



The new culture system targets a recirculating solution using heated seawater and computer controls.



Lobsters raised on cod feed had poor coloration. The addition of astaxanthine to formulated feed resulted in blue to black shells.

# Lobster Production

## Pilot Recirculation System Supports Species Development in Norway

### Summary:

A unitized intensive-culture recirculation system for raising high-value European lobsters has been developed in Norway. A pilot installation incorporates individual rearing compartments to control cannibalism, high temperature and water quality control, robotic operations, and specially formulated feed. Based on the system, construction of the first large-scale lobster factory in Europe is pending.

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The European lobster, *Homarus gammarus* L., is one of the most valued seafoods in the world, and it has a worldwide market. The lobsters are relatively easy to rear in aquaculture, and their biology is fairly well understood.

The main limitation for lobster aquaculture has been high production costs, due to the demand for 18-22° C water to get acceptable growth rates, and the need for individual rearing compartments to avoid cannibalism and uneven growth rates due to hierarchies. The lack of high-quality formulated feed has also been a limiting factor.

However, during the last decade, rising lobster prices and the development of new recirculation technology have made lobsters a more promising candidate for closed-cycle aquaculture. In addition, a new law that ensures property rights for sea-ranched lobsters has promoted an opportunity to mass-produce lobster juveniles for sea ranching.

### Kvitsøy Lobster Hatchery

The only lobster hatchery in Norway is located on the island of Kvitsøy in southwestern Norway. In 2000, a project was initiated by the company Norwegian Lobster Farm to evaluate the potential for commercial production of plate-sized lobsters of 20 cm length and 300 g weight. All trials were conducted on a rather small scale in order to reveal and solve the main biological, technical, and market bottlenecks before commercializing.

### Lobster-Rearing Technology

The ideal system for rearing lobsters individually should be relatively inexpensive to construct and operate, simple to maintain, and based on automatic feeding and self-cleaning of tanks and cages. It would also need to maintain ideal water quality conditions, enable high densities, conserve water at high temperatures, ensure good survival, and permit easy access to the livestock for inspection and feeding.

### Norwegian Lobster Farm

American researchers reported in 1995 that no successful designs included all of these features in a single design. During the last five years, however, Norwegian Lobster Farm tested and documented six different technologies for lobster culture with the aim of developing cost-effective farming solutions using recirculation of heated seawater. As a result of this work, Norwegian Lobster Farm patented farming technology that incorporates all the necessary prerequisites for successful culture into a single farming unit.

In addition, robots now supplement most of the procedures that previously were dependent on manual labor. The concept includes the use of robots for the classification of larval stages, feeding, and harvesting. Image-processing software is used to identify molts, mortality, and the time for harvesting.



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The farming concept has been successfully tested over the last nine months. The company is now commercializing the results and will soon start building the first large-scale lobster factory in Europe on the island of Kvitsøy.

### Feed Development

Norwegian Lobster Farm has also developed a formulated feed especially engineered for European lobsters (Table 1). In initial feed trials, all lobsters were fed ordinary cod feed. As a result, most lobsters had pale pigmentation due to the lack of pigment in this feed.

**Table 1. Chemical composition and nutritional content of feed (% dry matter).**

Ingredient	Percentage
Protein	54.7
Lipid	15.6
Carbohydrates	13.6
Ash	9.5
Water	6.8
Energy (MJ/kg)	21.6

It was easy to observe the changes that occurred in shell color and thickness after introducing the new lobster feed. After the first and second molting, the lobsters turned from white to blue and finally black.

Norwegian Lobster Farm has now produced the first plate-sized lobsters raised solely on a formulat-

ed diet (including the larval stages) for two years. The feed-conversion ratio was within the range of 1.00-1.14 kg feed/kg weight gain.

### Water Quality

The desirable levels of water quality for clawed lobsters are temperatures of 18-22° C, salinity of 28-35 ppt, greater than 6 mg oxygen/l, pH of 7.8-8.2, and less than 14 µg nitrogen/l as un-ionized ammonia. For short periods, lobsters tolerate considerably lower oxygen and higher ammonia concentrations than indicated as desirable.

Ammonia concentration is the most limiting parameter in recirculation systems for seawater. At Kvitsøy, the biofilter efficiently removes total ammonia nitrogen (TAN) at rates of 50-70%. In initial tests, concentrations of un-ionized ammonia in the tanks were in the 0-5 µg nitrogen/l range. Due to low biomass loading, only a minor part of the biofilter's capacity was utilized. Lobster feed is high in protein, and the ammonia excretion rates in the animals are correspondingly high. Average rates of 0.1-0.5 g TAN/kg/day have been reported for adult lobsters.