Fish Hatchery, the Regional Fish Health Laboratory, Fish Technology Center, and the Bears Bluff NFH, (South Carolina).

Warm Springs NFH is located on 56 acres of land with forty ponds, totaling 18.23 surface acres of water, ranging in size from 0.1 to 1.6 acres. Buildings on station include: an office/laboratory, public aquarium, wet laboratory/ spawning building, a fish holding house, two residences and various vehicle,

equipment, storage and shop buildings.

Warm Springs NFH has access to three springs, all located on the west side of U. S. 27 Alternate. The main supply comes from Cold Spring (the hatchery owns the right to two-thirds of the flow, the City of Warm Springs owns one-third of the flow) with a flow of approximately 1200 gallons per minute. The hatchery also owns North Spring, with a flow of 200 gallons per minute, and South Spring which provides approximately 180 gallons per minute to the newly renovated wet lab/spawning building. In 1995, a new water treatment facility was developed with the purpose of controlling and manipulating the pH, hardness and alkalinity of the spring water.

Warm Springs Fish Health Laboratory

The Fish Health Laboratory was established in 1989, when two former fish disease diagnostic labs located in Heber Springs, Arkansas, and Pisgah Forest, North Carolina were closed. This action was taken to establish a centralized fish health program for the Region, and upgrade fish disease diagnostic capabilities. The Fish Health Laboratory is physically located in the building formerly occupied by the Southeastern Fish Control Laboratory which was closed in 1983.

The Fish Health Laboratory provides fish disease diagnostic and certification services to a variety of National Fish Hatcheries, State fish hatcheries, and Private fish farms. Triploid grass carp certification inspections are also provided to private/commercial fish farmers in the Southeast Region.

	Year Established	Authority
Warm Springs National Fish Hatchery	1899	P. L. 30-612
Warm Springs Fish Health Center	1989	Agency
Warm Springs Regional Fisheries Center	1990	Agency
Warm Springs Fish Technology Center	1993	Agency

Station Mission

- Developing fish management and culture methods for depleted native fishes and other imperiled aquatic species, with particular focus on inter-jurisdictional freshwater and estuarine species.
- Developing alternatives to the traditional use of fishery drugs and chemicals.
- Evaluating water treatment technologies with emphasis on water conservation and physiological requirements of fish.
- Developing and applying cryogenic techniques used for reproductive biology, as applied to recovery and restoration of depleted fishery resources.

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Recent Activities

The Warm Springs Regional Fisheries Center's public outreach efforts refocused on public-use, and providing a message that would demonstrate the ways that fisheries contributed to the Service's comprehensive ecosystem approach. The Center has made plans to develop aquatic habitat awareness ponds, as well as new fish pond displays. The two-pronged message for visiting public first points to fishing as fun, with economic benefits to society derived from sport fishing; and secondly, points to the necessity for preserving the quality of aquatic habitats, and conserving species, as an important part of our human responsibility to keep America as a healthy place for all people..

The Warm Springs Center was directed to work with three National Fish Hatcheries and a fish food manufacturer to improve regional capabilities for assessing appropriate fish feeds for the Hatchery System. This involved a study of commercial-feed produced from one diet formulation using three different manufacturing methods thus generating diets with differing physical characteristics. This and other diet work will be undertaken to find answers to questions, and solutions for managers. The primary goal of this work is delineate feeds that are effective in meeting the Service Mission of Restoration and Recovery of many fish and other aquatic species, while simultaneously evaluating diets well-suited and cost-effective for traditional species.

Warm Springs has been active in the pre-listing recovery effort involving the Robust Redhorse (Moxostoma robustum) since the re-discovery of the species in 1991. Activities included the development of hormone induced ovulation, fish-egg incubation strategies, and culture of larvae and fingerlings. Current research activities include the development of sperm storage capabilities (refrigerated storage and cryopreservation), and evaluating and refining culture methods for fingerlings. Efforts to cryopreserve the sperm of Robust Redhorse has produced post-thaw motilities in the 30-40% range with some samples having post-thaw motilities as high as 60%. Staff plans to fertilize fresh Robust Redhorse eggs in May 1999 with cryopreserved sperm stored in liquid nitrogen since May 1998. Warm Springs staff also serve in an advisory capacity to the Robust Redhorse Conservation Committee.

Sperm cryopreservation can aid in the preservation of endangered fishes, and towards this end, refrigerated storage and cryopreservation studies are being undertaken at Warm Springs. The goal is to develop gamete preservation methods that are predictable and effective, and to apply these techniques for the establishment of a national germ plasm repository for endangered species. Initial work is being placed on sturgeon species, and in particular, shortnose sturgeon (Acipenser brevirostrum). Cryopreservation studies have focused on effective cryoprotectant concentrations and freezing rates. Five commonly used cryoprotectants (methanol, dimethyl sulfoxide, dimethyl acetamide, ethylene glycol and glycerol) were studied for their effects on sperm motility. Sperm were frozen by several methods. Data from these experiments are currently being analyzed. Sperm from other sturgeon species are being shipped from facilities (University of California at Davis, Gavins Point National Fish Hatchery, Natchitoches National Fish Hatchery, Marion (AL) State Fish Hatchery and others) to Warm Springs for further analysis.
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Warm Springs staff engaged in collaborative studies with several universities and research facilities. Work with Clemson University involved paddlefish, sturgeon, and striped bass. Work with USGS-BRD Wellsboro, Pennsylvania, involved chemical marking of shortnose sturgeon eggs and larvae with either cysteine (eggs), or B-BSA (larvae), and NN-BSA (larvae). In addition, the effectiveness of several chemical egg de-adhesion treatments (i.e. urea, tannic acid, and protease) were examined against the currently employed mechanical egg de-adhesion using Fuller's Earth. Other sturgeon partnership activities involved biomonitoring research at Columbia Missouri Toxicology Lab, physiology research at University of Maryland, fish culture and physiology work at USGS-BRD, Leetown Center, paddlefish work through Auburn University, and fish culture and reproductive physiology work through the University of Florida.

The Bears Bluff Unit to the Fish Technology Center maintains shortnose sturgeon broodfish whose parents were collected from the Savannah River, GA/SC and spawned at Orangeburg NFH, SC. The captive reared broodfish are being used to develop and refine techniques for spawning shortnose sturgeon, incubation and care of the eggs produced, development of fingerling culture techniques, and supplying qualified researchers with test animals. Biologists from Bears Bluff and Warm Springs are testing various spawning procedures in an effort to develop a protocol for spawning shortnose sturgeon broodfish. Additional studies at Bears Bluff and Warm Springs have focused on examining several commercially prepared diets and determining an effective tank stocking density for growth and survival of larvae and fingerlings

Bears Bluff has also supplied shortnose sturgeon larvae and fingerlings to several researchers under permit with the National Marine Fisheries Service. These researchers have used the test animals for various purposes, including: effects of acute and chronic ammonia concentration on fingerlings; evaluating damage to and survival of fingerlings held in cages exposed to blasting in the Cape Fear River, NC; evaluation of tags and tag retention; and suppling specimens, alive and preserved, to museums and aquariums/zoological

parks.

Warm Springs Regional Fisheries Center staff have served in an advisory capacity to the cooperators involved in the Alabama Shovelnose Sturgeon recovery effort. In this advisory capacity, staff members have assisted State of Alabama fishery biologists at the Marion State Fish Hatchery with examination of Alabama Sturgeon broodfish for the determination of spawning condition. The Regional Fisheries Center biologists also assisted with the administration of hormones to male and female Alabama Sturgeon in an effort to induce ovulation.

The Warm Springs Regional Fisheries Center enhanced its biological capabilities through the enlistment of new staff and improvement of existing facilities. The Center can now expand into population enhancement work through applied cryogenics and reproductive biology. Similarly, the Fish Technology Center continues to fortify its involvement in field assessment of native fishes, as related to controlled propagation. Moreover, facility changes at Bear's Bluff and Warm Springs broadened the range of species that might be studied (e.g., sturgeons, freshwater mussels, darters, madtoms, salmonids, etc.).

Warm Springs staff are also engaged in the development of national standards and setting policy for the triploid grass carp industry. The Center posted, on the Region-4 internet web site, the National Standards for triploid grass carp inspectors and producers, as applied under the Triploid Grass Carp Inspection and Certification Program. Center staff are also working on a pilot freshwater mussel plan, to help establish Region-4 guidelines for things to do before introducing a species into a national fish hatchery, for captive propagation or other purposes. The plan will hopefully serve as an effective template for others to use. Center staff have become active in six of the Region's Ecosystem Teams; Vince Mudrak and Carlos Echevarria have been involved in Team Leader positions on two different ecosystem teams.

Summary

Fish Technology Centers were established to provide leadership and guidance to the fish culture community. Over the years, fish culture studies focused on reducing costs, enhancing fish quality, and improving overall fish culture operations. The importance of Fish Technology Centers became clear as fishery managers became increasingly aware of the need to produce fish that are healthy, genetically diverse, and well-adapted to fishery management objectives.

Fish Technology Center roles and responsibilities have grown over the years, and areas of specialty have expanded to include technical support to fishery resource programs such as inter-jurisdictional fishes, estuarine and riverine fishes, non-indigenous aquatic nuisance species, threatened and endangered species, and other high priority aquatic resource issues. Each Fish Technology Center now maintains at least two areas of technical expertise. Functioning as a cohesive system, each Fish Technology Center strengthens the others, taking full advantage of various geographic differences to ensure that study results will successfully support a broad range of users. Through their partnership role with other Service programs and federal agencies, States, tribes, the private sector and international cooperation, Fish Technology Centers provide a vital link in the Service's commitment to conservation of our Nation's aquatic resources.

Guidelines for the Fish Technology Center Reference Listing

Purpose: To list published papers, project completion reports, annual reports, and station leaflets grouped by Technology Center.

This listing was predated by prior publications of the Fish Technology Centers as the Fish Technology Center Reference List. May 1990, and 1992 -- published by Office of Administration - Division of Fisheries, U. S. Fish and Wildlife Service. The Fish Cultural Development Center Reference List Revised as of October 1982 -- published by the Branch of Extension Services, Division of Hatcheries and Fishery Resource Management.

Copies of the previous listings may be available from:

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