MARINE RESEARCH NEWS

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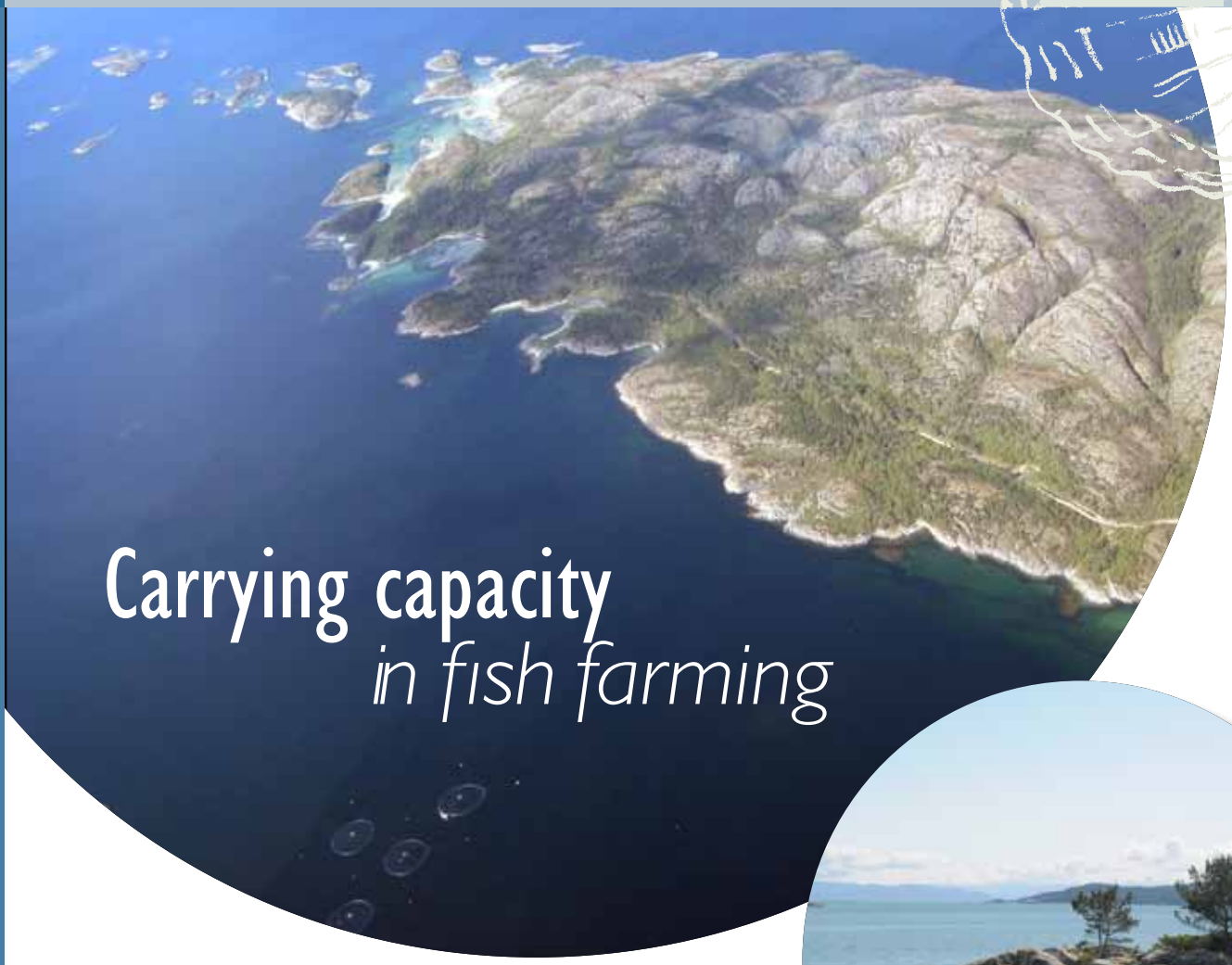
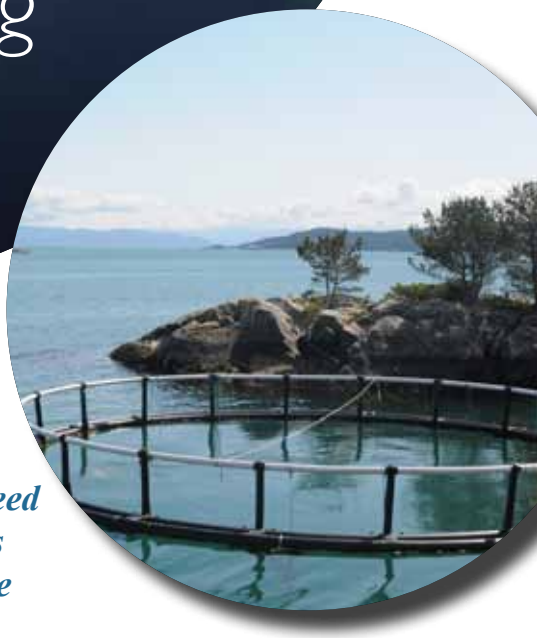


Carrying capacity *in fish farming*



We define the carrying capacity of a site or area used for aquaculture as the maximum quantity of fish or shellfish that can be farmed there without the environmental impacts exceeding agreed tolerance limits. These limits on permitted impacts must be measurable, and cannot be exceeded if the aquaculture industry is to be sustainable.

BY ARNE ERVIK AND PIA KUPKA HANSEN

Aquaculture affects the environment in a variety of ways: through the discharge of nutrients, excess feed and excrement; by spreading infections and parasites; and through genetic influences. Each of these impacts has its own tolerance limits and its own carrying capacity. This means that the individual impact resulting in the lowest carrying capacity determines the carrying capacity of the site or area. This means, that a high carrying capacity based on the discharge of excess feed and excrement is of little use if the facilities release so many larval salmon lice that wild salmon populations are endangered. Environmental impacts that can limit carrying capacity include effects on the seabed below farms, increased levels of algae, the spread of sea lice or diseases and impacts on wild fauna. In general, irreversible impacts are considered the most serious, but other factors are also taken into account, such as the size of the affected area or impacts on biodiversity.

The first Norwegian fish farms were located in shallow waters where there was little current. This limited their carrying capacity, and unsustainable amounts of excess feed and faecal matter were frequently deposited on the seabed below them, in spite of the fact that by current standards the facilities were small. As the farms moved to deeper sites with stronger currents, contamination of the seabed became less of a problem, and more

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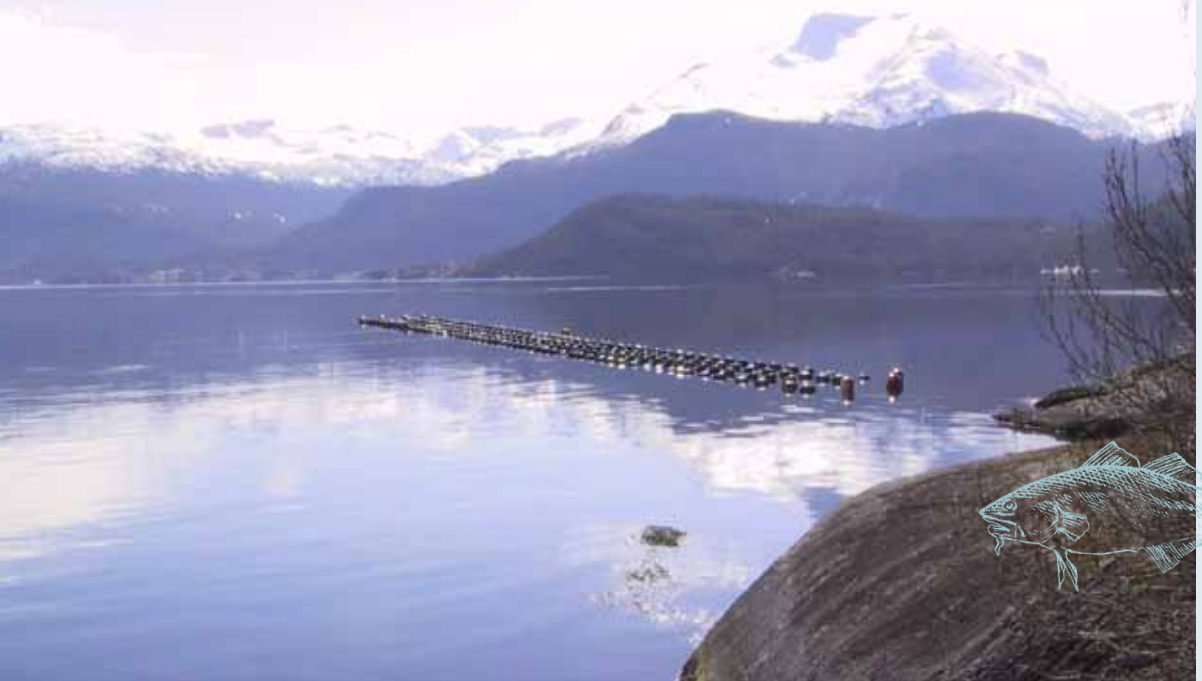
efficient production methods reduced the environmental impact per unit weight of fish produced. This was mainly due to better feed and feeding procedures, but also improved water quality in the cages on account of stronger currents, better positioning of the farms in relation to the direction of currents, and cleaner cages. Vaccines and various hygiene measures have reduced discharges of antibacterial agents to minimal levels.

However, the move towards ever bigger cages, containing large quantities of fish in a relatively small area, has brought forward the issue of seabed contamination again. A standard has therefore been produced, "Environmental monitoring of marine fish farms" (NS 9410), describing how the seabed below and around aquaculture facilities should be monitored, in order to ensure that its carrying capacity is not exceeded. The standard consists of two surveys, one for the facility itself and one for the areas around it. The B-survey is used in the area of the facility itself, where some impact on the seabed is acceptable. It consists of three groups of parameters, and is designed to assess the environmental condition of seabeds that can range from being highly contaminated to being relatively unaffected. The C-survey is an analysis of the benthic fauna community, and is designed for larger areas around fish farms. Here significant impacts are unacceptable, and the survey is sensitive enough to pick up even small changes.

If we want to effectively ensure that the environmental impacts of the aquaculture industry are adjusted to the local carrying capacity, we must be able to calculate the carrying capacity and monitor that it is not exceeded. This principle underpins the MOM system (the Norwegian acronym for "Modelling – Ongrowing fish farms – Monitoring"), but so far models and standardised monitoring programmes have only been developed for impact on the seabed. The goal is to develop equivalent management systems for the other important environmental impacts of aquaculture, and to use that knowledge to create comprehensive management systems. The Institute of Marine Research is therefore running the strategic programme CANO to develop methods for determining carrying capacities for fish farming, shellfish harvesting, and sea ranc-hing of lobster, as well as the MOLO project, which aims at creating a comprehensive system of environmental and area planning for the aquaculture industry.



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