

Summary

In 2002, some 440,000 tonnes of Atlantic salmon and about 77,000 tonnes of rainbow trout were harvested in Norway. In comparison with the previous year this was an increase of 8 percent for salmon and 17 percent for trout. During the first half of 2002, large numbers of harvestable fish were held in sea-cages, raising the pressure to slaughter the fish. Because of low prices, the minimum price policy, liquidity harvesting and harvesting made necessary by sexual maturation, the spring of 2002 was a difficult season for the Norwegian aquaculture industry. During the latter half of the year, the fish suffered from high temperatures and a reduction in growth in August and September, followed by compensatory growth during the final quarter of the year. Throughout the year, the Norwegian salmon and trout farming industry faced steadily tougher market competition, a consequence of exchange rate trends that by no means favoured the competitiveness of Norwegian salmon.

Once again, our experience in 2002 was that new diseases appear while “old” ones might turn up again. This is a situation which emphasises the continuous need to pay attention to measures to combat diseases and infections. The reporting situation for reportable diseases needs to be improved, and a good reporting system needs to be developed in order to provide us with a better overview of the occurrence of, and losses due to, all types of disease. The health situation in 2002 was characterised by problems of deformities, cataracts, winter sores and infectious pancreatic necrosis (IPN). There was a drop in the number of outbreaks of infectious salmon anaemia (ISA). There were also problems caused by new diseases such as parvicapsulosis, heart and skeletal muscle inflammation, and piscirickettsiosis. The salmon louse situation is under control, but is still a severe problem, with infection pressure vis-à-vis wild fish and the ever-present need for chemical delousing. The abnormally high temperatures throughout the summer resulted in major health problems in Southern Norway, both as a direct stress factor and because they produced large jellyfish blooms. Medicine consumption is still low, particularly as regards antibiotics. The use of vaccines containing oil adjuvants is currently a *sine qua non* for profitable operation. However, the side-effects of the vaccine on the fish are a source of anxiety.

Where marine species are concerned, 2002 saw a major increase in production of cod fry. A relatively small number of producers have made significant contributions to this result. The progress made in 2002 is thus less due to major new gains than to greater experience and the establishment of new facilities. We can expect to see a continued strong growth in the number of cod fry produced, a trend that will have important effects on the production of fish for consumption in a couple of years. Continued success with cod as a farmed species depends among other things on

solving problems related to deformities in fry and mortality in the early fry stages. It is also important to develop a standard for the quality and size of the produced fry.

There has also been progress in the production of halibut fry. Even with fewer producers in activity, production increased beyond the level of the previous year. Producers are still finding it difficult to utilise their full production capacity because eggs are not available in sufficient quantities throughout the year. The quality of fry is another area in which much remains to be done. A further increase in the production of fry can be expected within the next few years. The production of halibut for consumption has been held back by low fry production, variable fry quality and relatively poor growth in on-growing facilities, but is anticipated to surpass 1000 tonnes next year.

Other marine species currently being farmed commercially in Norway include turbot and spotted seacat. Interest in turbot is growing, and Norway is a net exporter of turbot fry from intensive production, as well as producing a few hundred tonnes of fish for consumption. Although we have many, often large-scale, warm-water resources in the form of waste water from industrial activity, no overall survey or goal-oriented development of these resources has been made so far. The utilisation of light and waste-water resources should enable us to produce turbot for the table that are capable of competing with southern European turbot farms.

Spotted wolffish require cold water, and are thus highly suitable for farming in Northern Norway. A fry production facility and two on-growing plants are currently in operation. More facilities are being planned, and this winter a company is due to start trials of spotted wolffish in sea-cages. The biological and production bottlenecks in wolffish production seem to have been solved, although of course there is still room for improvement in most aspects of production optimisation.

Other interesting species for marine aquaculture include lobster and labrids. Lobsters are currently in growing demand and are among the most expensive seafood products. Lobster farming is thus becoming more and more likely, and recent developments in biology, technology, feed, legal aspects, price and markets mean that land-based lobster production enjoys good conditions for commercialisation and good chances of success. Used in the right way, labrids are the most profitable and environmentally friendly alternative method of continuous control of salmon lice in salmon and trout farming. Labrid availability is currently dependent on catches at sea. The availability of the most widely utilised species is limited, and the development of labrid farming would thus be an alternative.

Mussel production has displayed a positive tendency during the past two years, and is currently well on the way to becoming a considerable industry in Norway. The good development in the mussel farming industry is largely a result of the increased efforts that have been put into solving the problem of toxic algae, as well as of more realistic expectations within the industry. Reciprocal influences between the environment and the design of mussel farms are also of great importance for good production results. King scallop and oyster production has encountered a number of problems which will have to be solved before these species can be produced in volumes similar to mussels. The indications are that this will happen, but progress depends on the priorities of the industry itself and the availability of resources for research and development.

The state of health in cod and halibut farming was generally good last year, particularly as regards infectious diseases. However, the industry suffered losses due to high seawater temperatures and water-quality problems related to certain types of operation. Environmentally related stress weakens the resistance of the fish to infectious agents, which increases the risk of infection.

The EU's Water Quality Directive comes into force in 2006 and this will help to ensure that the aquaculture industry benefits from good environmental conditions. The Directive is based on ecologically based environmental goals for all bodies of water, as well as regular monitoring of their ecological status. Ecological status is determined on the basis of the state of the biological components of ecosystems. This fits well in with the environmental monitoring programme that was proposed last autumn as part of a new system for regulating the production of Norwegian fish farms. This report offers a summary of this study, which supports a continuation of the limitations in quantity produced per locality and permit, in addition to routine monitoring of the environmental condition of aquaculture installations.

In order to further develop sea ranching of scallops and lobsters we need better knowledge of the genetic structure of wild stocks and the carrying capacity of localities, while strategies based on preventive health care should also be established in order to prevent fish farming activities from producing unexpected negative effects on wild populations and the spread of pathogens and parasites into the natural environment.

A more knowledge-based management of the aquaculture industry is currently in the planning phase. This will open up the possibility of more flexible localisation of fish farms, and the Institute of Marine Research is therefore working on a methodology, which can be used to regulate the effects of fish farms according to local carrying capacity. This will enable us to exploit the areas that are available for aquaculture by concentrating production in them, while sensitive areas remain under protection. We can also take into consideration several other aspects such as the spread of infection, eutrophication, and the sea-cage environment. Information of this sort is important for coastal-zone

planning, and the report describes how geographical information systems (GIS) can be utilised to identify areas suitable for aquaculture, with low levels of conflicting usage. The Aquaculture Report also presents a technique that can be used to evaluate the environmental costs of fish farming vis-à-vis the importance of this sector for the industry. This is called life-cycle analysis, and the report offers a Finnish example of such an analysis.

It is important to be able to document that Norwegian seafood is safe and that it has been adequately checked for the absence of toxins, bacteria and parasites. The Aquaculture Report provides an overview of current regulations and monitoring systems, which demonstrates that products meet the strict requirements that are in force. It also takes up the importance of good hygiene, and points out that there is still room for improvement in this area.

Efforts in preventive health care have led to a significant reduction in the use of medication in the aquaculture industry. Comprehensive research programmes have given us effective medicines for each species of fish, and the knowledge to use them appropriately. There are also alternative methods such as cleaner fish (wrasse), which are widely used to combat salmon lice. We also know a great deal about the environmental effects of the medicines that are in use, but in certain important areas we still lack standardised methods for testing the characteristics that are important in evaluating their effects on the environment.

The aquaculture industry is responsible for significant releases of copper from substances that are used to prevent algal fouling of the net pen. An alternative to impregnation is to change the nets at frequent intervals and allow them to dry out before they are returned to the sea, so that the growth organisms die off. This is currently being tried out on a commercial scale, and the results show that nets can be kept clean without the use of antifouling agents.

Consumer interest in the living conditions of farmed fish is growing, particularly in the EU and the USA, but also in Norway itself. A recent Parliamentary White Paper on animal welfare warns of stricter demands to be made of industry and the public sector. The aquaculture industry faces several problems related to fish welfare, and the Institute of Marine Research has therefore prioritised this area in its strategic plan, and has built up a number of special laboratories in which research can be done on behaviour, stress, pain and sensory physiology, and growth biology. In "The sea-cage environment laboratory" at Matre Aquaculture Research Station, which is the latest addition to this methodology apparatus, the behaviour and physiology of individuals and groups of fish can be studied in a highly monitored environment.

Aquaculture activities are capable of affecting wild populations in a variety of ways: via the spread of diseases and parasites and by fish escaping into the natural environment. While the number of escaped salmon has probably been falling for several years, there are definite indications that relatively many salmon escaped in 2002.

Catches of escaped rainbow trout have been rising for several years, in step with increasing production. A large proportion of the catches of escaped fish are made in the sea. This suggests that fishing for escaped fish in the open sea may be capable of reducing this problem to a certain extent, at least as far as rainbow trout are concerned, since these fish are more stationary after escaping than salmon.

Large numbers of escaped rainbow trout and salmon in the emigration route for wild smolt are a source of anxiety, in view of the potential of the escaped fish to act as a host for salmon lice. High numbers of escaped fish could negate the positive tendency we have observed during the past few years, with a lower incidence of salmon lice being found on emigrating wild salmon smolt. The situation as regards sea trout strains that remain in outer fjord regions with high incidences of salmon lice is more worrying.

Two problems in particular have been discussed in connection with potential genetic effects of escaped salmon: loss of genetic variation through domestication, and the effects on the natural characteristics and survivability of wild salmon. A comparison of the five most important lines of cultivated fish with wild salmon from four rivers, carried out by the Institute of Marine Research, showed that the cultivated salmon had a significantly narrower range of genetic variation than was observed in the wild stocks. The study also confirmed that the breeding lines are isolated units. Studies carried out by the Norwegian Institute for Nature Research and other institutions have also demonstrated that farmed salmon differ from wild salmon in such complex characteristics as growth, aggression and anti-predator behaviour. These complex characteristics are features that are known to affect survival in the wild. However, it has been demonstrated that spawning success in escaped salmon is often low, and that the survival rates of the offspring of escaped salmon are lower than those of wild salmon. This suggests that genetic transfer from escaped

salmon to their wild cousins has happened more slowly than was previously assumed. However, once crosses do occur, there can be major effects on stocks of wild salmon, in the form of reduced survival rates. The results indicate that we still have many intact populations of wild salmon, but that there is good reason to intensify efforts to reduce escapes from Norwegian fish farms.

Genetic engineering has several applications in aquaculture, including the development of vaccines and improved diagnosis of disease. The genetic modification of organisms produced in aquaculture makes it possible to improve their production characteristics, but such techniques are associated with several potential controversies related to escapes and their potential for affecting the ecosystem, problems of aesthetics and consumer attitudes to genetically modified organisms.

Norway has a unique coastline which offers undreamt of potential for aquaculture. Expectations with regard to the aquaculture industry of the future are also great, but it is essential to realise that much remains to be done before it will be capable of replacing the offshore industry. One possible limiting factor is the effects of the industry on the environment. For this reason, we need to arrive at an agreed point of view as regards the effects that we are prepared to tolerate from a large aquaculture industry. Debate on this question has not yet really begun, and in the last part of the Aquaculture Report, therefore, we have asked for the points of view of an environmental activist, a fish farmer and a representative of the aquaculture authorities. As might be expected, the three have different perspectives and their points of view differ to some extent, but all agree on two aspects. They all believe that aquaculture has great potential, but that this potential can only be realised if all parties involved take the environmental aspects seriously and deal with them in a responsible manner.