



SCIENCE-BASED HABITAT RESTORATION IN LAKES

by: Mike Allen and Wiley Kitchens

Ecosystem responses to habitat restoration are being evaluated in Big Gant Lake. This collaborative research project is being conducted by Drs. Mike Allen (FAS) and Wiley Kitchens (Department of Wildlife Ecology and Conservation and Florida Cooperative Fish and Wildlife Research Unit), with funding from the Florida Fish and Wildlife Conservation Commission (FWC).

The Situation

Channelization and flood control alter hydrology and create perhaps the largest anthropogenic impact to Florida's freshwater ecosystems. Historically, water levels in Florida lakes fluctuated substantially in response to variations in rainfall across seasons, years and decades. Channelization stabilized water levels in many lakes, so that levels now fluctuate nearly independent of rainfall amounts. Stable water levels foster dense stands of emergent plants in the narrow zone where water levels fluctuate, leading to very high plant biomass, excessive deposition of organic material, and eventual loss of littoral fish habitat. Examples where this has occurred include the Kissimmee Chain of Lakes, which support some of the state's most valuable freshwater fisheries, and many smaller lakes throughout Florida.

To reduce the influence of altered hydrology on fish habitat, the FWC has conducted some of the world's largest lake habitat restoration projects. Restoration efforts have focused on lake drawdowns and muck (i.e., organic plant material and sediment) removals, with the goal of improving sport fish populations, angler access and fishing quality. In a previous evaluation of the 1996 Lake Kissimmee drawdown and muck removal, Dr. Mike Allen and his students found that habitat restoration improved fish habitat in the treated areas, but did not result in lake-wide increases in the population abundance and angler catch rates of sport fish such as largemouth bass *Micropterus salmoides*.

An Integrated Approach

Lake restoration projects have the potential to benefit all components of the ecosystem including wildlife (e.g., amphibians, reptiles and birds) and sport fish. However, previous evaluations have focused on single species and lacked an experimental design to quantify responses. Drs. Allen and Kitchens recently began a seven-year project, funded by and in collaboration with the FWC, to evaluate fish and wildlife responses to a habitat restoration project at Big Gant Lake, located in Sumter County.

They will measure lake habitat characteristics (aquatic plants and sediment composition) and fish and wildlife community composition and abundance in two years of sampling before the drawdown and five years post-drawdown. Two control lakes will be sampled each year to separate effects of the restoration project from the effects of regional drivers such as rainfall.

Results of this project will aid resource managers in designing habitat restoration projects to maximize benefits to wildlife and fisheries resources. This collaborative project is the first experimental lake habitat restoration project in Florida, and the goal is to use this study to improve habitat enhancement projects in the future.



Satellite image of Big Gant Lake, showing extensive coverage of macrophytes around the lake shoreline (light green area around lake).

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Faculty Focus

Minimum Flows & Fish Resources

Florida freshwater resources include more than 7700 lakes and 1700 miles of rivers and streams within the state's borders. These resources are of substantial ecological and economic importance but they are becoming threatened due to rapidly increasing demands for water to meet both human consumption and agricultural needs. Florida receives high levels of rainfall, yet has tremendous water demands.

Modifications to riverine flow regimes in Florida should be viewed as a large-scale experiment and research efforts should be directed at developing techniques that can help predict and test ecosystem responses to flow modifications and the resulting changes in fish habitat.

In the Florida Rivers Lab (<http://floridarivers.ifas.ufl.edu>), we draw from our experiences with the Glen Canyon Dam Adaptive Management Program and the associated programs monitoring fish in the Grand Canyon reach of the Colorado River to develop new insights into how fish populations in Florida rivers respond to changes in flow. Currently, we are cooperating with the Florida Fish and Wildlife Conservation Commission and US Fish and Wildlife Service to evaluate movement patterns, habitat selection, feeding patterns, and relative abundance of fish in several coastal Florida rivers ranging from the Apalachicola River in the Panhandle to the Chassahowitzka River in southwest Florida.



Graduate students (Towns Burgess and Jared Flowers) hold a large sturgeon -- one species of fish that is threatened by reduced water flow.

Competing demands for fresh water are particularly severe and complex in south Florida where the majority of the state's citizens live, but where freshwater resources are relatively scarce. Legislation passed in 1997 mandated the development of Minimum Flows and Levels (MFLs) for water bodies within the state, but how aquatic organisms respond to water withdrawals and changes in flow are questions needing substantial research.

While this issue is new in Florida, western states such as Arizona, California, and Colorado have been wrestling with water shortages for many years and their experiences can offer important lessons to citizens, water managers, and scientists in Florida.



A field technician from Dr. Pine's lab works with a scientist from the USFWS to collect fish in the Apalachicola River.



By: Bill Pine

Our goal is to develop rapid evaluation techniques that identify relationships between fish populations, habitat availability, and riverine flow. This information could then be used by resource managers to develop flow regulations that protect riverine aquatic resources while trying to meet the needs of Florida's citizens for the state's limited fresh water.



Dr. Bill Pine is an Assistant Professor in FAS. His research focuses on processes that structure aquatic ecosystems with an emphasis on fish communities. Much of his work occurs in rivers and estuaries, where he and his students work to address major aquatic resource management issues with information derived from field studies, computer simulations and ecosystem manipulations. His recent research has included work dealing with apex predators in the Atlantic coastal rivers, as well as work to help develop management plans for the Colorado River fisheries.

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Adaptive Management of Native Fisheries in the Grand Canyon

By: Lew Coggins

Prior to European settlement, native fish in the Grand Canyon portion of the Colorado River were exclusively minnows and suckers. The biggest of these fish was the Colorado pikeminnow (*Ptychocheilus lucius*), the largest of all native minnows in North America (maximum size 6 feet and 80 pounds) and, like 85% of native Colorado River fish, is found only in this basin. Today, four of the eight species of native fish have been extirpated from Glen and Grand Canyons (roundtail chub, *Gila robusta*; bonytail, *Gila elegans*; razorback sucker, *Xyrauchen texanus*, and Colorado pikeminnow, *Ptychocheilus lucius*), while one is listed as endangered (humpback chub, *Gila cypha*) and one is listed as a candidate species (flannelmouth sucker, *Catostomus latipinnis*) under the Endangered Species Act. The remaining two fish (bluehead sucker, *Catostomus discobolus* and speckled dace, *Rhinichthys osculus*) are relatively common.

Prior to the construction of Glen Canyon Dam near the boundary of Glen and Grand Canyons, the Grand Canyon reach of the Colorado River was turbid and exhibited little daily but large seasonal variability in discharge and temperature. The post-dam river is generally cold and clear with a seasonally stable but diurnally variable hydrograph conducive to efficient water delivery and hydropower generation. Whereas the pre-dam river contained the depauperate native fish community described above, habitat modifications and species introductions have allowed development of a much richer fish community where non-native species outnumber native forms 4:1.

The Glen Canyon Dam Adaptive Management Program is charged with advising the Secretary of the Interior regarding resource management in Grand Canyon.

several focal resources in this program and as such there is much research and monitoring to discover successful management practices.

The US Geological Survey-Grand Canyon Monitoring and Research Center (GCMRC) is the scientific arm of the Glen Canyon Dam Adaptive Management Program. Since joining the GCMRC in 2002, I have been primarily involved with developing effective fish monitoring programs and conducting research on the factors controlling native fish population dynamics. Current knowledge suggests that likely factors influencing the population dynamics and viability of native fish in Grand Canyon include: 1) competition and/or predation by non-native fish, 2) low water temperatures that inhibit growth and survival, 3) flow regulation that destabilizes near-shore rearing environments, and 4) non-native parasites and disease.



Humpback chub

Modeling has shown that factors 1-3 are likely dominant drivers of native fish population dynamics in this system, and controlled manipulation of factors 1-3 in an experimental framework also is most tenable.

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Student Spotlight

Student & Faculty News



Heather Hamlin and Tina Crosby won first and second place oral presentation

awards at the World Aquaculture conference in San Antonio, Texas. Their faculty advisors are Ruth Francis-Floyd and Denise Petty, respectively.



Dr. Ed Philips was awarded a 2007 Research Opportunity

Seed Grant from the University, to promote interdisciplinary research on bioaccumulation, transfer and fate of algal toxins. Co-PIs are Shirley Baker, Patrick Baker, Deb Murie, Daryl Parkyn, Anita Wright (Food Science & Human Nutrition) and Denise Petty (FAS & College of Veterinary Medicine).



Jason Dotson won the best student paper award at the

annual meeting of the Florida Chapter of the American Fisheries Society. **Matt Catalano** was the first runner-up for this award. Both are students of Dr. Mike Allen



Matt Catalano also was awarded the Roger Rottmann Memorial

Scholarship at the Florida AFS meeting. This scholarship is given each year to an outstanding student in Florida AFS.

FLORIDA ECOSYSTEMS IN THE SPOTLIGHT

Florida Bay is another valuable ecosystem impacted by altered water inputs. It is a shallow lagoon located at the southernmost tip of the Florida Peninsula, between the mainland and a chain of islands known as the Florida Keys. The islands were formed from ancient coral and sand shoals that became covered by mangrove and tropical hardwood hammocks. The Bay is an area where fresh water from the Florida Everglades mixes with salt water from the Gulf of Mexico, forming an estuarine ecosystem with distinct biota. The Bay is characterized by a large number of shallow inter-connected basins, most with a depth of less than one meter. The Bay, and its associated mud flats and mangrove islands, provide nesting and/or foraging habitat for a wide variety of animals including the American crocodile, the West Indian manatee, the loggerhead turtle, bottlenose dolphins, and a variety of bird species and many gamefish. Certain parts of the Bay also are nursery grounds for economically important pink shrimp and spiny lobster. The Bay's shrimp fishery is valued at over \$59 million annually and the stone crab fishery at over \$22 million. A guide boat industry operates in the Bay, targeting snook, tarpon, bonefish, spotted sea trout and mangrove snapper. Until recent years, the Bay was noted for its clear water and lush seagrass beds. However, since the 1980s, there have been large die offs of seagrass and turbid water associated with blooms of phytoplankton. These changes have led to declines in shrimp, lobster and gamefish. In response to these changes, the State of Florida and federal government are working together to enhance regional water management in order to restore the bay toward a more natural state. Research regarding natural conditions of the Bay and effects of changing inflow of freshwater will provide scientific results that will be incorporated into a plan of action as part of the Comprehensive Everglades Restoration Program.



Sources: The Florida Bay Education Project (www.floridabay.org) and the South Florida Water Management District.

Grand Canyon Fisheries (Cont'd)

In 2003, the first multi-year program of experimentation was implemented to test policies associated with native fish conservation. Planned treatments include: manipulations of Glen Canyon Dam operations (discharge pattern and water temperature) and abundance of non-native fish in a 12-mile segment of the river deemed critical for the humpback chub. These treatments were to be applied in a factorial design over 16 years where non-native fish control was to occur in years 1-4 and years 9-12, and experimental warming in years 9-16 following installation of a temperature control device on the dam. The first four years of non-native control were quite successful with over 25,000 non-native fish removed. Community composition in this stretch of the river is now dominated by native fish (prior to 2003, non-native fish constituted 95% of the community) and monitoring programs are providing early indications of successful year classes associated with the 2001-2003 brood years. However, due to lowered reservoir levels associated with a drought since 2000, unexpected warm-water releases occurred simultaneously with non-native control. Thus, it is difficult to determine whether the strong year classes resulted from non-native

control, elevated water temperatures, or some other factor. Resolving this question is critical to the identification of successful management policies for Grand Canyon. If warm water releases and/or non-native control result in successful recruitment of native fish, current restrictions on Glen Canyon Dam operations might be unnecessary. Conversely, if sustained warm-water releases facilitate the spread of the non-native asian tapeworm (*Bothriocephalus acheilognathi*) or establishment of more problematic non-native fishes (e.g., smallmouth bass, *Micropterus dolomieu*), judicious use of warm-water releases may be necessary. The use of adaptive management to identify strategies for conserving biological resources is still in its infancy. If sound science and rigorous monitoring continue to guide design and implementation of experimental policies in Grand Canyon, this program may yield a robust case history documenting the efficacy of adaptive management in a large, highly modified river system.

Lew Coggins is a research scientist at the USGS Grand Canyon Monitoring and Research Center, and he is a PhD student in FAS. His major professor is Dr. Bill Pine.