Survival of one-year-old artificially raised lobsters (Homarus gammarus) released in southern Norway

Stein Tveite and Steinar Grimsen


“Tiedemanns”, a private firm in Norway, initiated a lobster farming research programme in 1978, based on the production of larvae from wild ovigerous lobsters, and in 1982 a production plant at Kyrksætersøra with the capacity for 120000 one-year-old lobsters was completed. This site was chosen because of the availability of heated sea water from a smelter. Most of the young lobsters were released in western Norway where the natural stock is at a very low level, so that the effect of the release programme could easily be detected. It was later discovered that at least some of the hatchery-reared lobsters could readily be recognized in the commercial catch, since many of them had two pincer claws and were bluish in colour. In this article we report the results of the yearly summer release of 7500 lobsters from 1985 to 1987 in a small area near Mandal. By 1990, 50% of the catch from this area was identified as hatchery reared lobsters.

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Introduction

Although it is biologically easy to raise lobsters from wild-caught ovigerous females, it is not yet commercially viable to culture them to market size. However, release programmes of postlarvae for stock enhancement purposes have been conducted in the United States, Canada, France, and Norway, but no beneficial effect on lobster stocks has been demonstrated from any of these efforts (Van Olst et al., 1980).

An alternative approach for sea ranching and stock enhancement is to raise lobsters onshore to a size that is less susceptible to predation than the postlarvae released in earlier studies. In 1977 such a cooperative project was initiated between SINTEF (Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology) and Tiedemanns, a Norwegian industrial company.

In 1980, after experimentation with both land-based and marine aspects of lobster farming at the Flødevigen Marine Research Station, Trondheim Biological Station and at Bulandet (Fig. 1), Tiedemanns built a full-scale production unit in mid-Norway at the Holla Smelting Works, Kyrksætersøra, where an abundant supply of heated sea water is available. It was intended to rear lobsters mainly for sea ranching, and the annual production capacity of the facility was 120 000 one-year-old juveniles.

In 1989, Tiedemanns handed over the facility to the Institute of Marine Research at Bergen. By this time the thought of sea ranching had been abandoned and work had been concentrated more on stock enhancement. Under government administration it was thought that it would be easier to enforce the new fishery regulations in the release areas. In addition, techniques for transportation and release of the lobsters needed to be refined through additional research that Tiedemanns was not willing to provide.

Methods

The techniques used to produce juvenile lobsters are described in Grimsen et al. (1987) and are similar to methods described by Van Olst et al. (1980), Chang and Conklin (1983), and Beard et al. (1985). Larvae were fed live or frozen brine shrimp (Artemia salina) and juveniles were fed five times a week with brine shrimp and/or a moist pellet at a rate of 5-10% of lobster wet weight per feeding. Feed was distributed by an automatic feeding system. At a seawater temperature of 20°C, lobsters reached a size of 8-10 g in 11-12 months. The mortality

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of the postlarval lobsters was 10–15% over the rearing cycle.

In 1979–1980, when the pilot lobster culture plant was operating at Bulandet, young lobsters were released by divers directly into the sea after being transported only a very short distance. Lobsters were either released into areas fenced off by various methods or they were released in a more natural environment. The lobsters were provided with artificial shelters and were fed blue mussels. Divers made observations both at the time of release and later.

After the maximum production of yearlings was reached in 1984 at Kyrksæterøra, the following method of releasing lobsters was used for experiments conducted at Kragerø, Kvitsøy, and Mandal from 1984 through 1987. The lobsters were packed in cardboard or polystyrene boxes with saltwater-moistened wood chips cooled by frozen newspapers or freezing elements. The time from removal of the lobsters from the water for packing until the last lobster had been released in the sea was kept to less than 24 h.

Release occurred in the summer, the lobsters being released directly at the surface from transport boxes from small boats at 2–10 m depth and a density of one juvenile per 10–20 m². The lobsters were released at the most favourable sites, i.e., sandy bottom with boulders where they dig burrows, local fishermen using their knowledge of the bottom conditions (Dybern 1973). None of the lobsters was tagged. Numbers released are given in Table 1.

### Results

*Lobsters released by divers at Bulandet*

The divers observed a few sudden deaths on release, but most of the lobsters were lively and able to find shelter within a few seconds. It was soon recognized that artificial barriers to contain the lobsters were inconvenient both economically and practically.

Of 45 lobsters released in a 50 m² fibreglass fenced area, only 12 were alive after 2 months and four of those had only one claw. Thirty-six additional lobsters were released in the same area, and after 10 months 11 were recaptured, indicating that in such an area it is only possible to raise one lobster per 4–5 m². Growth rate of the lobsters was poorer in the fenced area than in the open area.

The lobsters were quite stationary after release; those confined to small areas (0.2 m²) by net cages survived for 15 months and molted, although the growth rate was low. In larger enclosures or in areas without barriers it was difficult to recapture the lobsters in significant numbers; however, lobsters recaptured or observed by divers had achieved better growth than those confined to smaller areas.

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<table>
<thead>
<tr>
<th>Year</th>
<th>Place</th>
<th>Numbers released</th>
</tr>
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<tbody>
<tr>
<td>1979–1980</td>
<td>Bulandet</td>
<td>1000</td>
</tr>
<tr>
<td>1985</td>
<td>Kvitsøy</td>
<td>20000</td>
</tr>
<tr>
<td>1985</td>
<td>Mandal</td>
<td>7650</td>
</tr>
<tr>
<td>1985</td>
<td>Kragerø</td>
<td>7850</td>
</tr>
<tr>
<td>1986</td>
<td>Kvitsøy</td>
<td>11000</td>
</tr>
<tr>
<td>1986</td>
<td>Mandal</td>
<td>7500</td>
</tr>
<tr>
<td>1987</td>
<td>Mandal</td>
<td>7500</td>
</tr>
</tbody>
</table>
Table 2. Number, sizes, and location of lobsters caught at Bulandet in 1984 and 1985.

<table>
<thead>
<tr>
<th></th>
<th>&lt;22 cm</th>
<th>22–25 cm</th>
<th>&gt;25 cm</th>
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<tbody>
<tr>
<td>1984 Within the release area</td>
<td>26</td>
<td>36</td>
<td>29</td>
</tr>
<tr>
<td>1984 Outside the release area</td>
<td>0</td>
<td>10</td>
<td>72</td>
</tr>
<tr>
<td>1985 Within the release area</td>
<td>21</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td>1985 Outside the release area</td>
<td>6</td>
<td>10</td>
<td>169</td>
</tr>
</tbody>
</table>

Figure 2. Numbers of hatchery-reared and wild lobsters in the catch of one fisherman fishing in Mandal between 1988 and 1992.
but had two distinct pincer claws; and some were light in colour but had developed a crusher claw to some extent. All of these lobsters were categorized as released lobsters. Although we do not know whether any of the lobsters developed a normal appearance after release, examination of lobsters caught in areas where there was no release programme did not reveal any animals which would have been categorized as hatchery-reared stock. The recapture figures in this report must therefore be considered minimum figures. There were no observations from the fishery indicating differences between the released lobsters and the natural population, regarding catchability or depth distribution. Berried females have been caught, and maturity seems to be achieved at same size as wild stock.

**Kragerø**

No detectable effect of the release of 7850 lobsters in the Kragerø area in 1985 has been observed. Length measurements and c.p.u.e. from the area do not show any significant changes from normal fluctuations.

**Kvitsøy**

From Kvitsøy we have only anecdotal information from the fishermen and fish dealers. On average, they estimated that more than 50% of the lobsters between 22 and 25 cm in 1989 and 1990 were hatchery-reared. The estimate varied between fishermen in accordance with whether or not their pots were placed in areas known to be a release area.

**Mandal**

In the Mandal area lobsters were released at the same localities in each of three years (1985–1987). The first recaptures occurred in small numbers in 1988 (Fig. 2). Most of these were below the minimum size of 22 cm total length (TL) (~76 mm carapace length, CL).

In 1989 and 1990, hatchery-reared lobsters were more numerous than the natural stock in some size intervals (Fig. 2). Of the total catch, 43 and 50% were hatchery-reared in 1989 and 1990.

Growth was highly variable. In 1989 the size of released lobsters ranged from 16 to 28 cm TL (50–100 mm, CL), but it was not possible to distinguish the year classes and determine growth rates. However, the curves for female lobsters, in particular (shown in Fig. 3), have “shoulders” on both sides of the main peak, indicating that the 1986 release was the most successful. Experiments comparing growth rate of laboratory-reared lobsters at constant temperature (18°C) and lobsters grown in basins and in the sea at natural temperature showed similar growth rates (Knudsen, 1987).

The 1986 release is therefore assumed to be equal in size to the 1985 year class wild lobsters, which means that female lobsters attain a size of around 23 cm TL (80 mm, CL) and male 24–25 cm TL (84–88 mm, CL) in 5 years. The peaks move 3 cm per year, exceeding the results from tagging experiments in the same area (unpubl. data). The growth period was characterized by high winter temperatures (Fig. 4).

In 1989 a fisherman fishing partly in the release area found that 16% of his catch was hatchery-reared lobsters, while a fisherman fishing completely within the release area had 43% of his catch as released lobsters. Small lobsters therefore seem to be fairly stationary, as there were no physical barriers between the two areas.

**Discussion**

Although some experiments, such as the one in Kragerø, have been complete failures, results obtained to date demonstrate that in small areas a release programme may provide more lobsters than are obtained from natural recruitment. As the lobster stock was previously much larger (Rørvik and Tveite, 1982; Tveite, 1991), there should therefore be room for increased lobster populations. One could assume that the artificial doubling of recruitment would lead to a doubling of the lobster stock; however, the fishermen in the release area at Mandal had to double their effort by prolonging the season to double the catch (Fig. 5), suggesting that the
Survival of one-year-old artificially raised lobsters

![Temperature graph](image)

**Figure 4.** Temperature (°C) at a depth of 19 m depth at Flødevigen, 1985–1991.

![Catch graph](image)

**Figure 5.** Catch in number of lobsters (N), effort in number of trap-weeks and c.p.u.e. in N/1000 trap-weeks, for one fisherman fishing within the release area near Mandal (top) and in an area, Høvåg (bottom), without a release programme. □ = N, ■ = tr. weeks, ⧫ = N/tr. weeks.

released lobsters took part in the competition for food and space along with wild lobsters and other organisms. A change from an ecosystem with a small lobster stock to one with a higher lobster density might take longer to establish than 3 years of artificially-increased recruitment.

The total number of lobsters recaptured by the fisherman in the area of release from 1988 to 1992 was 574 lobsters. This fisherman was responsible for approximately half the effort in the area, suggesting that around 1100 hatchery-reared lobsters have been recaptured of the more than 22,000 released, giving a recapture rate of about 5%.

In the future one can expect more quantitative results, as lobsters will be microtagged. Improved method of release will probably increase the survival rate (Meeren, 1991), but whether it will be economically viable is another question.

### References