Annual report 2005

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Norwegian Institute for Nature Research

NINA
Norwegian Institute for Nature Research

TEAMWORK

ENTHUSIASM

INTEGRITY

QUALITY

Cooperation and expertise for a sustainable future

Cooperation and expertise for a sustainable future

NINA's company values:

- Teamwork

- Enthusiasm

- Integrity

- Quality

The Norwegian Institute for Nature Research (NINA) is Norway's leading institute for applied ecological research. NINA performs short- and long-term research projects in support of local, national and international utilization and management of natural resources. The institute's highly qualified staff collaborate closely with resource users as well as research and management institutions in Norway and abroad to reach the best environmental solutions. NINA offers broad-based ecological expertise covering the genetic, population, species, ecosystem and landscape levels in terrestrial, freshwater and coastal marine environments. In addition, NINA addresses interdisciplinary issues involving both natural and social scientists.

Resource Mapping, Resource Use and Resource Management

NINA has a wide network and plays an important role in national and international research. Its experienced staff of researchers within the fields of natural and social sciences collaborate with 119 international institutions in 33 countries in Europe, Africa, Asia and the Americas.

NINA FACTS:

Staff:	158 persons
Operating income:	USD 25 million
Research facilities:	7 locations in Norway
Publications 2005:	92 scientific papers
	140 technical reports

NINA'S MAJOR SERVICES:

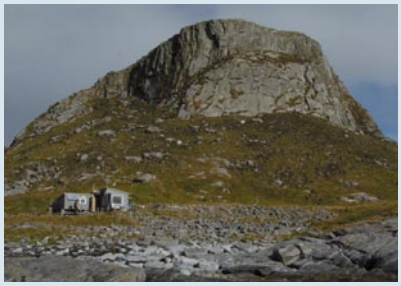
- Research
- Dissemination of scientific results
- Environmental impact assessments
- Environmental monitoring
- Status reports
- Consultancy and evaluation
- Courses and training

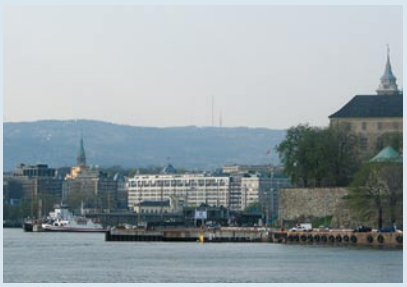
Photos: P. Jordhøy, E. B. Thorstad, K. Kringstad, T. Anker-Nilssen

NINA's expertise is directed towards basic and applied research, consultancy work, and advice to management and industry.

Selected areas related to natural resources are:

- Harvest and sustainable use of game and fish stocks
- Land use and nature management, including landscape analysis in the coastal zone and on land
- Community development and local participation in resource management
- Socio-economic issues related to subsistence, recreational and commercial use of natural resources
- Conflict resolution related to natural resource use and management
- Commercial development of biological resources
- Red-list evaluation and conservation planning
- Monitoring and time-series analysis
- Environmental databases – development, operation, use and public information
- Impact analysis and monitoring of pollution
- Environmental impact assessments





The institute have well-equipped laboratories and research facilities at seven locations in Norway. NINA offers broad-based ecological expertise covering the genetic, population, species, ecosystem and landscape level, in terrestrial, freshwater, and coastal marine environments.

Photos: J. Backer, O. T. Sandlund, T. Anker-Nilssen, K. B. Strann, B. Finstad, B. K. Dervo.

Collaborative networks

NINA has an extensive professional network in Norway and abroad:

- **ENVIRA** (The Environmental Research Alliance of Norway; www.miljoalliansen.no) consists of six institutes in addition to NINA: **NIBR** – The Norwegian Institute for Urban & Regional Research; **NIKU** – The Norwegian Institute for Cultural Heritage Research; **NILU** – The Norwegian Institute for Air Research; **NIVA** – The Norwegian Institute for Water Research; **Bioforsk** – the Norwegian Institute for Agricultural and Environmental Research; **CICERO** – Centre for International Climate and Environmental Research.
- **NODE** (www.node.org) is a multidisciplinary research and consulting consortium consisting of The Chr. Michelsen Institute (CMI) and Centre for International Environment and Development Studies (NORAGRIC), in addition to NINA.
- NINA is a partner in the **ALTER-net** (A Long-term Biodiversity, Ecosystem and Awareness Research Network; www.alter-net.info), a network of excellence consisting of 24 European research institutions in 17 countries, funded by EU's 6th framework programme.
- NINA is involved in collaborative projects and programmes with institutions in approximately ten developing countries in Central America, Africa and Asia, as well as a number of institutions in developed countries.

Coastal ecology: Ecosystem processes and human impacts

Martin-A. Svenning and Bror Jonsson

The main goal of NINAs Strategic Institute Programme "Coastal ecology; Ecosystem processes and human impact" (2001-2005) was to achieve a better understanding of how natural fluctuations and human activities influence the stability and the structure of populations and communities along the Norwegian coast. The program focused on coastal pelagic systems, the kelp belt, the tidal zone and estuaries. Three main themes were addressed: a) the importance of the kelp/seaweed belt and some consequences of its utilization, b) the importance of habitat and trophic interactions for coastal predators, and c) the importance of the coastal zone for anadromous salmonids, including possible effects of exploitation and fish farming.

The Norwegian shoreline is approximately 80 000 km long. The shallow, coastal waters cover an area of some 10 000 km^2 and are among the most productive ecosystems at this latitude, i.e., approximately 58-71 °N. A high diversity of organisms (algae and animals) live among the seaweed and kelp at densities up to 100 000 organisms m^{-2}. The seaweed belt is important as spawning and nursery areas for marine fish species, and as feeding areas for anadromous fishes such as brown trout (*Salmo trutta*) and Arctic charr (*Salvelinus alpinus*). Furthermore, many sea bird species, otters (*Lutra lutra*) and seals feed in these areas. The coastal ecosystems along the Norwegian coast thus represent unique and productive areas, with complex trophic interactions. These communities are also highly influenced by humans, through fishing, kelp trawling, fish farming, runoff from the land, long range pollution, and the activities in the petroleum industry.

Kelp trawling

By removing or reducing the kelp forests, kelp trawling influences the abundance of small fish and fish-eating seabirds such as the great cormorant (*Phalacrocorax carbo*). In the harvested areas, the density of small gadids (mainly cod, *Gadus morhua*, and saithe, *Pollachius virens*) was only 20% of the density in unaffected areas. This difference persisted for at least one year after the kelp harvest. The study also showed that the cormorants had to dive more frequently, and spend more time searching for fish, in harvested than in unharvested areas.

Photo: H. Christie.

Photo: J. O. Bustnes.

To achieve sustainable management of these areas, there is a pressing need for more ecosystem-based research.

Sea birds as indicators

In areas north of 62 °N, the breeding performance of several seabird species reflects the year-class abundance of young saithe. This response is seen several years before the trend in saithe recruitment is revealed by traditional research vessel surveys. This was demonstrated analysing 15-25 year long data series from seabird colonies along the coast of the Nordland and Trøndelag counties. In combination with climate variables in complex statistical models, the reproductive success of sea birds may be useful as a prognostic tool for fisheries management.

Along the Finnmark coast, sea bird counts from a small aircraft demonstrated that seabird density and species composition was highly correlated with physical conditions as well as human activities. Our results indicate that aerial surveys are well-suited for studying human impacts in coastal habitats.

Anadromous salmonids as indicators

The life cycle of anadromous brown trout (sea trout) has been thought to consist of a juvenile stage of one or two years spent in the home river, while older fish spend 2 - 3 months in coastal waters every summer, and the remainder of the year in freshwater. North Norwegian sea trout usually follow this pattern. In the Skagerrak region in southern Norway, however, adult trout may feed at sea all year round except for 1-2 weeks in the autumn when ascending their home river to spawn. In these southern streams, juveniles may also move to brackish water in case drought hits their nursery habitat. Trout of any age may move between the streams and the coastal areas during most months of the year except in mid winter when water temperature is below 4 °C. This means that sea trout movement between fresh and salt waters is more dynamic than previously reported. A large part of the Skagerrak trout originate from small streams, often considered insignificant and worthless for fisheries. The populations in the various streams are genetically differentiated, and the difference increases with distance between the streams.

The study of anadromous Arctic charr and brown trout in the river Halselva in Finnmark demonstrated significant correlations between growth rate, sea temperature and the duration of the period spent at sea. The two fish species utilised different depth strata in the fjord, and their diets were good indicators of the available prey in the fjord and the nearby coastal areas. This study again documented the importance of long-term data series in ecosystem research. Moreover it shows that not only sea birds, but also anadromous salmonids may be useful environmental indicators in coastal ecosystem management.

Wild salmon and aquaculture

The increased production of salmonids in sea net pens has increased the abundance of salmon lice larvae in coastal areas. Salmon lice infection is probably a major mortality agent for wild salmonid post-smolts. Studies in Romsdalsfjord and Hardangerfjord have produced new information on post-smolt behaviour in fjord systems with respect to swimming performance, residence time in the fjord, and diving behaviour. The salmon lice infection risk is greatest in the vicinity of fish farms and in areas where the smolt migration route meets the water currents from fish farms. By integrating the migratory route of post-smolts with data on water currents, temperature, salinity and salmon lice pressure, a model can be developed to ensure a more prudent localization of fish farms in order to reduce the conflict with wild salmon interests. This model may be generally applied in all fjord systems.

Through the strategic research programme on coastal ecology NINA has achieved a better understanding of how human activity influences the stability and structure of species populations and biological communities along the Norwegian coast. New methods and approaches improve our ability to predict and evaluate possible consequences of human activity at an early stage. This strengthens our capacity to work with management authorities in order to sustainably manage coastal resources and biodiversity.

Photo: J. O. Bustnes.

Landscape ecology

Thrine Moen Heggberget and Bror Jonsson

NINAs Strategic Institute Programme "Area use and landscape analysis" (2001-2005) has studied the composition and structure of landscapes as a basis for species and ecosystem processes. Main issues were ecological effects of habitat change, modelling, and the significance of the selected scale at which landscapes were studied.

Wilderness is becoming rare. There is a continuous demand for new areas for human use. Already developed or cultivated areas become more intensively utilised. New insight is required to understand the impacts of enhanced human use of nature, in order to sustainably manage nature and landscapes.

Through the present programme, NINA's capacity on landscape ecology has been enhanced both by establishing new methods and study techniques, and by allowing the scientists to improve their theoretical and practical competence on relevant issues. By doing this, NINA is able to provide better support for the management of landscapes. Below, we give some examples of results provided by the programme.

Scale and modelling

The geographic scale at which landscape ecology is studied influences interpretation of the results. Results cannot automatically be extrapolated to another scale. Thus, the relevant scale for a study must be subjected to thorough consideration. Extensive data sets for topographic, geological and biogeographic variables exist, and can be used to model the landscape. A crucial issue in landscape ecology is to decide whether or not the scales of the datasets are relevant. This should be evaluated, and, if possible, tested, before the data are incorporated in a model.

A dispersal model was developed and tested in a rural landscape, ranking landscape elements by their empirically established resistance to crossing by two particular species of butterflies, and thus calculating the length of the easiest dispersal routes between localities (ecological distance). This ecological distance model resulted in better predictions of dispersal than a straight line distance model.

Cultural versus natural landscapes

As human use of a landscape changes, the species composition of the biotic communities also changes. However, species richness does not change consistently with the degree of human exploitation of an area. This is the conclusion of a series of investigations in different anthropogenic landscapes.

Patchy landscapes extensively grazed or managed (by heath burning) contain more species of plants and beetles, but not of birds, than abandoned farmland

Photos: B. K. Dervo.

with re-established, natural coniferous forest. The diversity of plants and animals may be high in cities and urban areas with a high variety of habitat types. Remnants of natural habitats within urban areas, and unmanaged edges in agricultural areas, are important in maintaining biodiversity in such intensively used areas. These landscape elements should be preserved. Legislation and economic conditions that govern changes in agricultural practices are drivers that cause continuous changes of rural landscape elements. This concerns both technical infrastructures and species composition and abundance. At present in Norway, the diversity of species may increase temporarily in rural landscapes, during a transition phase of early regeneration stages of natural vegetation on abandoned grazing fields. A difficult issue for management authorities is how we evaluate and rank different cultural landscapes, typical of different time periods.

Investigations of human impacts on floodplain landscapes and biodiversity demonstrated that apparently moderate landscape alterations may result in major changes in some components of biodiversity. Stabilizing river banks and controlling flooding on floodplains, and various human uses of the flood-controlled areas, reduced the crustacean species diversity in the oxbow lakes and ponds compared to a control area. The species richness of water beetles, however, was similar in the impacted versus the control area.

The coast

Coastal industries are important in Norwegian economy, and they are key to future economical development. Economic development in the coastal zone may seriously impact the environment and fauna. Our research has revealed several examples. Construction of wind power plants has negative effects on sea eagles. The Eurasian otter tend to avoid roads and buildings, but is attracted to fish farms. Feral American mink, introduced as fur farm animals, has a negative effect on the nesting distribution of guillemot. Increasing numbers of spring staging pink-footed geese on coastal arable land in Central and North Norway are in conflict with farming interests. The geese are chased away from foraging areas, and reach their nesting grounds in the high Arctic in poor condition.

Small brooks along the coast are important, but extremely variable spawning and nursery habitats for anadromous brown trout. Trout populations in such habitats are frequently fragmented by barriers to migration, and locally eradicated because of draught or episodic pollution. The populations downstream from migration barriers survive by migration to brackish water or the sea during such episodes. This behavioural pattern which is particularly important for the survival and recruitment of sea trout, was previously unknown. More attention should be paid to the preservation of healthy environments in these small streams, in order to maintain the populations of the attractive trout along the coast.

Traffic on and off roads

Transport infrastructure fragments the landscape and affects nature. Animals are killed by road traffic, and the localization of roads relative to the habitat and behaviour of animals determines the outcome of this conflict. Many of the investigated vertebrate species avoided roads, and the risk of road-kill was greatest where roads crossed preferred habitats. Contrary to this, birds of the Corvidae family were attracted to roads and road-side picnic areas.

Driving with all-terrain motor vehicles (ATVs) and off-road bicycles on snow-free ground impacts vegetation and fauna. Open landscapes of wetlands, mountains and tundra are particularly vulnerable, due to a soft substrate and/or a long regeneration time. The possible ecosystem effects of off-road cyclists should be tested. Possibly, reindeer herds are significantly affected by such traffic. Driving with ATVs leaves lasting tracks in bogs which can be traced on satellite images. The diversity and abundance of plants and nesting wetland birds were reduced in bogs traversed by off-pist tracks. Strengthening the surface of soft ground and restoration of damaged vegetation had a positive effect on flora and fauna.

Photo: B. K. Dervo

Ecosystems: Structure and Function

Bror Jonsson and Nigel Yoccoz

Key issues in NINA's strategic institute programme "Ecosystem dynamics" (2001-2005) were, i.a., land use, habitat fragmentation, grazing, harvesting, introduced species, and eutrophication. Human existence depends on ecosystem services such as food, shelter and clothing, and many of our finest personal experiences are associated with natural ecosystems. However, the ability of ecosystems to provide services is often negatively affected by anthropogenic pressures such as over-exploitation, habitat destruction, introduction of exotic species, and climate change. The aim of this research programme was to focus our effort on studies of ecosystem structure and function, to further develop our capacity to advice clients with regards to ecosystem management issues.

The following presents a summary of a few selected results from the diverse projects included in this programme.

Terrestrial ecosystems

Norway has substantial areas of coastal birch forests, which are globally quite rare. Together with other countries in Northwest-Europe, we are responsible for managing and conserving these ecosystems. Over the last 50 years, significant areas of these native deciduous forests in western and northern Norway have been replaced by conifer plantations. The plantations modify soil fauna and bird communities, and may have long-lasting ecosystem effects. Furthermore, planting of exotic trees have changed coastal landscapes. For example, introduced European larches (*Larix* spp.) exhibit an ability to spread over long distances. The exotic trees have also brought new fungal species to these localities. This highlights the importance of assessing the risks and impacts of secondary spreading before new species are introduced.

Herded reindeer (*Rangifer tarandus*) may overgraze their resource base in Finnmark, a situation sustained through economic subsidies. Overgrazing is a problem in areas where the reindeer herds are large, primary production is low, and the area is vulnerable due to variable winter conditions. Grazing of sheep can also impoverish the mountain vegetation, and the plants may produce toxins for defence. The toxins decrease the edibility of the plants and reduce the grazing opportunities for wild animals such as hare, ptarmigan and lemmings. Floristic diversity and productivity, on the other hand, may increase due to the grazing effect of sheep.

Photo: B. J. Bårdsen.

Photo: J. D. C. Linnell.

Management practices have recently increased the abundance of large terrestrial predators such as brown bear, lynx and wolf, to some extent restoring previous ecosystem processes. At the same time, this has brought new challenges to the management of the ecosystems. Large predators reduce the abundance of the ungulates, and affect their behaviour, constrain their habitat use, and affect the conditions for scavengers and decomposers. Because of the increased populations of large predators, it may be necessary to reduce moose hunting, particularly in areas where the productivity is low.

Aquatic ecosystems

Eutrophication increases organic production and reduces the oxygen saturation in the deep zone of lakes, especially towards the end of the stagnation periods in early autumn and late winter. This can also increase the sedimentation rate and destroy opportunities for fish spawning on the bottom. The deep-benthic fauna of Målsjøen, one of Norway's most well-studied lakes, has been reduced during the last 30 years due to eutrophication. Chironomids are almost extinct from the profundal zone. Furthermore, Arctic charr has disappeared due to sedimentation on the spawning grounds, with reduced predation pressure on large zooplankters as a prime effect. Therefore, algae of the groups Chrysophyceae, Chlorophyceae and Dinophyceae and total algal biomass have decreased and Cryptophyceae have increased due to a cascading effect induced by increased zooplankton grazing.

Individual growth rate depends on density in fishes. Experimental evidence from Arctic charr indicates that growth rate decreases already at rather low densities, with the strongest effect on large individuals. The density-dependence is not caused by reduced food consumption, but because growth efficiency decreases owing to increased energy use. Competition with brown trout has little effect on the diet of Arctic charr. The charr feed mainly on zooplankton both in the presence and absence of trout.

Atlantic salmon spawn in rivers and number of spawning pairs influences recruitment, especially at low stock densities. Field experiments in a small river indicate that the distribution of nests is more important for the number of recruits than the actual number of nests. Highest production was achieved when the nests were well distributed in the river, probably because competition and mortality among offspring are higher when the nests are located close together. Presence of Atlantic salmon parr constrains the production of brown trout in the river when the total fish density was high, but not when it was low. Flooding and breaking-up of the ice during winter increased downstream movement and spreading the fish in the river.

Human installations such as dams, impoundments and fishways as well as harvesting and introductions of exotic species, influence biodiversity from genes to populations and communities. Species often exhibit meta-population structure with genetic exchange among stocks. Before management actions are taken, one should therefore assess effects on genetic variation in present and neighbouring populations. Large, productive populations may be important for the maintenance of genetic diversity in a region. However, it is also important to maintain smaller adjacent populations, especially when the large population is severely diminished by a human induced threat such as the lethal parasite *Gyrodactylus salaris* exterminating populations of Atlantic salmon. To maintain genetic diversity of harvested stocks, large populations can be harvested more intensely than less productive ones.

The present programme has strengthened the research for managing ecosystem services and biodiversity. Ecological competence combined with ecosystem monitoring and surveillance are crucial for the early detection of ecosystem and population changes, whether these are natural or human induced. Remedial actions and adequate monitoring must be based on specific hypotheses and management targets rooted in our knowledge of ecosystem structure and function.

Photo: K.-B. Strann.

National Park Management in Indonesia

Jørn Thomassen and Bjørn P. Kaltenborn

The main focus of the 5-year agreement on cooperation in sustainable environmental management signed by the Governments of Indonesia and Norway in 2001 was conservation of biological diversity. Two projects were initiated in the Riau province of Sumatra, one in Bukit Tigapuluh National Park (BTNP), the other in a marine and coastal ecosystem, the Barelang and Bintan islands. The purpose of the projects is to build the capacity of district authorities regarding integrated environmental planning and man-agement based on the principles in the Convention of Biological Diversity (CBD) including the ecosystem approach. NINA has been the Norwegian partner in the terrestrial project.

Bukit Tigapuluh ("The 30 hills") National Park is situated on Sumatra's eastern plains just south of the Equator. In this hilly area, ranging from 60-843 m a.s.l., we find some of the last lowland tropical rainforest left in Indonesia. Three ethnic groups inhabit the park and its sur-roundings: the Talang Mamak, the Malay and the Orang Rimba. The first two groups practice shifting cultivation and collection of non-timber forest products (NTFP) while the Orang Rimba are a nomadic people. They share a dependence on the tropical rainforest as habitat and source of food.

The traditional livelihoods and the rich and unique biological diversity face serious threats from increasing deforestation and degradation of biodiversity mainly caused by illegal logging in the buffer zone close to the NP. Other impact factors like illegal wildlife hunting, un-sustainable collection of NTFP, forest conversion and coal mining are also present.

The main objective of the project has been to address the serious threats to environment and people, and to increase the competence and awareness of key stakeholders concerning the current situation. This includes the preparation of a Strategic and Action Plan (SAP) for the NP and its buffer zone. The SAP is based on the Indonesian Biodiversity Strategic Action Plan (IBSAP) from 2003, which is the national document for implementing the CBD.

An overriding objective for the SAP is the delineation of land use cover, ownership and practices. This requires addressing three key issues: (i) mapping of land use types and their distribution, (ii) the clarification of land and resource ownership, and (iii) the accepted and legally agreed land use practices among stakeholders in the BTNP and the buffer zone areas.

The following issues are especially important for the implementation of the SAP:

- Land use and vegetation status (state classification and local classification),
- Ownership (under state regulations, regional/local and customary law) of land (forest, agricultural, fallow, etc).
- Ownership of biota (animals and plants) – any special ownership that may be present due to socio-cultural norms, local land ownership laws, and communal forests.
- Land use practices – that are accepted by state, regional/local and customary law. This is to be related to land use (types and location) in the area, including land concessions.

Parallel with the local and regional land ownership and use issues, it will be of vital importance to stop the underlying forces for illegal logging, to increase the efforts for law enforcement in connection with illegal activities in the park and the surroundings, to reshape the borders of BTNP to better fit the ecological conditions in the area, and to generate opportunities for alternative income for local people in the area.

Photos: J. Thomassen.

Impacts of MPAs on coastal fisheries in South Africa

Tor Fredrik Næsje

The project "Impact of MPAs on the conservation of fish resources for sustainable use" will improve the scientific basis for sustainable management of coastal fish stocks and multi-species fisheries, and enhance collaboration between protected area managers, fishery managers, and fishery scientists. Results from the project will improve the knowledge base for management of marine protected areas (MPAs) both in South Africa and internationally. The project is implemented through collaboration between Norwegian Institute for Nature Research, and the South African institutions Marine and Coastal Management, South African Institute for Aquatic Biodiversity, and South African National Parks.

Photo: T. F. Næsje.

South Africa's marine protected areas (MPAs) play a central role in the conservation of coastal resources. Among their many objectives is the protection of fishery resources. In the West Coast National Park in Western Cape, sun-warmed, sheltered waters of the Langebaan Lagoon provide an important environment for marine life along the otherwise cool, wave-exposed coast. The lagoon waters are productive and support important recreational and commercial fisheries, as well as the largest mariculture enterprises in South Africa.

The fish stocks of Langebaan are heavily exploited. The rapidly expending towns of Langebaan and Saldanha and an increasing tourism industry, is associated with an increasing recreational fishery. The fish stocks also sustain important subsistence fisheries. Consequently, the natural resources of Langebaan Lagoon are severely threatened, and the effectiveness of fishery regulations in protecting these resources is brought to a test. The lagoon was zoned in 1976 to include a substantial no-fishing area, which was later declared as a National Park and a RAMSAR site. It is now apparent that this MPA, where fishing is excluded, may play a vital role in sustaining stocks of important fish species.

The project consists of the following components:

Monitoring of the fishery. Fishery monitors record fish landings by shore- and boat-based fishers.

Fish biology. The breeding biology, size and age at maturity and growth rates of important species are investigated.

Fish catches. Comparative catch rates of fish are used to infer seasonal migrations, density differences between exploited and unexploited sites, and the impacts of harvesting on the fish populations.

Mortality rates. Fish are tagged with Passive Transponder Tags (PIT) *en masse* and the catches screened for tags to estimate fishing mortality rates and growth rates.

Area use by fish species. Key fish species are tagged with sonic transmitters to study their movements in relation to the MPA.

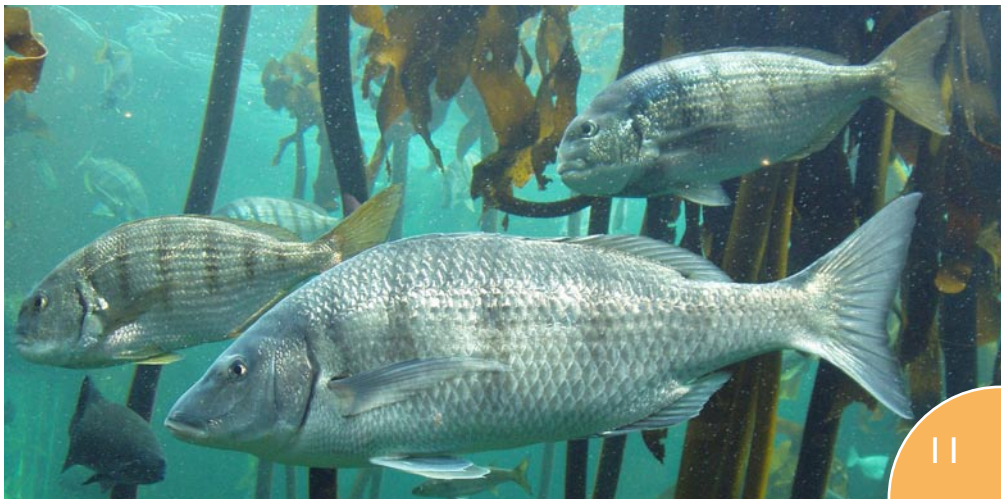
Recommendations. The results of the programme will be presented to fishery and park managers, including management recommendations.

Capacity development. Student and park staff are trained through the project. A deliberate effort is made to recruit and train previously disadvantaged groups.

Collaboration. The cooperation of four agencies in this project will facilitate future collaboration on coastal concervation and management between cientists and managers from South Africa and Norway.

The project is funded by the Progamme of Marine Fisheries Co-operation between South Africa and Norway, which is a part of the South African Department of Environmental Affairs and Tourism (DEAT) and the Norwegian Agency for Development Co-operation (NORAD).

Photo: T. F. Næsje.



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