Seaweed—

A Natural Bioremediator in Finfish Aquaculture

Graduate student Jennifer Day grinds tissue samples for pigment analysis as part of Kraemer's project. Photo courtesy of Robert Forsberg

Can nori seaweed be paired up with marine fish in order to provide more environmentally-friendly and economically-sound aquaculture techniques? Researchers funded by New York and Connecticut Sea Grant programs think that this duo is a good match.

The nutrient enrichment of coastal environments has had significant negative ecological impacts including blooms of undesirable, even toxic algae and development of stressful oxygen-depleted bottom waters. One of many sources of coastal nutrient enrichment is the effluent from onshore aquaculture of marine fish. Although these facilities can provide a much needed boost to local economies, these aquaculture operations also deliver significant quantities of fertilizing nutrients into local coastal waters in flow-through systems. However, tank systems can be converted to the recirculating type if a means of removing excreted ammonium is provided. A possible method of achieving this is a polyculture system in which ammonium-absorbing seaweed tanks are inserted downstream from the fish tanks. Benefits of this integrated aquaculture system–seaweeds plus vertebrate animals–include the reduction in water-born nutrients as they are absorbed by growing seaweed and the production of marketable seaweed products. The integration of seaweed production with land-based finfish farms can be both economically and ecologically attractive.

Nori seaweed drying in the New Hampshire lab. Photo courtesy of Christopher Neefus

To obtain information on the growth, nutrient uptake and optimal growing conditions of native northeastern seaweed, the research team of **George Kraemer** of SUNY Purchase, **Charles Yarish** of University of Connecticut and **Christopher Neefus** of University of New Hampshire, conducted lab and mesocosm studies of abundant northeastern *Porphyra* species. The team examined such factors as the effects of irradiance, temperature, and nutrient concentration on the growth, photosynthesis, and nutrient uptake of four local species of *Porphyra* in laboratory culture and in greenhouse mesocosms. The scientists also set out to determine growth and effluent removal rates of *Porphyra* in 1000-liter mesocosms as a function of nutrient concentration, flow rate, culture density, and culture method. Ultimately they hoped to provide knowledge of the best conditions for growing seaweed in a recirculating polyculture system.

The results from this project have expanded what scientists know about the relationships between nutrient availability, temperature and uptake and tissue production in *Porphyra*. The research has also identified *P. amplissima* as a very strong performer in terms of rate of tissue production and, hence bioremediation. A large-scale test run indicates that *Porphyra* can remove ammonium from fish tank effluent to allow the operation of a recirculating system in which the fish remain healthy and growing. With the continued refinement of the system (engineering, operating conditions, etc.), the team predicts this system will make more profitable and ecologically benign those marine animal aquaculture businesses sited onshore.

In fact, the scientists found that for efficient nitrogen uptake, one square meter of nori will clean the wastewater from 10 kilograms of fish—that's equivalent to 22 seeded nori nets to clean the waste of one ton of fish.

Since this NYSG project was completed, other groups have begun using nori in aquaculture research and have fostered more partnering between academia and industry.

Using this project as a springboard, **Don Cheney** of Northeastern University began to look more closely at nori in a related MIT Sea Grant funded project. According to Cheney, “Kraemer’s team proved nori’s ability to take up nutrients. We’ve taken advantage of that to learn more about nori with a goal of finding a better replacement for commercial fish meal.”

Cheney’s team has discovered that the *Porphyra* species are very rich in fatty acids as well as protein needed for fish growth, and thus could be suitable as a replacement for current fish meal, which may contain PCBs and mercury. Nori would provide the added benefit of removing toxins from the tanks.

In a related project funded in part by the USDA, Cheney’s team is eyeing the ability of various seaweed species to tolerate and remove pollutants such as PCBs and PAHs from water. Working with a fish aquaculture facility in Massachusetts, the team is going to compare seaweed growth rates with that of soybeans. Soybeans are a great source of protein, but lack the essential fatty acids that seaweed contains.

In a project that involves many Canadian governmental agencies, **Thierry Chopin** and his research partners at the University of New Brunswick are developing integrated polyculture growing mussels and *Laminaria* (kelp) in offshore salmon pens near the Bay of Fundy.

To move the new technology out of the laboratory and into the real world, demonstration integrated aquaculture/bioremediation facilities have been constructed at Great Bay Aquaculture, NH, and in Bridgeport, CT, at the regional aquaculture high school. If the use of seaweed for bioremediation catches on, it promises to enhance both the aquatic environment and healthy seafood supplies.

— Lane Smith, NYSG Research Program Coordinator and Peg Van Patten, Communications Director, CT Sea Grant and author of *Seaweeds of Long Island Sound*