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**Environmental performance
indicators**

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No. 43
Marine Environment**

**Environmental
Performance Indicators:
an analysis of potential
indicators for fishing
impacts.**

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for the Environment by:
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Signposts for sustainability

Title: **An Analysis of Potential Indicators for Fishing Impacts**

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Executive Summary

Fishing Impacts

Fisheries activities are widespread in the marine environment, and directly affect virtually every habitat except the deepest sea floors. These impacts include: direct harvest, by catch effects (including marine mammals and seabirds), benthic habitat disturbance, food web changes and genetic changes. Dayton et al (1995) stated that the removal of target and non target species and habitat disturbance by commercial fishing activities are probably the most important human impacts on the marine environment.

This Report

This is one of several reports analysing potential indicators for the marine environment strand of the Environmental Performance Indicators Programme. The purpose of the EPI Programme is to develop a set of national environmental indicators for State of the Environment Reporting. The Ministry for the Environment is co-ordinating the development of this programme under an April 1993 cabinet directive.

The Potential Indicators

This table summarises the main recommendations/suggestions for each of the reviewed indicators.

| Potential Indicator | Summary |
|---|--|
| 1. The extent and condition of benthic communities that are sensitive to being damaged by bottom fishing methods. | <p>A research programme by Thrush et al (1998) provides the framework within which this indicator could operate. It would be difficult to design a suite of sites, habitats and parameters that will provide effective national reporting .</p> <p>An alternative could be to monitor changes in habitat/community extent and condition, and to match these with changes to various pressures such the as method and intensity of fishing.</p> |
| 2. The biomass by trophic level inside fished and non fished areas. | The large amounts of data required by this potential indicators limits its potential usefulness. It would be necessary to scale site specific data from representative sites. |
| 3. The number of marine mammals and seabirds caught by species by fishery, by area, by year. | This is a good indicator of the pressure posed by fishing activities on marine mammals and seabirds. The information is currently collected. |
| 4. The level of fishing effort by method of area by habitat type | This is good indicator of fishing pressure on marine species and habitats. Information on fishing effort by method by areas is currently collected. |
| 5. The area of marine farms by types above selected marine habitat types | This provides a general representation of the direct pressure of marine farming on marine habitats. It does not address the effects of transporting marine farming equipment and spat. Most of the information required is currently collected. |

Purpose of This Report

This is one of several reports analysing the potential indicators for the marine environment component of the Environmental Performance Indicators Programme. The purpose of the EPI Programme is to develop a set of national environmental indicators for State of the Environment Reporting. The Ministry for the Environment is co-ordinating the development of this programme under an April 1993 cabinet directive.

Other marine environment reports address:

- Human uses and values (Robb, 1998)
- Physical and chemical processes (Robb, 1998)
- Marine biodiversity (Froude, 1998d)

The purpose of these reports is to review the potential indicators proposed by working groups that met during the first half of 1998. This review was required to address the following for each of the potential indicators:

- an explanation of the indicator
- identification of the relevant marine biodiversity issues used in the indicator development process
- relevant national policy goals
- current research, monitoring and databases
- possible methodology
- an analysis of the usefulness and practicality of the potential indicator.

Details of the indicator development process and the potential indicators for fish stocks can be found in the EPI Programme marine environment discussion document (Ministry for the Environment, 1998a). Ongoing discussions between the Ministry for the Environment and other parties led to a modified set of fishing impacts indicators being included in the discussion document.

Fishing Impacts Introduction

Fisheries activities are widespread in the marine environment, and directly affect virtually every habitat except the deepest sea floors. Even with the current legislative regime and management practices fishing activities have major impacts throughout the marine environment. These impacts include: direct harvest, bycatch effects, benthic habitat disturbance, food web changes and genetic changes.

The extraction of large numbers of wild organisms from the world's marine habitats may be the most important fishing impact (Committee on Biological Diversity in Marine Systems, 1995). Dayton et al (1995) considered that the removal of target and non-target species and habitat disturbance by commercial fishing are probably the most important human impacts on the marine environment. Studies of marine habitat trophic structure indicate that these removals do have a major effect on the composition and abundance of other species in these habitats, and on the overall functioning of marine ecosystems. For example, on the Georges Bank (USA/Canada) fishing activities have largely removed the original cod, flounder and haddock fish populations. These fish populations have been replaced by shark and ray populations. This has resulted in substantially different patterns of energy flow through the system (Barkus & Bourne, 1987).

Fishing activities also cause changes in the demography of target species. Selectively removing the largest, and therefore oldest, components of the populations can have significant effects. In the California sardine fishery, collapse occurred once the population had been reduced from 5 to 2 reproducing year classes and two consecutive years of poor environmental conditions led to spawning failure (Murphy, 1967). The extraction of long lived species has often led to a significant truncation in the age structure (Leaman, 1991).

Smith (1994) gives a number of examples where fished teleost species (bony fishes), show a decline in their age and/or size at sexual maturity including:

- In the Arcto - Norwegian stocks of Atlantic cod most fish matured at 8 to 10 years in the 1930s but by the 1970s most cod matured at six years (Borisov, 1979). This decline has been attributed to the selective removal of late maturing cod from the population.
- In Hawaii the size of the lobster *Panulirus marginatus* at the time of first egg production declined followed heavy fishing pressure on a virgin stock (Polovina, 1989). As this decline is the reverse of what naturally happens when densities are naturally low, Smith suggested that this could indicate a genetic change.
- The shrimp *Pandalus borealis* reproduces first as a male. The subsequent sex change to a female occurs once a threshold size is reached. Following a period of heavy fishing pressure the number and size of females declined. The percentage of large female shrimps declined from 44% in 1944 to 14% in 1961. While small females (same size as one-year males) were not present in 1953, they formed 21-30% of the catch in 1961 (Jensen, 1965).

Until recently the possible genetic implications of fishing were not considered by researchers or managers. This means that generally it has not been possible to determine whether observed changes in fish size and/or age of maturation are the result of genetic changes or a response to lowered densities (Smith, 1994). The New Zealand orange roughy fishery is an example of a recently exploited fish stock that has exhibited decline in genetic diversity. During the first ten years of fishing the New Zealand orange roughy fishery biomass was reduced by 60-70 %. Genetic diversity measured by gel electrophoresis showed a significant decline in three geographically isolated fishing grounds between 1982-3 and 1988 (Smith et al, 1991).

Trawls and dredges potentially impact many species that live on or near the sea floor. Fishing gear physically disturbs sea floor habitats as it is dragged across the sea floor. Direct changes can result from the crushing of individuals and/or their removal as bycatch while the partial excavation and damage of near surface dwelling organisms can attract mobile predators and scavengers (Dayton et al, 1995). The intensity of ecological impact from bottom fishing methods depends on the spatial extent and frequency of habitat disturbance. Thrush et al (1998) provided evidence of broad scale changes in benthic communities in the Hauraki Gulf that can be directly related to fishing activities.

Some benthic communities are highly vulnerable to being damaged by bottom fishing methods. These are described further under potential indicator FI 1. *The extent and condition of benthic communities that are sensitive to being damaged by bottom fishing methods.*

Goni (1998) describes how the different fishing techniques result in different types and rates of by catch. This by catch can include marine mammals, seabirds, other fish species and various benthic species. Estimates of recent marine mammal and seabird in New Zealand fisheries waters are in Baird (1997).

Goni (1998) discusses how the large scale discarding of fish and other organisms caught while fishing is a widespread feature of commercial fisheries around the world. He also discusses how the large amount of organic material that may result from the processing of fish at sea (offal) and from discards, can cause changes in the structure and diversity of marine communities, by generally favouring scavenger and decomposer species. This is in addition to the benthic animals damaged or disturbed by trawling and which in some areas, constitutes a significant food resource for opportunistic species. A study of the New Zealand Hoki fishery off the West Coast of the South Island, showed that excess organic material reaching the sea floor can have negative effects on benthic communities. Oxygen depletion to 45-55% saturation near the seabed was registered after the dumping of 47,800 tons of discards over a 60 day period (Rutherford, 1987).

Marine farming can have important impacts on coastal habitats. These impacts include extensive changes to the benthos and altered local nutrient inputs. Marine farming can reduce the genetic diversity of the species if the individuals in cultivation begin to contribute substantially to the gene pool of the wild populations (Mark, 1991). Marine farming can also subject wild populations to an increased incidence of disease resulting from the increased susceptibility of large homogeneous populations (Padhi et al,1994). The transfer of marine farming equipment and spat between marine farming sites can move indigenous and alien biota to new locations.

Review of Potential Fishing Impacts Indicators

This report reviews the following potential fishing impacts indicators:

- FI 1. The extent and condition of benthic communities that are sensitive to being damaged by bottom fishing methods
- FI 2. The biomass by trophic level inside fished and non fished areas
- FI 3. The number of marine mammals and seabirds caught by species, by fishery, area, by year
- FI 4. The level of fishing effort by method by area by habitat type
- FI 5. The area of marine farms by type above selected marine habitat types

FI 1. The extent and condition of benthic communities that are sensitive to being damaged by bottom fishing methods

Proposed state indicator, stage 2.

Explanation

There is New Zealand and overseas literature on the damaging effects of marine bottom fishing methods on sea floor habitats/benthic communities. Jones, in his 1992 review of the impacts of trawling on the New Zealand sea floor, concluded that the impacts of trawling may be greatest in deeper waters, especially on sea mounts and pinnacles. This is because of the likely slower recovery time compared to benthic communities in shallow waters. These pinnacles and sea mounts have discontinuous populations of structurally important corals with rich associated biotas. For example gorgonian coral can form stout trees up to 10 m high and black coral can probably reach 5 m (Nelson and Gordon, 1997). Nelson and Gordon report anecdotal stories of nets from initial trawls on sea mounts being filled with black coral and similar forms.

Other known highly vulnerable benthic communities include the now protected Tasman Bay bryozoan coral, the bryozoan structured reefs of Foveaux Strait, and benthic sponge and bryozoan communities between North Cape and Cape Reinga.

Thrush et al. (1998) demonstrated broad scale changes in benthic communities that could be directly attributed to fishing. Samples were collected along a gradient of fishing pressure in the Hauraki Gulf. With decreasing fishing pressure they observed increases in the:

- densities of large epifauna and echinoderms,
- numbers of long lived surface dwellers,
- total number of species and individuals, and
- Shannon Weiner diversity index.

In addition there were decreases in the: density of deposit feeders and small opportunists, and the ratio of small to large individuals of the infaunal heart urchin *Echinocardium australe*.

Habitats and parameters that could be used for this indicator are:

- sea mount communities (coral colony size/frequency)
- bryozoan beds and sponge gardens (bryozoan/sponge size and shape and abundance)
- horse mussel beds (horse mussel bed size and abundance)
- sea grass beds (sea grass patch size and frequency)
- macro algae beds on soft substrate (frequency of beds, density of macro algae)

Issues

- The mechanical disturbance of fisheries habitats that occurs with some fishing methods can adversely affect benthic communities. The Fisheries Act requires that habitat of particular significance for fisheries management should be protected.
- Benthic communities including sea mounts, volcanic vent communities, bryozoans, corals, hydroids and sponges are vulnerable to human disturbance. The mechanical disturbance of marine habitats that occurs with some activities (such as trawling, dredging, dumping; and oil, gas and mineral exploration and extraction) can substantially change the structure and composition of benthic communities.

Policy goals

- The biological diversity of the aquatic environment should be maintained (Fisheries Act,s9)
- Associated or dependent species should be maintained above a level that ensures the long term viability (Fisheries Act,s9)
- Avoid, remedy or mitigate any adverse effects of fishing on the aquatic environment (Fisheries Act,s8).
- Preserve the natural character of the coastal environment (territorial sea) (excludes fisheries)(RMA,s6a).
- Protect areas of significant indigenous vegetation and significant habitats of indigenous fauna (territorial sea, excludes fisheries,RMA,s6c).

Current monitoring and research

There are no long term monitoring studies of the effects of fishing activities on benthic communities in the New Zealand EEZ. There are however research findings and methodologies that can be used to develop this indicator.

Thrush et al. (1998) reports on the effects of fishing activities on benthic communities in the Hauraki Gulf. The basic methodology used by this team is as follows:

- the spatial extent of disturbance by bottom trawling, Danish seining and scallop dredging was estimated to provide an indication of the intensity of the fishery

- areas were ranked in terms of the potential habitat disturbance resulting from bottom fishing methods. This was based on legislation and regulations that limit the use of some methods in some locations and information from fisheries managers to identify areas with different histories of exploitation from the scallop industry.
- High-resolution side scan sonar was used to survey the sea floor to identify sites with different environmental conditions and levels of fishing activity. This was done to determine the representativeness of small scale intensive sampling.
- A remotely operated vehicle was used to conduct video transects of the sea floor at each site to assess the density of large epifauna.
- Macrofauna were sampled from the centre of each site using a variety of techniques depending on the substrate and macrofauna size class.
- Surficial sediment samples were collected from each site and analyzed for sediment grain size and chlorophyll content.
- Statistical analytical tools were used to assess the importance of fishing pressure on the macro benthic community structure. This approach eliminates all variables such as sediment grain size and relates the residual variation in the community data to fishing pressure.

There have been investigations into the impacts of bottom fishing methods on particularly sensitive benthic communities. For example, Battershill et al (1998) reported on the response of several bryozoan species to trawling. Changes in these species could be recognized as part of a monitoring programme.

A programme to investigate bottom fishing induced changes in community structure and species diversity for the benthic sponge and bryozoan communities between North Cape and Cape Reinga is due to begin in late 1998.

Methods

Thrush et al (1998) provides the basic method that can be used in developing this indicator. The detailed methodology for assessing the extent and condition of particular benthic communities will be specific to the community being monitored. A number of the methods are described in Froude (1998d) for potential marine biodiversity indicators: *MB7. The spatial extent of selected habitats/communities in relation to historic and current baselines; and MB 8. The extent and condition of benthic communities sensitive to sedimentation.*

Reporting

The unit of reporting could be the percentage of specified community types that have been subject to various levels of impact from bottom fishing methods. Reporting could be by way of pie graphs showing the relative proportions of habitat with different levels of impact from bottom fishing methods.

Commentary

The methodology used by Thrush et al (1998) provides the framework within which this indicator could operate. Methodology is available to measure some of the potential parameters. It would be difficult to design a suite of sites, habitats and parameters that will provide effective national reporting on national trends in *the extent and condition of benthic communities that are sensitive to being damaged by bottom fishing methods*.

This indicator is closely related to *MB 8 The extent and condition of benthic communities sensitive to sedimentation*. In that indicator the pressure on the benthic communities is the physical impacts caused by changes in the amount and type of sediment. In some locations both pressures (sediment changes and bottom fishing methods) may be operating and so it may be difficult to identify the specific cause of an observed change in a particular benthic community. The methodology in Thrush et al (1998) addresses the variability caused by factors unrelated to bottom fishing.

As discussed in indicator MB 8 an alternative way to address the matters covered in indicator MB8 and this indicator could be as follows:

- state indicator: the extent and condition of selected benthic communities;
- pressure indicator: changes in the amount and type of sediment in selected environments (this may initially be represented by, for example, a risk of sedimentation indicator)
- pressure indicator: *FI 4 The level of fishing effort by method, by area, by habitat type*.

This indicator does not address the historical damage to benthic communities caused by bottom fishing methods.

FI 2. The biomass by trophic level inside fished and non-fished areas

Proposed state indicator, stage 2.

Explanation

The removal, by commercial fishing, of large numbers of wild organisms from their marine habitats has a major effect on the composition and abundance of other species in these habitats and on overall ecosystem functioning (Committee on Biological Diversity in Marine Systems, 1995). This potential indicator seeks to represent the nature and extent of those changes in ecosystem functioning for the New Zealand marine environment.

Issues

- Fishing can adversely affect marine ecosystems by the selective reduction of certain species and by impacts on predator prey relationships and marine food webs. The Fisheries Act requires avoiding, remedying or mitigating any adverse effects of fishing on the aquatic environment.
- Most marine ecosystems have been modified through the harvesting of marine biota. The selective reduction of certain species and size classes has modified food webs, including the detrital components.

Policy goals

- Avoid, remedy or mitigate any adverse effect of fishing on the aquatic environment (Fisheries Act,s9).
- Associated or dependent species should be maintained above the level that ensures their long term viability (Fisheries Act,s9).
- The biodiversity of the aquatic environment should be maintained (Fisheries Act, s9)
- Develop a network of marine protected areas (E2010).
- Marine reserves are to be protected as far as possible in their natural state with marine life protected (Marine Reserves Act,s3)

Current monitoring and research

Various monitoring and research programmes address components of this potential indicator. For example there are Department of Conservation programmes associated with some no-take marine reserves (e.g. Mayor Island, Long Island) that monitor changes in the relative abundance of various edible species since the time of marine reserve establishment and, compared with equivalent fished areas. The methodology associated with these monitoring programmes is described in Froude, (1998a). Methods for estimating relative fish abundance include: counting individuals by species and size class within x metres of a swim transect; and catching, measuring and releasing individuals. The abundance of selected edible invertebrates is usually estimated by counting individuals in quadrats.

NIWA has recently begun a four year research programme to investigate biomass trends in selected species in marine reserves (no fishing); taiapure (no commercial fishing); and areas subject to all fishing methods. The selected species are: lobster, paua, kina, blue cod and butterfish. For these species size, abundance and sex ratio (for lobster, blue cod and butterfish) will be measured using standard methodology. The size and abundance measurements will be used to estimate the relative biomass for those species.

Methods

Calculations of changes in biomass for different trophic levels will require some intensive data collection at selected sites, and modeling to translate the detailed information into broader trends.

There are 2 main ways to estimate on-site biomass:

- sample and weigh the organisms of interest
- sample and measure some parameter (e.g. length) of the organisms of interest and then use a regression model to convert this measured parameter into biomass estimates.

Which ever method is used, it would be essential to identify the variance associated with the biomass estimates as this will determine how meaningful the data will be.

Reporting

The unit of reporting could be percentage biomass at each trophic level for selected habitats inside fished and non-fished areas. Data could be reported by way of bar graphs.

Commentary

Considerable work would be required before moderately accurate estimates of biomass could be made for all trophic levels in specific marine habitats. Pelagic species would be particularly difficult to work with because of their high degree of mobility.

The large amounts of data required by this potential indicator limits its potential usefulness. It may be possible to gain sufficient information from well studied ecosystems such as estuaries. For other ecosystems this would be unlikely. A possible alternative for these other ecosystems would be to monitor changes in the relative abundance of selected species inside and outside the fished and non-fished areas.

For either approach to work as a national indicator, it would be necessary to scale site specific data from representative sites.

FI 3. The number of marine mammals and seabirds caught by species, by fishery, by area, by year

Proposed pressure indicator, stage1.

Explanation

This indicator represents the direct pressure of the activity of fishing on marine mammal and seabird species.

Issues

- Fishing can adversely affect populations of protected marine wildlife through the incidental capture of marine mammals and seabirds. The Fisheries Act requires measures to be taken as necessary to avoid, remedy or mitigate any adverse effects of fishing on protected species.
- Although marine mammals and seabirds are protected in the New Zealand EEZ they continue to be damaged by human activities.

Policy goals

- Avoid, remedy or mitigate any adverse effect of fishing on the aquatic environment (Fisheries Act,s8).
- The biodiversity of the aquatic environment should be maintained (Fisheries Act,s9)
- Protect marine mammals within New Zealand's fisheries waters (Marine Mammals Protection Act).
- Protect wildlife (seabirds) throughout New Zealand's fisheries waters(Wildlife Act).

Current monitoring and research

There is a joint Department of Conservation/Ministry of Fisheries programme of about 4000 observer days per year on commercial fishing boats. The protected species bycatch observers (approximately 1000 days) target those fisheries where there is a significant take of protected marine species. During the 1998/9 year. it is intended that this will be distributed as follows:

- jack mackerel - 66 days
- squid trawl - 200 days
- squid jigged - 100 days
- orange roughy -50 days
- tuna long lining -195 days
- ling long lining - 90 days

Observers report the number of individuals for each species of marine mammal and seabird caught and the total catch of fish for the boat that the observer is on. Observers also record:

- characteristics of the fishing operations (e.g. target species, gear used)
- the behavior and number of seabirds and marine mammals around the boat
- and the number and type of marine mammal and seabirds interactions with fishing gear

The catch information is scaled up to estimate the total marine mammal and seabird by-catch for the commercial fishing fleet. The scaling is based on information provided by commercial fishers on: their methods of fishing; and for each method the amount of effort, the time of fishing and their general location when fishing.

Methods

The current monitoring programme provides the methodology for this indicator.

Reporting

Currently reporting is through scientific papers (eg Baird,1997). This provides estimates of protected species bycatch reported by species, by fishery, by area. Future reporting could also use bar graphs with annual and running five yearly totals.

Commentary

This is a stage one indicator as the information is currently being collected. This is a good indicator of the pressure posed by fishing activities on marine mammal and seabird species.

FI 4. The level of fishing effort by method by area by habitat type

Proposed pressure indicator, stage 1-2.

Explanation

This indicator identifies the fishing pressure on marine species and habitats.

Issues

- Fishing can adversely affect other marine life through the incidental harvest of non-target fish species. Associated and dependent species are required to be managed to level that will not affect their long term viability.
- Fishing can adversely affect marine ecosystems by the selective reduction of certain species and by impacts on the predator prey relationships in marine food webs. The Fisheries Act requires avoiding, remedying or mitigating any adverse effects of fishing on the marine environment.
- The mechanical disturbance of fisheries habitats that occurs with some fishing methods can adversely affect benthic communities. The Fisheries Act requires that habitat of particular significance for fisheries management should be protected.
- Fishing can adversely affect populations of protected marine wildlife through the accidental capture of marine mammals and seabirds. The Fisheries Act requires measures to be taken as necessary to avoid, remedy or mitigate any adverse effects of fishing on protected species.
- Most marine ecosystems have been modified through the harvesting of marine biota. The selective reductions of certain species and size classes has modified food webs, including detrital components.
- Benthic communities including sea mount communities, volcanic vent communities, bryozoans, corals, hydroids and sponges are vulnerable to human disturbance. The mechanical disturbance of marine habitats that occurs with some activities (such as trawling, dredging, dumping; and oil, gas and mineral exploration and extraction) can substantially change the structure and composition of benthic communities.

Policy goals

- The biodiversity of the aquatic environment should be maintained (Fisheries Act,s9).
- Associated or dependent species should be maintained above a level that ensures their long-term viability (Fisheries Act,s9).
- Avoid, remedy or mitigate any adverse effect of fishing on the aquatic environment (Fisheries Act,s8).

Current monitoring and research

Commercial fishers complete forms that specify:

- the fishery;
- the fishing methods used;
- a relevant measure of effort;
- times of fishing; and
- the area fished.

The quality of the area information varies. In some cases it is relatively specific as GPS measurements are used. In other cases location is recorded as presence within one of the approximately 40 "fisheries areas" that are used for statistical purposes.

Information is not collected on the habitat type or types.

Methods

Most of this indicator can be addressed by information that is already collected. The identification of habitat types will require further work, depending on the level of detail required. The broad identification of marine environments could be compiled relatively easily using existing maps, charts and GIS. More work will be required to identify specific habitat types. Refer to Froude (1998d) potential indicator *MB7 The spatial extent of selected habitats and communities in relation to historic and current baselines*.

Reporting

The unit of reporting could be the level of fishing effort by method by fishery by area by marine environment or habitat type. Reporting could be by way of a series of maps showing the interactions between the various elements of this indicator.

Commentary

This is a good indicator of the fishing pressure on marine species and habitats. Information on fishing effort, by method, by area is currently collected. Further work will be required to define habitat types.

FI 5. The area of marine farms by type above selected marine habitat types

Proposed pressure indicator, stage 1-2.

Explanation

This indicator represents the extent of different marine habitats directly affected by the physical and biological effects of marine farming, excluding those effects relating to the movement of biota and farming equipment. The main effects represented by this indicator are:

- altered local nutrient inputs;
- extensive changes to the benthic communities under marine farms; and
- a potential reduction in genetic diversity if the species in cultivation contributes significantly to the gene pool of nearby wild populations.

The following selected marine habitats were suggested by the marine biodiversity working group for this indicator:

- horse mussel beds
- biogenic reefs
- sea grass beds
- sand flats and mud flats
- kelp beds and rocky reefs

Issues

- The mechanical disturbance of fisheries habitats that occurs with some fishing methods can adversely affect benthic communities. The Fisheries Act requires that habitat of particular significance for fisheries management should be protected.
- Aquaculture can adversely affect natural character.
- A number of inshore marine ecosystems (especially estuaries and other sheltered waters) have been modified by sediment, contaminants and nutrients derived from human land use activities. Coastal margin development has had a major impact on some inshore marine ecosystems.

Policy goals

- Avoid, remedy or mitigate any adverse effects of activities on the environment (RMA,s5).
- Protect the natural character of the coastal environment
- Protect the integrity, functioning and resilience of the coastal environment including the natural movement of biota, natural biodiversity, productivity and biotic patterns and intrinsic values of ecosystems (NZCPS 1.1.4).

Current monitoring and research

Marine farms are licensed under both the Marine Farming Act 1971 and the Resource Management Act 1991. The former is a license for carrying out a marine farming operation, while the latter is a license to occupy space in the marine environment. The Resource Management Act 1991 coastal permit consent process is intended to address the adverse environmental effects of marine farming. The Resource Management Act 1991 processes are administered by regional councils who generally have databases of structures in the marine environment. The regional councils should also have databases of marine farms that have coastal permits but have not yet been built or are only partially built. These databases could provide information on the location, size and nature of constructed as well as approved but not yet constructed marine farms.

Information on habitat type under particular marine farms will be more difficult to compile. The original applications under the Resource Management Act 1991 for coastal permits should have included habitat information. This information could be collated by regional councils if it has not already been done so. For older marine farms marine habitat information may be less available.

Methods

A database with the size, location and type of marine farms could be maintained by regional councils as part of their monitoring responsibilities under the Resource Management Act. Where possible this database should also include the habitat type. This information can easily be obtained for marine farms that have been licensed under the Resource Management Act. For older marine farms a variety of techniques will be needed to obtain habitat information. This may include using information used to develop indicator *In MB 7 The spatial extent of selected habitats in relation to historic and current baselines*. (Refer to Froude, 1998d).

Reporting

The reporting unit could be marine farm type by size by habitat type. Reporting could be by pie graphs that show the relative amount of each marine farm type above different marine habitats.

Commentary

This potential indicator provides a general representation of the pressure posed by marine farming on marine habitats. Generally it should be relatively easy to compile the information required from existing regional council databases. Habitat information for older marine farms may be more difficult to obtain.

This indicator would however only be indicative of the direct pressure of marine farming on marine habitats. The actual pressure of any particular marine farm on its local environment would need to be assessed in each case. This indicator does not address marine farming effects on scenic values, recreational activities and other human values. It also does not address the effects of transporting marine farming equipment and spat between different locations. These effects can be highly significant, especially when alien biota is transferred to locations where it did not previously exist.

Potential indicators that will not be developed further

| Potential indicator considered | Reasons for not developing indicator |
|---|---|
| Changes in relative abundance for selected species in fished and non fished areas | The results would be site specific |
| The number of mitigation devices used (to reduce bycatch) | The types of devices for reducing bycatch are highly variable and their effectiveness depends on how they are operated |
| Numbers of observers on fishing boats | The number of observers is not directly related to the amount of bycatch |
| % EEZ where controls under the Fisheries Act exclude the use of damaging fishing methods | The intent of this indicator is incorporated within FI 1 <i>the extent and condition of benthic communities that are sensitive to being damaged by bottom fishing methods</i> |
| % estuaries and sheltered waters where marine farms affect natural character values | The pressure indicator FI 5 <i>the area of marine farms by type above selected marine habitat types</i> is proposed as an alternative because it is easier to measure and less subjective |
| The number of permits by type and area for bio-prospecting and harvesting of new marine species | This does not provide a good measure of harvesting pressure. New harvestable species will be added to the quota management system and addressed through the fish stocks indicators |
| Number of beaches where intertidal stripping of biota occurs | This is a localised problem around the main centres. It would not be a national indicator |

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