Enhancement, Early-rearing & Recirculation for Better Profits.

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A happy fisherman: KTOI Fish Hatchery Manager; John Siple holding burbot. *Photo courtesy Mathew Neufeld*

RESEARCH

Burbot – *Not just another cod*

Dedicated citizens and scientists in the United States and Canada are developing spawning and early rearing techniques to save this unique endangered freshwater fish.

BY NATHAN JENSEN AND KEN CAIN

North American burbot (*Lota lota maculosa*) populations have declined rapidly in the Kootenai(y) River and Kootenay Lake regions of Idaho, USA and British Columbia, Canada. This stock of freshwater cod has traditionally sustained valuable social, economic and sustenance fisheries for Native Americans in the region and provided sport and commercial fishing opportunities until stocks collapsed in the 1970s and 1980s. The Kootenai Tribe of Idaho (KTOI) along with the Kootenai Valley Resource Initiative (KVRI) and concerned citizens have initiated efforts to re-establish burbot in this system.

A conservation strategy was developed by the Burbot Subcommittee of KVRI and aquaculture was identified as a key component to rebuild a harvestable population. Initial experimental scale efforts were carried out at the KTOI Fish Hatchery and later expanded to the University of Idaho's Aquaculture Research Institute (ARI) in 2003. Spawning, semen cryopreservation, egg incubation and larval weaning techniques have been evaluated and continue to be optimized.

As with most species with a distinct larval stage, weaning from live prey to formulated feeds is challenging but production of feed-trained burbot has occurred annually since 2003. In addition to intensive methods, semi-intensive and extensive culture practices are being developed.

Broodstock rearing

Broodstock rearing and spawning occur in a 20,000L recycling system designed to maintain 3°C during spawning season (February-April) and 10-15°C during the off-season. Photoperiod and water temperature are adjusted to mimic the Kootenai River down to 3°C where it is held until river temperatures begin to increase. The water supply consists of 15-19°C municipal water pre-filtered with fluidized carbon, trickled through a degassing column and aerated before entering the system. Additionally, sodium thiosulfate is used to neutralize residual chlorine. Recycled water flows though two fluidized sand beds and one fluidized

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HATCHERY FEEDS

The fishery for Artemia cysts is organized with the aid of spotter planes that cruise low over the lake and alert the harvester organizations to any streaks of cysts on the lake surface. The boats deploy booms to surround and harvest the cysts, which are then pumped aboard the boats.

Utah's Great Salt Lake: a lucrative natural hatchery for Artemia harvesters

The Great Salt Lake in Utah is too salty for fish: in the southern part, salinity frequently runs at 120-170‰, and in the northern part it may go as high as 270‰. Ocean salinity by contrast is 32- 35%. But the 14,400km² lake is so rich in high quality brine shrimp (*Artemia salina*) that the cysts are harvested, dried and sold to shrimp and fish hatcheries around the world. For more than two decades, says Donald Leonard, chairman of the Great Salt Lake Brine Shrine Cooperative and president of the Utah Artemia Association, the lake has yielded *Artemia* cysts that are known in the aquaculture industry for their quality and hatching rate, and the ease with which they can be 'revived' from dry storage and the nauplii used as live feed for fish and shrimp larvae

Of the 700-1,500 tonnes of cysts produced each year, said Leonard, less than one per cent stays in North America. With the growth of the aquaculture industry in the past 25 years, especially shrimp farming in Asia, about 70% now goes to Thailand, Vietnam, Japan, India, Korea and Indonesia; 15% to Europe, and 14% or so to Central and South America.

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Reproduction and Larval Culture of Turbot in Spain

Turbot larva, 4-days post-hatch.

11 days post-hatch

17 days post-hatch

BY JOSÉ LUIS RODRIGUEZ

Marine fish culture in Galicia on the Northwest coast of Spain, has focused mainly on turbot, *Scophthalmus maximus*, although in the past few years new projects have been developed for the culture of common- and Senegalese sole (*Solea solea and S. senegalensis*).

Turbot culture began in Galicia in 1983 and increased quickly: as early as 1990 there were 16 farms in the area. However, in 1992, when more than

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Burbot – *Not just another cod* continued from cover

carbon filter before being chilled, exposed to UV, and aerated upon entering the rearing system tanks.

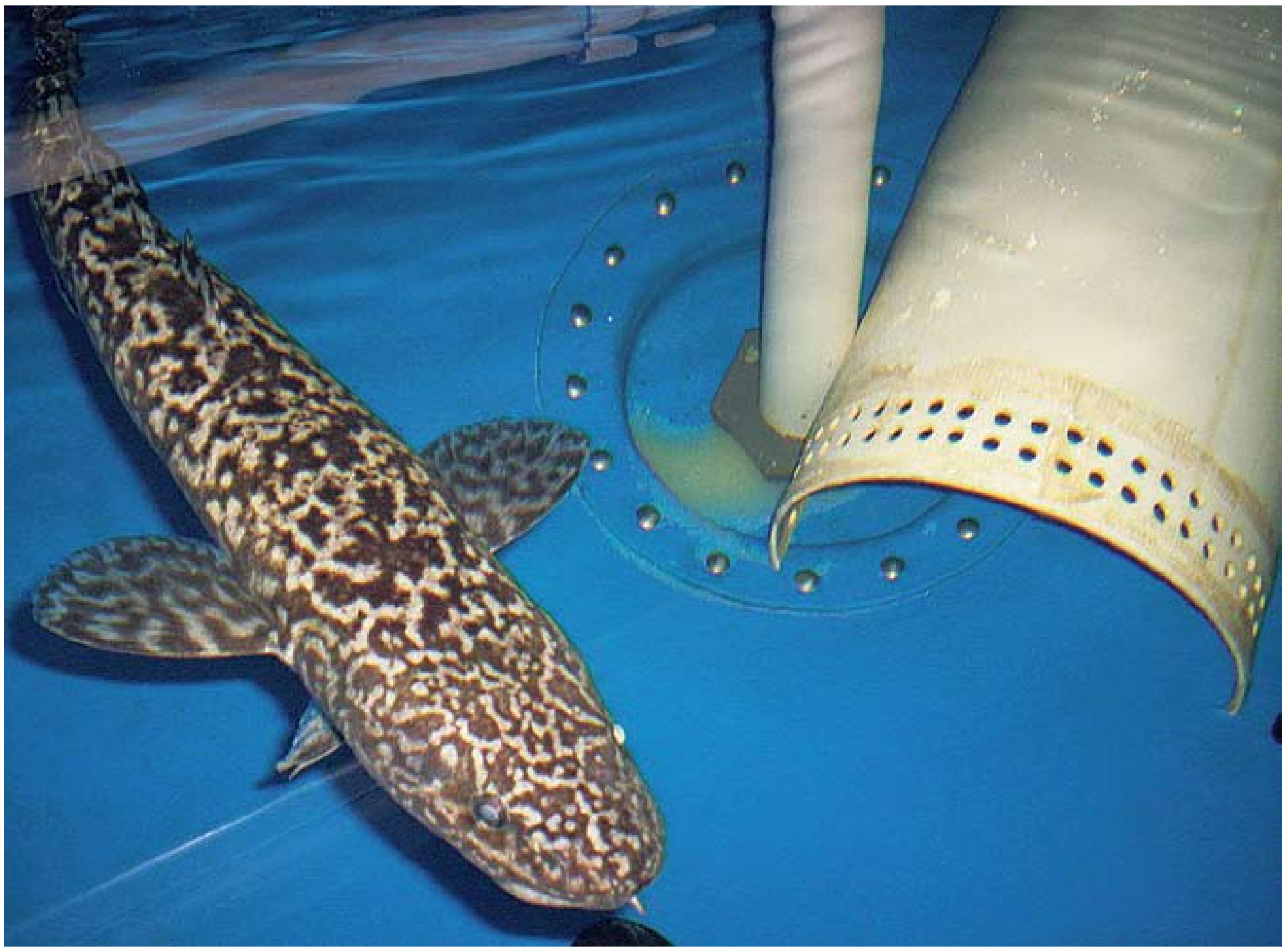
Wild caught adult broodstock (40-50; 2.5kg average body weight) are maintained in the system year-round and fed rainbow trout (*Oncorhynchus mykiss*; 10-40g average body weight). Standard veterinarian ultrasound technology is used to verify gender and monitor gonad development prior to spawning.

Spawning process

Fiberglass tanks (1300L) fitted with 500micron screened outflows are used during spawning season to prevent egg loss due to volitional (in tank) spawning. Adults are checked for ripeness weekly and spawned manually if possible. Volitionally released eggs are collected by removing adults from the rearing tanks, allowing the eggs to settle and then siphoning them out. Exogenous hormone analog and gender segregation trials have shown adults release gametes volitionally with or without hormone. Additionally, semen cryopreservation trials were performed and showed methanol concentrations in semen freezing extender of 10 or 20% increased motility and fertilization compared to 5%. These trials verified that previously reported methods with European burbot (*Lota lota lota*) work reliably with our Southern BC broodstock.

Egg incubation

Egg incubation occurs at 2-5°C by recycling water through a series of four 1HP chiller units with a maximum inflow rate of 40L/min of treated municipal supply



Burbot, with egg mass at centre of tank.

water. Water leaving the chilling system then flows through incubators and leaves the system. Incubation trials revealed that 1-2L conical incubator jars work better than 6L McDonald type jars at flows of 250-500 ml/min. Low flows are required to retain the 1mm semi-buoyant eggs within the incubators and accommodate stocking densities of approximately 300,000 eggs/L. Fungus development on eggs has been a problem and both formalin and hydrogen peroxide have been used for control. Egg masses also have been observed to become adhesive during incubation.

Hatching typically begins 35-40 days post-fertilization or 130 degree days on average. Eggs within a mass have been observed to hatch over a 40 day period at 2°C unless incubation temperatures are increased as hatching occurs. Larvae (3-4mm) hatch and collect in 250L black plastic tanks plumbed with three separate inflow lines that supply water to incubators prior to hatch.

Tank set-up with spawning adult burbot. Photo courtesy of Jimmy Barron.

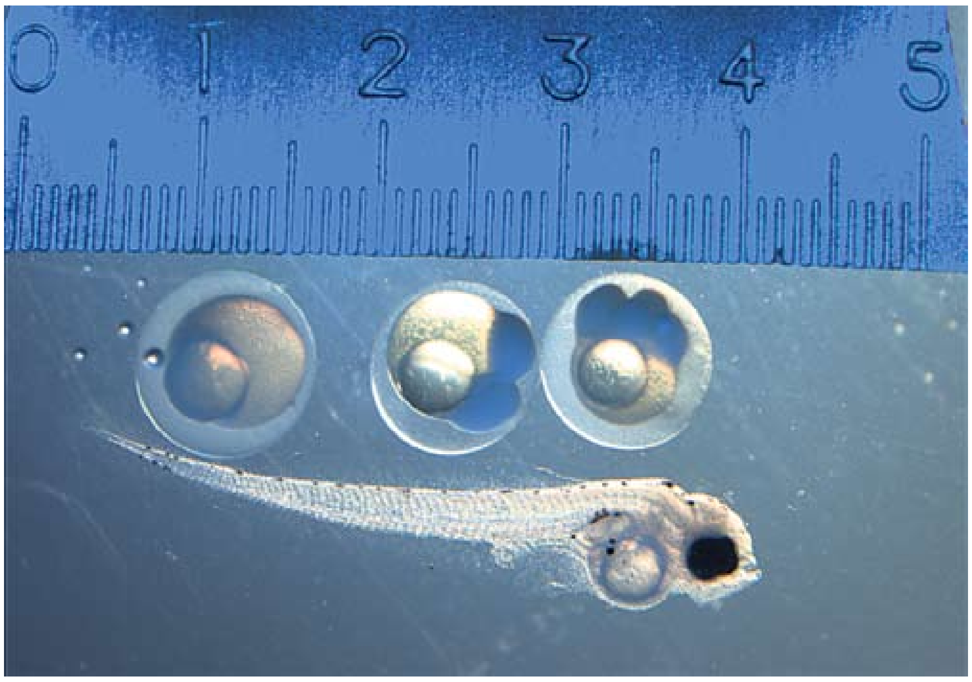
Post hatch

After hatching is complete, two inflows are used to disrupt water surface tension for swim bladder inflation and the third introduces water near the bottom of the tank. In addition, a bubble ring is plumbed at the base of the outflow screen to help disrupt surface tension, repel larvae away from the outflow and create a current for uniform feed and larvae distribution. It takes 10-20 days for larvae to develop a mouth, alimentary tract and begin exogenous feeding. A live diet is required at the onset of exogenous feeding and begins with "L-type" brackish rotifers (*Brachionus plicatilis*); followed by decapsulated "GSL" *Artemia* nauplii hatched in 5 gal water containers.

Weaning trials at the ARI showed that the earliest they could wean larvae onto a formulated diet was after 30 days on live feeds or approximately 45 days post hatch. However, prolonged *Artemia* feeding beyond 30

Dr. Cain stocking burbot brood into rearing tanks at ARI.
Photo courtesy of Nathan Jensen.

COVER FEATURE



Burbot larvae at the onset of exogenous feeding and eggs; (left to right) unfertilized, 2 and 4 cell stage. Minitool used for scale; 1mm +/-0.1mm. *Photo courtesy of Nathan Jensen.*

Collecting spawned eggs.
Photo courtesy of Jimmy Barron

Standard veterinarian ultrasound` technology is used to verify gender and monitor gonad development prior to spawning.

days resulted in greater transition success. Although these strategies have been successful, larval weaning remains the foremost bottleneck to production.

Disease challenges

In addition to the work described above the researchers recently completed studies establishing baseline disease susceptibility by challenging burbot with a wide range of pathogens. These data are crucial to satisfying requirements for eventual stocking efforts.

During 2009, temperature related growth trials will involve larvae and weaned juveniles and they will continue investigating extensive and semi-intensive rearing strategies. These efforts are part of a graduate (MS) project and ongoing collaboration between the KTOI, the University of Idaho, U.S. Fish and Wildlife Service and the Idaho Department of Fish and Game. Two man-made earthen ponds (approximately 1500m^2), located near Bonners Ferry, Idaho will be used for extensive rearing while semi-intensive rearing experiments will be conducted at the ARI using six aerated in-ground 4m diameter fiberglass tanks.

Multi-agency international agreements are in place and given that experimental release permits are obtained, researchers hope to begin tagging and releasing juvenile burbot into the Kootenai(y) system as early as this fall. In addition, established culture methods will eventually be compiled into a technical manual.

The KTOI is currently designing a new hatchery to re-establish the Kootenai(y) River burbot stock. Work described above provides a valuable foundation for conservation aquaculture regionally and elsewhere. This work also provides potential benefits for future commercial burbot production.

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