Guideline for ecological investigations of proposed marine farm areas

Marlborough Sounds

Prepared for Marlborough District Council
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Cover photographs:
left: diver descending (Malcom Francis)
centre: shell debris and starfish under a mussel farm (Rob Davidson)
right: burrowing tube anemone (*Ceriantbus* sp.)(Roger Grace)

CONTENTS

1. Introduction

This report is a guideline describing the type and quality of subtidal ecological investigation appropriate in order that a marine farm application can be assessed under the Resource Management Act 1991.

This report is intended to provide clear direction on the level of information necessary for informed decision making by the administering body. The report also provides guidelines for authors about the type of information required and issues that should be addressed.

The guideline proposes a two tier approach to the collection of environmental information. The first level is an investigative study which provides a standardised description of habitats, species and communities located under and adjacent to (up to 50 meters distant) a proposed area. The second or detailed study is flexible and either responds to findings from the investigative study or various environmental issues also outlined in this guideline.

An **Investigative Study** should collect qualitative or descriptive information about the proposed site and activity. This type of study should be the minimum requirement for any marine farm application, and can be designed to provide maximum information about a large area with minimum cost to the applicant. The information gained during this study may initiate a detailed study.

A **Detailed Study** is not always required but in some cases, will become relevant as a result of the initial investigative study. This detailed study should be considered necessary if the applicant wishes to proceed with an application when:

(a) the species, communities or habitats recorded during the investigative study are regarded as having particular ecological or scientific importance (see Table 1); and/or

(b) any of a variety of ecological issues are involved (Table 2);

(c) species in densities which are important to recreational and commercial interests;

(d) the applicant wishes to provide a more comprehensive account of an area under investigation in order that potential or actual objections to the proposed marine farm may be addressed eg. a particular species found in the area may be of recreational or commercial interest eg. scallop, oyster, horse mussel, blue cod.

A detailed study should respond to application specific details such as location, species, farm structure and environmental issues. Detailed studies which collect quantitative data from the field should always require a robust scientific design and appropriate data analysis or literature review in order that an accurate account of the issues is achieved. The detailed study would most often require greater effort than an investigative study alone and should be carefully focused.

TABLE 1: EXAMPLES OF SPECIES, COMMUNITIES AND HABITATS OF SCIENTIFIC AND ECOLOGICAL IMPORTANCE IN THE MARLBOROUGH SOUNDS AND THEIR ASSOCIATED TRIGGER LEVEL ACTIVATING A MORE DETAILED STUDY.

SPECIES	COMMON NAME	TRIGGER LEVEL	INFO. REFERENCE NO.
Callorhinchus milii	elephant fish embryo	one individual egg case seen	4, 7, 9, 10, 11
Neothyrus lenticularis	lamp shell	one individual seen	4, 7, 8, 8b, 12b
Magasella sanguinea	lamp shell	bed (>20 per m^2) in a distinct zone	2
Waltonia inconspicua	lamp shell	bed (>20 per m^2) in a distinct zone	2
Atrina zelandica	horse mussel	bed (>0.2 per m^2) in a distinct zone	3, 7, 12
Pecten novaezelandiae	scallop	bed (>0.1 per m^2) in a distinct zone	
Galeolaria hystrix	tube worm	mounds common, large or zone forming	7
Other erect bryozoans	Bryozoan 'corals'	bed (>5 % cover) in a distinct zone	6, 7, 13
Cerianthus sp.	burrowing anemone	three individuals seen	6, 7, 11
Celleporaria agglutinans	Separation Point 'coral'	bed (>5 % cover) in a distinct zone	1, 3, 4, 6, 7, 11, 13, 16
Galeopsis grandiporus	Bryozoan 'coral'	bed (>5 % cover) in a distinct zone	6, 7, 13
Uncommon sediment type	Well sorted sands/ gravels	substrate observed	
Solanderia racemosa	hydroid tree	>3 individuals seen	6
Rhodolith	calcified algae	bed (>10 % cover) in a distinct zone	3
Lenormandia chauvini	red algae	bed (>10 % cover) in a distinct zone	
Glycymeris spp.	dog cockles	bed (>10 per m^2) in a distinct zone	6
Sponge species	sponge community	bed (>0.2 per m^2) in a distinct zone	2, 7
Notoplax latalamina	chiton	one individual seen	11
Macrocystis pyrifera	bladder kelp	>5 plants seen	7

SPECIES	COMMON NAME	TRIGGER LEVEL	INFO. REFERENCE NO.
Macroalgal bed	seaweed/algae	bed (>10 % cover) in a distinct zone	
Other tube-worm beds	polychaete worms	bed (>10 % cover) in a distinct zone	
Reef	hard substrata	area >25 m^2 observed	
Community oasis	localised patch of species	>0.2 per m^2 in a distinct zone	
Salt marsh vegetation	rushes/sedges	bed (1 % cover) in a distinct zone	
Zostera novazelandica	eel grass	bed (>10 % cover) in a distinct zone	
Triostrea chilensis	dredge oyster	bed (>0.1 per m^2) in a distinct zone	
Epigonichthys hectori	lancelet	>10 individuals seen in a distinct zone	5, 15

TABLE 2: ECOLOGICAL ISSUES RELATED TO THE ESTABLISHMENT OF MARINE FARMS WHICH SHOULD BE ADDRESSED WHEN AND WHERE APPLICABLE.

Important ecological effects such as potential for impacts on habitats and/or species listed in Table 1.
Ecological implications if farmed species exotic to New Zealand (nb. genetic issues may also be important for particular species or locations).
Ecological implications if farmed species/stock is exotic to locality or biogeographic area.
Any uncertainties regarding environmental effects.
Farming methods or techniques employed for which impacts on the environment have not been documented.
Any monitoring of the impacts of a marine farming activity on the environment.
Time scale and permanence of the effects of a marine farming activity (eg. time scale for the recovery of a polluted benthos).
Measures which may be appropriate to mitigate any adverse impacts or lowering of existing ecological values.

2. Investigative Study

AIM: To provide a description of substratum and the distribution and/or abundance of conspicuous species or features of particular ecological interest in, and immediately adjacent to, a proposed marine farm area.

2.1 INSHORE BOUNDARY INVESTIGATION

For sites that are located close to shore (ie. <150 m distance from high tide), substratum and communities present along the inshore boundary and adjacent inshore coast of a marine farm should be described. This description allows habitats and communities recorded within the farm boundaries to be compared with those located in the immediate vicinity. It is recognised that impacts from particular activities may extend outside the boundaries of the farmed area.

Methods suitable for data collection from this wide ranging investigation include the use of a manta board or motorized scooter. These devices can cover large areas in a relatively short time. This inshore investigation could also be carried out by a free swimming diver. In certain instances (eg. the inshore boundary was beyond safe diver limits), this may not be practical. In this instance, additional shore profiles should be established. When this occurs, depth sounding and/or spot dives along the inshore boundary should also be collected.

Based on inshore boundary information, the investigation coordinator could:

(a) establish the extent of any hard substrata extending from the shore up to and into the proposed farm area;

(b) recognise existing distributional patterns in substrata and associated biota along the length of the proposed farm; and

(c) recognise the occurrence of any rare or patchily distributed biota.

Based on these data, shore profiles can be situated to adequately describe substratum and biotic patterns observed during this boundary investigation.

For marine farms whose inshore boundary is greater than 150 to 200 m distance from shore, a thorough investigation of the inshore boundary may not be necessary. Profiles and spot dives, where suitable, located at appropriate spacings throughout the marine farm area are suggested.

Investigations can be supplemented with depth sounding (scrolling or 3 dimensional types). Sounding can assist in locating reef structures and "foul ground" (ie. bryozoans, horse mussels). Depth sounding alone, however, do not replace the need for collection of ecological data.

2.2 SHORE PROFILE (TRANSECT)

Shore profiles should, in most cases, be orientated 90° to the shore and extend in an offshore direction from an appropriate bench mark such as low water mark.

The minimum requirements are two shore profiles or transects for any new marine farm application of two to four hectares or one shore profile for a marine farm extension (< 2 hectares). These profiles should be chosen at random, off particular coastal features or be based on echo-sounding. More profiles would be necessary for large application areas (ie. > 4 ha in area) or where the inshore boundary investigation showed considerable habitat diversity. The extent and location of profiles should be plotted in relation to the location of any proposed marine farm. This provides an accurate perspective of where the proposed farm inshore and offshore boundaries lie with respect to habitats and communities located on the sea floor. In addition, the extent of reef or other habitats extending into the proposed marine farm area should be plotted. For an offshore extension to a marine farm that is some considerable distance from shore, a single profile bisecting the extension area is suggested.

Depth (adjusted to chart datum), substratum, associated conspicuous (macroscopic) biota and features of particular ecological interest should be recorded. An example of one type of profile is depicted in Figure 1. A species list with relative abundances of conspicuous species and species of particular ecological interest should also be included in the report. Notes on their recreational or commercial importance shoul also be included. The abundance scale used may have to be tailored to the site and/or the species in question, but the scale used should always be defined in the report. A suggested abundance scale between 1 to 3 relating to:

1 = **rare** (only one or two individuals, colonies or plants observed during inshore boundary and shore profile investigations);

2 = **occasional** (seen in low abundances, often only in a particular depth zone or from a particular habitat type, never forms a zone, bed or school);

3 = **common** (seen often or in large numbers or over the entire study area, and may form a zone, bed or school eg. tube worm mounds, horse mussel bed, brachiopod bed, macroalgal forest).

Approximate densities based on numbers observed over a known distance such as the transect line using a known width (eg. 1 m) can be useful. When this method is adopted, it should be made clear that density estimations are based on this methodology.

Profiles should extend sufficient distances offshore to a point where the biological habitat (ie. depths, substratum, community) remains relatively constant. This usually occurs well offshore where substratum is often dominated by silts and clays (mud). Where practicable, transects should extend across the entire farm width. This may not always be possible as depth, current or water visibility may make this task unsafe. In these instances, the author should state reasons for the reduction in the profile length. If depths exceed those deemed to be safe by the survey coordinator grab or dredge samples could be collected. At depths where bottom time is limited, or in the case of a large marine farm area, spot dives may provide additional data (see section 2.5). In areas such as offshore headlands or in channels where currents are often relatively strong (eg. Hikapu Reach, Waitata Reach, Tory Channel), profiles should extend the entire width of the proposed marine farm as there is considerable potential for the existence of benthic communities which prefer a current swept habitat.

Profiles should be presented graphically in the report. In most studies the distance along the sea floor and the depths at varying distances are measured, allowing surface distance to be determined. Sea floor distance in reality is never a straight line due to natural features and bottom topography. Surface distances should therefore always be stated as approximate surface distance.

It should be noted that in most survey plans, all offshore distances are taken from mean high water mark, therefore the distance between mean high and low water (ie. the intertidal shore distance) should be included in profile calculations and noted in the profile figure.

An example of a shore profile is presented in Figure 1 where the intertidal shore between mean high water and mean low water is 20 m, the inshore boundary is 50 m offshore from mean high water and the proposed farm is 150 m wide. This figure displays common names for species recorded from various substrata. A separate table displaying species scientific names and relative abundances should accompany this type of figure.

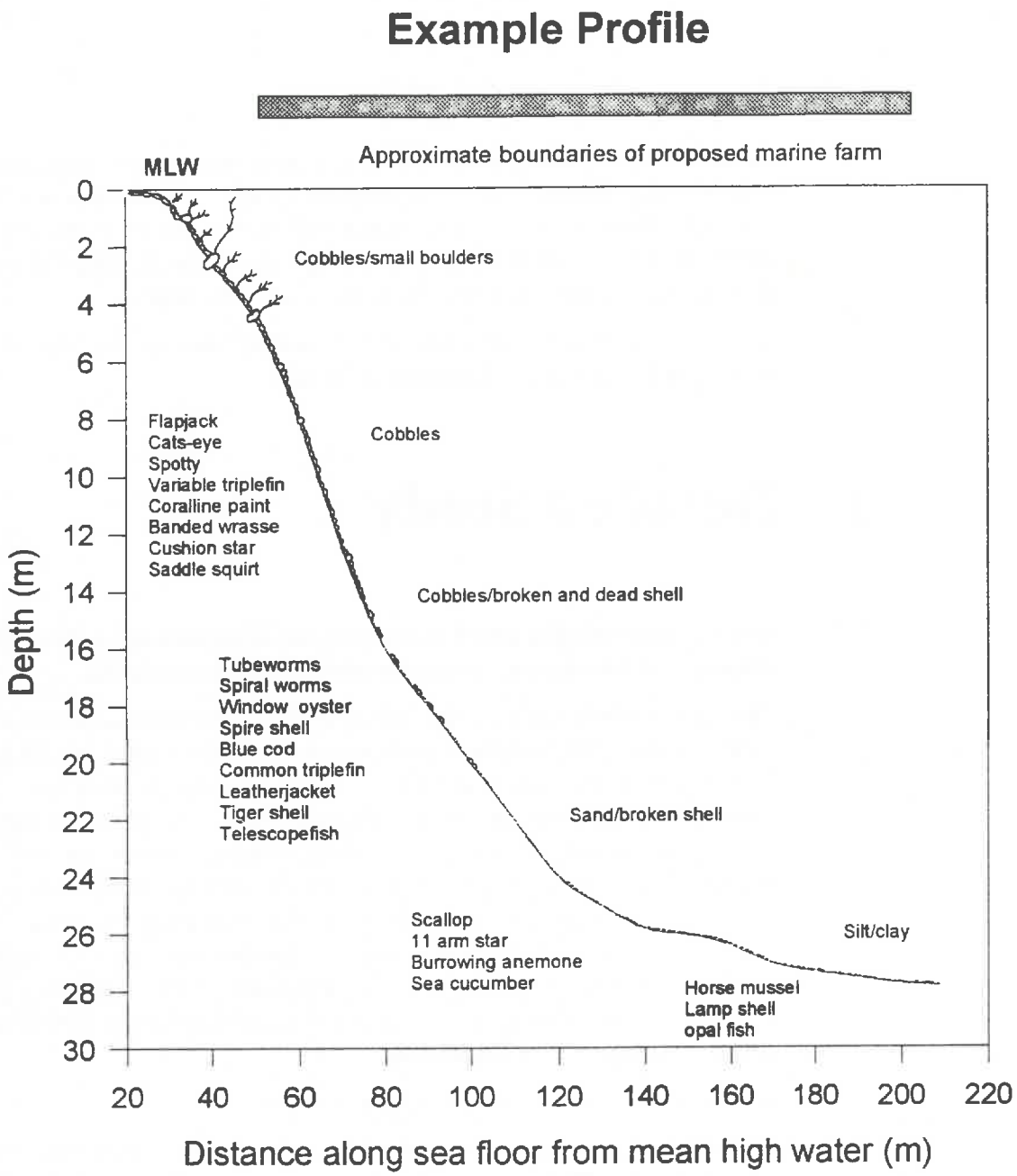
2.3 SPECIES, COMMUNITIES OR FEATURES OF ECOLOGICAL IMPORTANCE

Table 1 outlines a preliminary list of species, communities or features of particular ecological interest. The table also presents abundance or density values which should trigger a detailed study. This aspect of the investigative study is critical and should receive priority in the field work and report. The study coordinator and assistants should be familiar with these species and where they are most likely to occur.

2.4 DEPTH SOUNDING

The depth of water at each corner of a proposed marine farm should be provided. Depth readings should be collected in relation to distance from either mean high water or mean low water mark on the shore and should be stated in the report. For the purposes of assessing the suitability of any structure, the Marlborough District Council requires that the depths be adjusted to represent mean high water. For ecological purposes all depths used in the final report should be adjusted to chart datum (defined using the New Zealand nautical almanac) and should be collected from all corners and where changes in farm alignment occur (ie. inside or outside corners). This should preferably be done using radar with a variable range finder or some other position finding device (eg. hand held range finder, tape, DGPS) in order to establish the position of each point accurately. It should be noted that farm boundaries may change depending on the results from the ecological investigation making depth figures incorrect.

Figure 1 Subtidal shore profile, substrata and common names for conspicuous species recorded from a proposed marine farm site 150 m wide.



2.5 SPOT DIVES

Spot dives can be useful in gathering information on the benthos in the outer reaches of any proposed marine farm. These should be carried out when water depth or water clarity limit the extent to which profiles can be extended into the marine farm site. Information on location, substratum, depth, conspicuous species and features of particular ecological importance should be collected from any spot dives conducted.

2.6 VIDEO AND PHOTOGRAPHY

Video and still photography can be a useful interpretive tool and can be collected in a variety of ways. For example it may be used to record a feature of particular interest or to depict representative habitats or community types. Whatever the use, all photographic material should be accompanied by a full description of where they were from and what they depict.

Photographic data can also be used to collect data in the second type of ecological investigation outlined in this report.

3. Detailed Study

AIM: To provide detailed descriptive and/or quantitative information in response to particular environmental issues or concerns.

This type of study will vary depending on the environmental issues unique to each application such as site characteristics, the species involved, the particular feed involved, the potential impacts of the species or farm type, and the communities identified in the investigative study. Some of the factors that initiate and guide the design of this type of study are outlined in Table 1 and 2. In general the reason for initiating this type of study may be obvious at an early stage (eg. due to the species involved), or may only be initiated in response to findings from the investigative study. The list of important species and communities which would initiate a detailed study (Table 1), are not exhaustive, and inclusion of other species, habitats or community types should be at the discretion of the study coordinator.

Some potential case studies are included below.

EXAMPLE 1: During the investigative study, five individual burrowing tube anemones (*Cerianthus* sp.) were observed from a particular depth zone and substratum type. This was confirmed by two shore profiles, one of which was positioned in an area where these anemones were recorded. Anemones were found to only exist on silty broken shell substratum in depths of 14 to 18 m and distances of 45 to 60 m from the mean high water mark. The applicant wished to pursue the application further, so a detailed study was undertaken. Quantitative counts of anemones were collected as part of a detailed study from

ten 30 x 2 metre random quadrats stratified from only the silty broken shell substratum between 14 to 18 m depth. These data provided a density of 0.1 individuals per m^2 with a standard deviation of 0.076. Based on this information the inshore boundary of the marine farm was modified to avoid impact on the anemones.

EXAMPLE 2: Black foot paua (*Haliotis iris*) is one species included in an application. The applicant intends to establish a 3 ha area using barrel culture and artificial paua food. The impacts of this type of culture on the environment are largely unknown. Therefore an investigative and detailed study would be required. The detailed study should involve the collection of data which aims to answer concerns about the impact of this activity on the environment. Further, if there are no data on the ongoing impact of this activity, the detailed study could be designed to form the basis for any future monitoring programme. Over time sufficient information may be gathered on the environmental impacts of this type of farm under a variety of circumstances (ie. site specific) that make a detailed study unnecessary for future applications.

EXAMPLE 3: The introduced (adventive) seaweed *Undaria pinnatifida* is included in an application for a marine farm. *Undaria* occurs in the Marlborough Sounds (Picton) but its spread is undesirable. Although this species occurs in the Sounds it is exotic and therefore requires an investigative and detailed study. The detailed study would probably be both a desk top and field orientated exercise and should address issues such as: does the species already exist in the locality proposed for the marine farm, will the farm result in an increase in the spread this algae and what effect will farming of this species have on native biota. This sort of study may also require a monitoring component.

EXAMPLE 4: The impacts of a mussel spat catching or spat holding have not been studied in New Zealand and are largely unknown. A detailed study in this case may involve a desk top exercise where the author uses data on mussel farm impacts to comment on the probable impacts of a spat holding or catching site. As usual an investigative study would be required.

EXAMPLE 5: An elephant fish egg case is observed on a profile within the marine farm boundaries. A detailed study is therefore initiated (Table 1) but based on the type of marine farm proposed (ie. an algal farm), the author feels sufficiently confident to comment on the impact of this type of farm on the elephant fish spawning ground. The appropriateness and quality of this type of study would depend on the author's experience in this field, literature cited and reasons why no field work as part of the detailed study was initiated.

The present report cannot provide a definitive guide to detailed study design, analysis and interpretation. The variation of circumstances which might arise is endless and the appropriateness and adequacy of each assessment would need to be considered by the administering body on a case by case basis. It is recommended that this work not be taken lightly as there are many pitfalls in sample design. Study design will vary depending on the type of marine farming proposed, site configuration and location, natural species and communities present, their distributional patterns and the need for any ongoing monitoring. The weight placed on interpretation of results will ultimately depend on the authors credibility and experience on such matters. Citing of appropriate

literature should also be included to support claims or statements made in the detailed study.

4. Reporting

The report should follow accepted scientific protocols with concise and clearly documented material. Methods, results, and a conclusion or summary should be mandatory. All profiles and a list of conspicuous or special species (identified to the lowest taxonomic level practical) and their relative abundances should be displayed. Where quantitative data are collected, a map of key species distribution (where appropriate) and density values with associated confidence intervals (where applicable) should be presented. All raw data should also be made available.

Authors should comment on the likely impacts of the particular type of marine farm on the environment and ways of avoiding, remedying or mitigating these effects (eg. boundary modification). This becomes a main objective for detailed studies when exotic or new species or farming methods are involved. References to the literature may be a valuable source of information.

Results from the study should be put into context in terms of the Marlborough Sounds marine environment (ie. how representative are the features found at the site? how important is the site for a species or community). Examples of this type of information could be:

(a) this species/community/habitat is widespread in the sheltered waters of the Marlborough Sounds;

(b) this species has a localised distribution in the Marlborough Sounds and is only known from a few other areas;

(c) high densities of this species have been recorded from few areas in the Marlborough Sounds;

(d) this density of animals may represent a commercially viable bed;

(e) this density of animals may be of interest to recreational divers or fishers; and

(f) the site is one of the few known sites where this species spawns;

(f) important feeding area for an important species;

(g) area important in the life history of an important species; and

(h) this substrata had low species richness when compared with other habitats in the sheltered waters of the Marlborough Sounds.

This information, is very helpful during the assessment stage, but should be supported by appropriate references or only be made when the author has the appropriate background in the topic.

Figures of the location of the marine farm site, location of profiles and boundary investigation, raw data, analyses used and tables of densities should be included either in the report or as appendices.

The author or authors names should be indicated in the report and their relevant qualifications and experience should also be included as background information. The Marlborough District Council requires that the field and report coordinator have a tertiary qualification in a relevant biological science. Field and report compilation should be coordinated and undertaken by the same person unless clearly stated in the report. This situation should be avoided where possible. This information is important in establishing accuracy and a high level of credibility for the report and its findings and recommendations. References used in the report should be cited.

5. Wider Ecological Issues

This guideline acknowledges a number wider ecological issues related to marine farming where the responsibility may not necessarily lie with individual applicants but with the industry as a whole. These include:

- the cumulative effects of marine farms on the Marlborough Sounds environment, notably regional depletion of food levels important to the sustainability of natural biota of the Marlborough Sounds; and
- localised or regional lowering of water quality.

These issues are recognised here but do not lie within the scope of this report.

6. Safety

It is not the intention of this guideline to suggest activities which threaten the safety of those who undertake field surveys. Personnel and diver safety should be the utmost consideration and is the responsibility of the field work coordinator and each individual diver involved in the study. In situations where visibility, current or depth make collection of data dangerous, then alternative methods or sample occasions should be adopted.

7. Acknowledgements

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