



STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

FACING OUR FUTURE: Fisheries Adapting to Connecticut's Changing Climate

“Thermal tolerances for cold water fish like salmon, trout, alewives (herring) are likely to be exceeded in the northeastern USA resulting in significant reductions in suitable habitat. Other species will thrive in warmer waters.”

Impacts of Climate Change on Hydrologic Regimes: Implications for the Northeastern U.S. at the New England Interstate Water Pollution Control Commission (NEIWPC), June 26, 2008, presentation by the United States Geological Survey (USGS)

Implications for Fisheries

Climate change is expected to cause a general increase in average temperatures, causing Connecticut's climate to be similar to that of New Jersey under the reduced emissions scenario, and more like Virginia under the high emissions scenario. There are also anticipated changes in rainfall patterns and severity of storm events, amount of snow pack, and timing of snow melt and spring freshets in rivers along with changes in riparian vegetation and location of salt wedges in Connecticut's major rivers. Furthermore, water temperatures will continue to increase in freshwater and Long Island Sound. With these increased water temperatures New England can expect the abundance and distribution of coldwater species to decline and warmwater species to increase. This will have consequences for how Connecticut manages fisheries and fish habitat.

A total of 168 species of fish (63 freshwater and diadromous, and 105 saltwater) are found in Connecticut, including seven species that are recognized to be of special concern, threatened or endangered (*Connecticut's Comprehensive Wildlife Conservation Strategy*, 2005). As with terrestrial species, Connecticut is experiencing subtle but documented shifts in its freshwater and marine fisheries resources. As a result, climate change is something Connecticut

currently must consider when implementing Connecticut Department of Environmental Protection (CTDEP) fisheries programs and regulations.

In Connecticut's freshwater environment anadromous and coldwater fish species will likely be the first and most severely impacted by a warming climate. Earlier snowmelt and the timing of the annual spring freshet may inhibit or reduce spawning of native fish such as american shad, alewife and blueback herring. A recent review of the historical records on the timing of the spawning migration by alewife in the Connecticut River revealed that it is occurring 12 days earlier than during the 1970's. More southerly occurring anadromous fish species such as hickory shad and gizzard shad have become common visitors to Connecticut coastal streams.

Due to development and its impacts on water temperatures and stream flow, Connecticut has experienced a dramatic decrease in coldwater fish habitat that supported native stream dwelling species such as the eastern brook trout. It is currently estimated that less than 2% of Connecticut's 23,000 km of stream hold healthy wild brook trout populations. This change has occurred most notably in Fairfield and New Haven Counties. According to a recent publication, *Eastern Brook Trout: Status and*

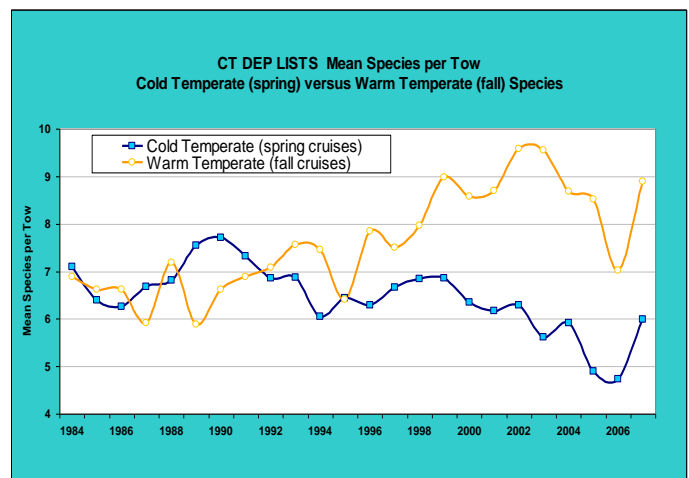
Threats, 2006, “Brook trout serve as indicators of the health of the watersheds they inhabit. Strong wild brook trout populations demonstrate that a stream or river ecosystem is healthy and that water quality is excellent. A decline in brook trout populations can serve as an early warning that the health of an entire system is at risk”. Fragmentation of migratory corridors by dams and low flows has reduced the ability of fish populations to adapt to temperature change. Further stress on Connecticut’s coldwater habitat is one of the major anticipated repercussions of a warming climate.

In a recent study of the Connecticut River, a continuous trend toward increased water temperatures, from the mid-1970’s to 2003 was concurrent with observed shifts in the predominant fish species. Sunfish species that were rare, or absent, are now abundant (rockbass, redbreast sunfish, and pumpkinseed sunfish) and catfish species have undergone a dramatic shift (channel catfish have replaced white catfish and brown bullhead). The degree to which these changes are the result of increasing temperatures is uncertain. However, it is likely that warming will cause additional adjustments in the Connecticut River’s fish populations.

Connecticut lakes are currently undergoing tremendous development related pressure. According to CTDEP’s 1996 *Caring For Our Lakes*, “Under natural conditions eutrophication is the natural aging process of lakes that occurs over a long period. [An undisturbed] forested watershed contributes minimal amounts of nutrients and sediments, and takes centuries to change a lake’s appearance. The aging process speeds up considerably, however, when the amount of nutrients and sediments that drain into a lake increases due to development, farming, and other human activities. The term commonly used when eutrophication is accelerated by these man-made conditions is cultural eutrophication.” Land use in the lake watershed is tied directly to the rate at which the lake ages or eutrophies. Projected increases in water temperatures and a longer growing season will accelerate the balance between nutrient dynamics within the lake and its watershed and can lead to increased algal blooms and aquatic plants that die and deplete oxygen. Increased rates of eutrophication lead to a loss of habitat for

coldwater species such as trout and coolwater species such as walleye and northern pike.

Water temperature in Long Island Sound has been increasing. Continuous temperature readings at Millstone Point in eastern LIS show a 1.3°C increase since 1976. Bottom temperature readings taken through the middle of the Sound since 1991 show a similar increase. Concurrent with the temperature increases, the Long Island Sound Trawl Survey (LISTS) has documented a significant decline in the overall abundance and average number per sample of “cold temperate” species captured in the spring, and a significant increase in the occurrence of “warm temperate” species. LISTS cruises now encounter an average of 10-12 warmwater species per sample during the fall survey compared to just seven to nine species per tow when the survey began in 1984. Of 11 cold temperate species in decline, winter flounder is the most widely known and heavily fished. However, other cold temperates in decline include the longhorn sculpin, sea raven and cunner - species experiencing very little or no recreational or commercial harvest. Smelt and tomcod are two other cold temperate species in severe decline, based on research conducted by the University of Connecticut, and they are identified as species of special concern.



Another local species that has declined concurrent with the regional warming trend is American lobster, a boreal species at the southern boundary of its range. The Long Island Sound lobster population experienced a severe mortality event in 1999. In the summer of 1999, bottom water temperatures were 1-2°C warmer than average, exceeding the lobsters’ stress

threshold temperature (20°C or 68°F) for weeks. The CTDEP's Long Island Sound Water Quality Monitoring Program (LISWQMP) has generated monthly water temperature and dissolved oxygen profile maps of Long Island Sound since 1991. To add fine-scale detail to these maps, Marine Fisheries staff initiated a cooperative program with commercial lobstermen who have set continuous temperature recorders in their lobster traps beginning in 2006. Recognizing 20°C as a stress threshold for lobster and possibly other cold temperate species, the number of days when continuous readings averaged above this value has been recorded. In 2006 and 2007, daily average water temperatures exceeded this stress threshold 4-16 days in Long Island Sound's eastern basin; 51-66 days in the central basin; and 55-73 days in the western basin. As average water temperatures increase the increased seasonal abundance of some mid-Atlantic fish species will create opportunities for fishermen. However, the blue crab that thrives in mid-Atlantic temperatures has not shown a consistent increase in abundance locally since most winters remain too cold for good overwinter survival. The CTDEP's Water Bureau and Marine Fisheries Division staffs are collaborating with University of Connecticut faculty to continue to assess the implications of these temperature patterns.

The Food Web that supports all finfish may be altered by climate change in ways that humans are only beginning to understand. When phytoplankton, zooplankton or fish grazers are differentially impacted by climate change, cascading impacts on the structure of the food web may result. Harmful algal blooms, which can be toxic to fish and shellfish, may become widespread. Fortunately, to date only one extensive bloom of a potentially harmful species (the dinoflagellate *Prorocentrum minimum*) has occurred in Long Island Sound. In the summer of 1987, this species disrupted the planktonic and benthic food webs in the western Sound from New Haven to the East River, NY. Since that time, all other algal blooms in the Sound have been localized and of short duration. However, continued increases in environmental fluctuation causing alterations in land runoff, water column stratification or acidification may allow harmful algal species greater opportunity to dominate Long Island Sound's plankton

community. Algal blooms in freshwater lakes may also increase with a longer growing season and with the direct impact of higher temperatures result in further reductions in dissolved oxygen and coldwater fish habitat. (Additional information about the food web can be found in the Biodiversity fact sheet).

Both freshwater and saltwater marshes and wetlands are vital to local fisheries production. Not only do these areas act as sponges for water retention and buffers against the impacts of severe rainfall, storms and pollution events, they are also important nursery areas for many aquatic species. For example, in the freshwater environment, wetlands perform the critical function of regulating flows that help to cool headwater streams during the low-flow summer months. Wetland areas also provide sources of nutrients. These nutrients promote primary production which in turn provides a food source for aquatic invertebrates and insects, the basis of the food web for fish. In the marine environment, small killifish enter brackish water marshes on high tides in large numbers to consume marsh invertebrates that feed on decaying marsh grasses. The killifish then migrate to coastal waters where they become prey for fish like fluke, stripers and bluefish thereby exporting marsh energy to open marine waters. If the marshes and marsh grasses are drowned or degraded by sea level rise or severe storms, all the associated species along the food chain will also be affected. (For additional wetlands related information see the Natural Coastal and Water Resources fact sheets).

Invasives – A warming climate will likely create a more conducive environment for invasive species. Aquatic invasive species (both plant and animals) have been a long-standing problem in both the freshwater and marine environments. Many of these invasives have been unintentionally introduced from ballast water transfers of ocean going vessels and through the live bait, pet trade, and water garden industries. Invasive species often proliferate at alarming rates due to the lack of the natural controls or predators that kept their populations in check in their native range. Once aquatic invasive species become established they are often relocated by recreational boaters. Boats, contaminated with aquatic plants or animals from one area, can introduce nuisance problems

to other locations, when these invasives ‘hitchhike’ to new lakes and rivers. The introduction of zebra mussels into East Twin Lake in the late 1990’s is but one example of a recent invasion. The spread of Eurasian water milfoil, an invasive aquatic plant, throughout the state is an example of how an invasive can cause widespread damage.

What Connecticut is Doing

The CTDEP’s Inland and Marine Fisheries Divisions are working to protect, restore and enhance fish habitat so that fish populations have as great an opportunity as possible to adapt to a changing climate.

Overcoming fragmentation of populations by providing migration access to upstream spawning habitat and potentially cooler water temperatures is essential for the continuation of diadromous and stream-dwelling coldwater fish species. The CTDEP’s Inland Fisheries Division provides technical guidance in designing fish passage facilities. For example, fisheries restoration in 2008 included fabricating and installing a new eel pass at the state-owned Bunnells Pond Dam (Pequonnock River, Bridgeport). This eel pass, with a new design, is expected to greatly increase the number of eels able to get over the nearly 30 foot high dam. The CTDEP assists in the completion of approximately three fish passage projects per year (fishways and eel passes) that successfully open up large stretches of previously inaccessible riverine habitat. Providing “connectivity” to resident populations of fish in smaller streams, especially during low flow periods of the year, is accomplished by taking advantage of opportunities to remove barriers to fish migration including dams, improperly installed culverts and other obstructions. Furthermore, the CTDEP requires that thermal discharges minimize the impacts to fish habitat. In the broader context of maintaining diverse habitat, the CTDEP is in the process of developing comprehensive stream classification criteria and stream flow regulations designed to maintain fish communities.

With a changing climate will come changes to recreational fishing, in both the marine and freshwater environments. Once common, species such as winter flounder may become less

common while other, more adaptable species flourish. Freshwater fish such as trout may not be as plentiful, or available at all, in former locations. Connecticut will need to invest in habitat protection where appropriate, especially with cold, headwater streams that still support healthy populations of native, eastern brook trout. The recent implementation of a statewide Trout Management Plan (2002) based on stream survey data that identifies valuable cold water resources is a step in the right direction. Subsequent resource protection will be critical such as with the Belding Wildlife Management Area where the headwaters of the Tankerhoosen River are found. This stream supports a healthy, self-sustaining population of native eastern brook trout and wild brown trout.

The CTDEP’s three trout hatcheries currently produce approximately one million trout annually. These fish are distributed into lakes and streams with suitable coldwater habitat and support a very popular recreational resource. The CTDEP is considering opportunities for further stocking of warm water species and alterations of state hatchery management practices to support these opportunities as the climate changes. Despite the observed and projected future changes due to a warming climate, Connecticut’s freshwater fisheries resources are well poised to adjust to changing conditions by utilizing naturalized populations of cool and warmwater species such as northern pike, walleye, channel catfish, and largemouth and smallmouth bass. Proactive management of species in addition to trout will ensure maintenance of diverse freshwater fishing opportunity throughout the state. (See the Outdoor Recreation fact sheet for information about fishing programs).

Monitoring – Conducting monitoring programs to assess the status and health of populations and habitat, and re-evaluating those programs to determine if they should be modified, will help Connecticut understand how a changing climate is affecting fish communities and habitats. This information will help the CTDEP adapt fishery management and habitat conservation programs to more effectively respond to variations caused by climate change.

The CTDEP’s Marine Fisheries Division supports several long-term monitoring programs

that are vital to understanding the impacts of climate change and associated geographic shifts in species distributions as well as to the practice of ecosystem-based fishery management in the face of a changing environment. These programs include the Connecticut River Shad Study beginning in 1979, the Connecticut Larval Lobster Survey beginning in 1983, the Long Island Sound Trawl Survey beginning in 1984, the Connecticut Estuarine Seine Survey beginning in 1988, and the Long Island Sound Water Quality Monitoring Program (LISWQMP) beginning in 1991. These long-term monitoring programs are positioned to provide a quantitative context for effects of climate change on key marine species and life stages.

The CTDEP's Inland Fisheries Division has also been involved in long-term monitoring of inland fisheries resources. This monitoring includes the Lake and Pond Survey beginning in 1988, Stream Survey beginning in 1988 and Diadromous Fish Enhancement and Restoration beginning in the late 1970's. University of Connecticut researchers have recently completed a four-year survey of striped bass and river herring populations in the Connecticut River. Information on striped bass consumption rates, striped bass abundance, and river herring population structure derived from these field studies will be used in a population modeling analysis.

As waters continue to warm Connecticut will need more focused monitoring of habitat conditions and species' abundance to ensure healthy and diverse fisheries for years to come.

Action is Needed Now

Steps can be taken now to help Connecticut's fisheries resources adapt to a warming climate. The acquisition and protection of critical coldwater, and wetland habitat, along with migratory corridors, will help mitigate the effects of a warming climate. New ways to control or limit the effects of stressors will be sought wherever possible. Preventing the introduction of new aquatic invasive species and limiting the spread of currently existing ones is one example. Continued and expanded programs to monitor both marine and inland fisheries resources will be critical to providing timely information on the effects of climate change.

This is one of eight documents in the series *Facing our Future* concerning Connecticut's changing climate, www.ct.gov/dep/climatechange

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IMPROVEMENTS AND CHALLENGES FOR TODAY

Individual, Corporate, Municipal and State Stewardship

- Avoid fragmentation of habitat, stream channel modifications, adverse water level manipulation, adverse diversion, filling, dredging, impoundment, sedimentation and nutrient loading, removal of riparian vegetation, excessive vegetation control, and shoreline modification.
- Support land acquisition and conservation easements containing critical habitat and head waters.
- Support monitoring programs focused on climate change that will provide the needed information to guide effective management actions.
- Expand efforts to prevent, eradicate, and control invasive aquatic species.
- Continue proactive efforts to develop and enhance fisheries for temperature tolerant species.