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Issue # 71
April 11, 2017

Lake Trout fry sampled on Julian's Reef in spring 2016 *Photo by Z. Zuckerman*

Illinois Making Strides in Lake Trout Restoration

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Lake Trout (Salvelinus namaycush) historically were the top piscivore (fish eater) in Lake Michigan and provided the largest Lake Trout harvest of the Great Lakes. By the 1950s, Lake Trout were extirpated from Lake Michigan due to overharvest and predation mortality from the invasive Sea Lamprey (Petromyzon marinus). The *Great Lakes Fishery Commission* was established in 1955 by the Canadian/U.S. Convention on Great Lakes Fisheries to coordinate International fisheries, since the other four lakes share a border with Canada, and to facilitate Sea Lamprey control. The eventual development of a lamprey control program utilizing lampricides and trapping allowed for the reintroduction of Lake Trout by the mid-1960s.

The primary effort to reestablish Lake Trout has been through stocking and continued control of Sea Lamprey populations. A formalized Lake Trout Plan was not adopted until 1985, after which a portion of stocking efforts were shifted to offshore reefs that were known historic Lake Trout spawning sites, and refuges from fishing were established. Stocking in Illinois was moved offshore to Julian's Reef in 1985. Stocked Lake Trout have been from multiple sources (strains) such as Lake Superior, where Lake Trout were not extirpated, or from lakes where some remnants of introduced Lake Michigan Lake Trout exist (e.g., Green Lake, WI and Lewis Lake, WY). The Fish-Community Objectives for Lake Michigan, adopted in 1995, call for reestablishment of native species and that 25% of the salmon and trout harvest consist of natural Lake Trout.

All Lake Trout stocked into the Great Lakes, primarily facilitated by the

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*@ORC is a weekly publication by the IL Department of Natural Resources **O**ffice of **R**esource **C**onservation about exciting and wonderful things ORC staff are doing throughout Illinois.*

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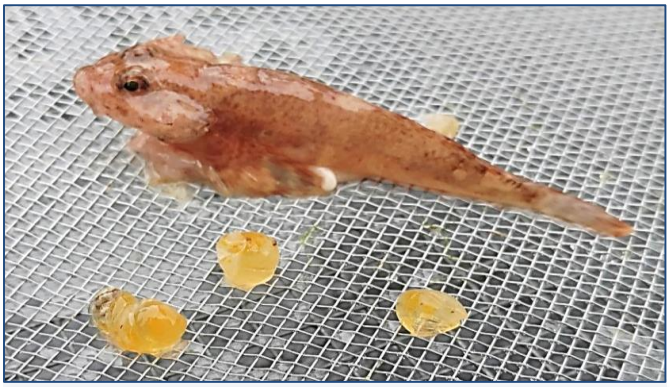
Sea Lamprey wounds on adult Lake Trout. *Photo by V. Santucci*

U. S. Fish and Wildlife Service, have been marked with either fin clip and coded-wire tag (CWT) or just a fin clip. Little measurable natural reproduction was observed from these initial stocking efforts as noted by the lack of unmarked (unclipped) fish caught by anglers or in sampling gear. Beginning in the late-1990s, a full review of factors impeding Lake Trout natural reproduction was undertaken. Following the development of the "impediments document" the Lake Trout Task Group of the Lake Michigan Committee was charged to update the 1985 Plan with current knowledge and produce a guide for fisheries managers to consider. The Lake Michigan Committee subsequently adopted a Fisheries Management Implementation Strategy for Rehabilitating Lake Trout in Lake Michigan (Strategy) in 2011 based on recommendations in the guide. Lake Michigan Program biologists have monitored Lake Trout population abundance and other indices through annual gill net surveys as far back as 1978. More recently, these sampling efforts have been formalized into two lake-wide surveys. Since 1998, a coordinated lake-wide sampling effort to measure Lake Trout abundance has occurred in the spring with participation by the four states, two Federal agencies, and tribal entities. A standardized survey of spawning Lake Trout was adopted in 1999 whereby these agencies sample historic spawning reefs using similar gear in the fall to measure success in developing spawning populations. Sampled fish are measured, weighed, and checked for fin clips, sex and reproductive status, lamprey wounds, and CWTs are extracted to determine stocking location, age, and strain. In Illinois waters of Lake Michigan, fall spawning surveys have focused on Julian's Reef, where the last indigenous Lake Trout in Lake Michigan were harvested, and nearby Waukegan Reef.

A target of 50 fish/1000 ft. of gill net was adopted for spawning population abundance in the Strategy. This target is a conservative threshold by which abundance is sufficient for natural reproduction as witnessed from other areas of the Great Lakes. IDNR fall spawning surveys have measured populations at this level at both

DNR biologists remove Lake Trout from gill nets aboard the Clifford J. *Photo by S. Robillard*

Waukegan and Julian's reefs since 1997, and other strategy objectives such as proportion female and number of age classes older than age 7 also have been achieved at these two Illinois reefs.



Three Lake Trout eggs removed from a sculpin's stomach. *Photo by Z. Zuckerman*

However, a high abundance of adult Lake Trout does not necessarily mean recruits to the population from natural reproduction will result. From previous work, it has been noted that Lake Trout are impeded by not only insufficient numbers of spawning adults, but that spawning often occurs in areas where eggs may not develop to hatch, predators may consume eggs or fry, or fry may lack sufficient food resources.

Since 2012, the proportion of unmarked, presumably naturally produced, Lake Trout has substantially increased in the fall spawning survey to over 40% of the samples at each reef. A baseline of up to 4% unmarked fish is expected and deemed hatchery error. This increase in unmarked fish is a milestone in Lake Michigan where rehabilitation efforts have been ongoing for 50 years. Length at age analyses and age determination from otoliths (ear bones) indicate that these mature, potentially natural fish are ages 4 through 11. The quick increase in unmarked fish is similar to successes experienced in other Great Lakes when naturally reproduced fish took hold. While the proportion of unmarked fish has increased to lesser degrees in other areas of the lake and unmarked juvenile Lake Trout have been documented elsewhere, no other area of the lake has witnessed the significant increases we observe on our two reefs. Continued monitoring of the population is essential, and additional research into the phenomenon has been undertaken through cooperative projects with the Illinois Natural History Survey.

A mapping project by INHS Lake Michigan Biological Station provided more detailed bathymetric and substrate maps of the reefs to focus future egg and fry sampling. Recently completed was a study involving IDNR, INHS, and Greg Whitledge from SIU-C whereby otolith microchemistry from unmarked adult lake trout was compared to hatchery fish provided by USFWS and to other Lakes Michigan and Huron Lake Trout. Findings indicate that the unmarked fish sampled on the Illinois reefs are not of hatchery or Lake Huron origin; further confirming that they are in fact of Lake Michigan origin!

An ongoing study at Julian's Reef by INHS using Great Lakes Fish and Wildlife Restoration Act funding is measuring egg deposition and estimating recruitment to the fry stage. In spring 2016, a ROV, equipped with an electrofishing unit and suction sampler, was able to successfully sample emergent fry at Julian's Reef. These studies provide critical information on early life stages of Lake Trout that sampling of adults alone does not provide. The next steps for this potential success are to determine when stocking may be reduced or eliminated so that stocked fish do not impede naturally-produced fish from producing more offspring. When natural populations sustain themselves without stocking we will be able to declare this long-term, multi-agency restoration effort a success.

Clifford J retrieving gill nets on Julian's Reef. *Photo by Z. Zuckerman*