Responsibility

Lingcod stock enhancement under study as management tool in U.S. Pacific Northwest

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Seven-year research project under way

Seven-year project will investigate stock enhancement as a tool for rebuilding depleted lingcod populations in Puget Sound, Washington.

Lingcod is an important sport fish in the United States' state of Washington. Its large size and aggressive feeding behavior make it ecologically important, as well. Lingcod are susceptible to pollution, shoreline development and overfishing, but populations are rebounding.

Stock enhancement of lingcod is being studied as a potential management tool. Because lingcod adapt well to culture, live ship with minimal mortality and produce high-value fillets, they may make an excellent aquaculture species, as well.

Stock enhancement

Building on the past success of lingcod culture at the National Oceanic and Atmospheric Administration (NOAA) Manchester Research Station in Port Orchard, Washington, USA, the authors have begun a seven-year project to further investigate enhancement as a tool for rebuilding depleted lingcod stocks in Puget Sound, Washington. The February-June season cultured approximately 2,000 juvenile lingcod, short of the goal of 10,000 but enough to move forward with the planned studies outlined below.

Collaborators on the project include the Washington Department of Fish and Wildlife, Puget Sound Recreational Fisheries Enhancement Oversight Committee, Northwest Indian Fisheries Commission, Puget Sound Anglers, Washington SCUBA Alliance and University of Idaho.

Lingcod larvae

Lingcod spawn in nearshore high-relief areas, where females deposit their eggs in nests that are fertilized and guarded by males until hatch. This year, divers collected portions of approximately 30 nests. During dives, nest locations were marked, and small quantities of eggs were removed from the nests without harming the remaining eggs and brought back to the hatchery.

The lingcod larvae hatched at approximately 8 mm and began feeding within a couple of days. The larvae were reared in 2-m-diameter 10,000-l bags. The lingcod were fed a combination of enriched artemia nauplii, wild-captured zooplankton and frozen copepods. The larvae were gradually weaned onto prepared feeds 60 to 90 days post-hatch at a length of 40 to 50 mm. At this stage, they were size graded and moved from the mesocosm bags to small net pens.

This year, the Manchester Research Station increased its live feed production capacity in order to raise enough artemia nauplii as feed for approximately 29 mesocosm bags. New staff were trained on the production of juveniles using methods previously developed at the hatchery. The facility also made improvements to the dock area where the mesocosm bags are held to prevent damage by seals and sea lions, and added a computer-automated feeding system.

Cannibalism was seen in much younger and smaller fish than in previous years.

Larval challenges

Larvae face a number of challenges in the large mesocosm bags, including cannibalism, fluctuating water quality and introduced predators and parasites. This year, cannibalism was seen in much younger and smaller fish than in previous years. Cannibalism attempts caused significant mortality in larvae and juveniles because the skin and eyes of the fish were often damaged during the attacks.

Cannibalism mortality was quantified in tanks using small juveniles. Mortality was significantly greater in tanks with different-sized fish (Fig. 1). This study also suggested that cannibalistic behavior is reduced after fish are fully weaned onto pellets.

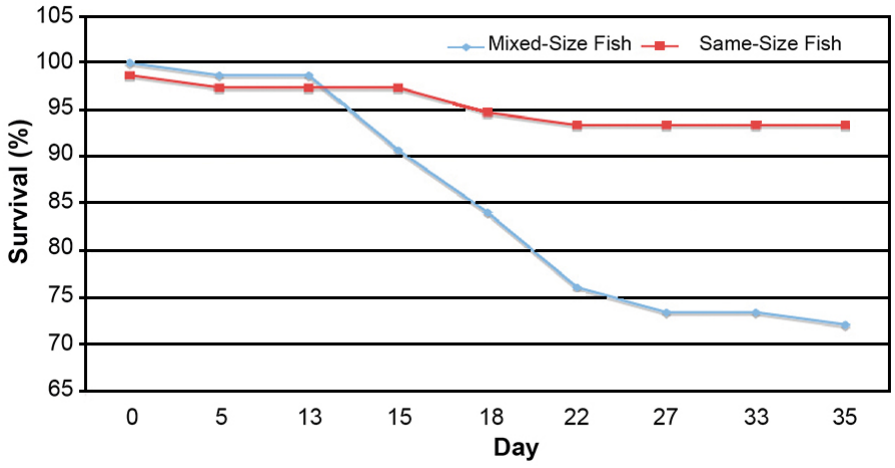

Fig. 1: Mortality in tanks with same-size fish or mixed-size fish. Cannibalism accounted for most of the mortality.

Diets and feeding

Future experiments will test if weaning fish onto artificial diets as early as possible can minimize cannibalism. Early weaning to artificial diets, however, could increase fouling with diatoms, algae, feed and feces in the culture bags, resulting in high ammonia levels and generally poor water quality. Water quality becomes less of an issue in the small-gauge nets. In 2009, the authors plan to introduce fish into nets sooner.

Artemia feeding is supplemented with wild zooplankton that include copepods, amphipods, fish eggs and invertebrate nauplii. The zooplankton are automatically collected with drum filters and distributed to the bags 24 hours a day. Although live zooplankton is the natural diet of lingcod larvae, researchers are unsure if they help or hurt lingcod survival in study.

Previous studies successfully reared larvae only on enriched artemia. Larvae may eat less enriched artemia and other feeds if they only select preferred, but limited species from the zooplankton. Also, predatory organisms such as amphipods and jellyfish, which can become numerous, can impact health and mortality during the first two months.

Predatory organisms such as amphipods can impact the health of lingcod larvae during the first two months of culture.

Tag, release studies

In 2004 and 2005, researchers evaluated tagging equipment and procedures. Fourteen hatchery-produced adult lingcod were surgically tagged with acoustic tags and released at two sites in southern Puget Sound. Stationary acoustic receivers were positioned at each reef for five months after release. Stationary hydrophones from the release sites and similar habitats in Puget Sound were retrieved during the spring of 2005.

Data showed that lingcod can be successfully tracked for significant lengths of time after release and revealed potential for future larger-scale stock-enhancement releases. Currently, NOAA is focusing in part on refining tag and release methods.

Acoustically tagged and coded-wire-tagged lingcod will be used in small-scale releases to determine the effects of releasing subyearlings versus yearlings, and releasing in nearshore versus rocky reef habitats. Data from this work will test hypotheses about habitat preferences, movement, recruitment success and ecological impacts of lingcod releases.

Lingcod larvae were reared in 10,000-l mesocosm bags.

Further development

Some goals for the near future include early weaning studies to reduce reliance on artemia (https://www.aquaculturealliance.org/advocate/artemia-the-magic-powder-fueling-a-multi-billion-dollar-industry/?__hstc=236403678.1523e7430fc3cf23c566a7eb29d59409.1681034166593.1681034166593.1681034166593.1&__hssc=236403678.1.1681034166594&__hsfp which reached $500/kg for the premium cysts required. This year, fish responded well to a fish-based flake feed produced by the Northwest Fisheries Science Center in Seattle, Washington, USA, but rigorous feeding trials are needed to determine the optimal time and conditions for weaning. Questions regarding paternal contribution to each lingcod nest will also be investigated by taking genetic samples of eggs from different locations within a single egg mass.

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