Sugar Loaf Islands Marine Protected Area monitoring programme

Shane Kelly
Coastal and Aquatic Systems Limited
PO Box 193
Clevedon

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Summary

The Sugar Loaf Islands Marine Protected Area monitoring programme is designed to assess lobster, blue cod, and sea urchin size and abundance. Two sites will be surveyed within the fully protected fisheries conservation zone, 2 sites in the partially protected zone, and 4 control sites on the surrounding coast. The survey design aims to detect differences between the protected areas and the surrounding coastline, and to monitor changes in population parameters within each of the survey sites. However, the ability of the sampling programme to meet its objectives should be reassessed over the first 3 years of sampling. Initial sampling periods should be used to refine the strategy, and improvements should be incorporated, where necessary, to ensure that the long-term aims of the monitoring programme are achieved.

1. Background

The Sugar Loaf Islands Marine Protected Area was gazetted in 1986 in response to local community initiatives. The protected area includes two management zones:

1. The outer management zone, where commercial fishing and recreational set netting and longlining are prohibited.

2. A central fisheries conservation area, where all fishing is prohibited except for trolling and spear fishing for kingfish (*Seriola grandis*) and kahawai (*Arripis trutta*).

The impacts of 13 years of protection on organisms within the protected area are unknown. Previous monitoring has been limited to a photographic record of fixed 1 m^2 quadrats in the fisheries conservation zone starting in 1994. While this provided qualitative data on changes within the protected area, the sampling technique was not robust enough to allow a thorough assessment of changes within the marine protected area. This report outlines a new monitoring programme designed to overcome the limitations of the previous strategy.

An effective monitoring programme should be able to do the following:

1. Measure the effectiveness of environmental policies.

2. Determine the status of resources.

3. Discern changes and trends.

4. Provide an understanding of ecological patterns and processes.

5. Provide an early warning of emerging problems.
(source - Bricker & Ruggiero 1998, Stewart-Oaten 1996)

Within this context, the objectives of the Sugar Loaf Islands Marine Protected Area monitoring programme are to:

1. Detect and monitor the changes that occur between the Sugar Loaf Islands Marine Park and the surrounding coast to assess the effectiveness of the marine park as a conservation tool.

2. Determine the current population status of the species monitored.

3. Monitor changes and trends in the population characteristics of these species through time.

4. Provide a long-term data set, which shall assist in understanding the ecological processes occurring in the Taranaki coastal marine environment.

5. Monitor the state of the coastal environment around New Plymouth with the objective of detecting adverse impacts, and differentiating between impacts due to fishing activity and those due to other natural or human-induced phenomena.

6. Be compatible with regional, national or international marine protected area monitoring schemes.

2. Sample design

2.1 SURVEY DESIGN AND INTERPRETATION

In order to fully satisfy "Objective 1"(see above) the monitoring programme should allow inferences to be made about the effect of protection on organisms resident within the Sugar Loaf Islands Marine Protected Area. To do this it would have been necessary to take random, spatially and temporally replicated, samples before and after the establishment of the marine protected area. These samples should have been taken at sites within the protected zone and at replicated, unprotected control sites, i.e. a Before,After, Control, Impact, or BACI, sample design (Underwood 1991, Underwood 1992). Unfortunately, no systematic sampling programme was set up prior to the establishment of the park so a BACI survey design could not be used in the proposed monitoring programme. An alternative, though less robust, approach that is commonly employed, is to compare the size and abundance of organisms within the protected area with those at similar unprotected sites. This allows differences between locations to be detected, but attributing causality is somewhat problematic because of natural spatial and temporal variability. For example, although the monitoring programme may show that lobsters are larger and more abundant within the fisheries conservation zone than on the sur-

rounding coast, the sampling design will not allow these differences to be attributed to protection. If differences between the control and protected sites are consistent through time, temporal variability can be discounted as a potential cause for the observed patterns, but spatial variability cannot. Fortunately, it is possible to strengthen the argument that protection has contributed to the observed patterns if the results from Sugar Loaf Islands Marine Protected Area correspond to those from other marine protected areas.

2.2 SITE SELECTION

Sites should be randomly or haphazardly selected for sampling from those conforming to the following criteria:

- A maximum depth limit of 20 m should be set to ensure repetitive multi-day diving can be conducted safely and allow enough bottom time for sampling to be completed.

- All sites have to contain habitat suitable for the species being sampled, and during the initial survey the species being sampled must be present at each site. Accordingly, suitable shelters must be available at the lobster sites, while blue cod and urchin sampling should be restricted to urchin barrens.

- The unique characteristics of the Sugar Loaf Islands on the Taranaki coast means that similar control sites are not available. However, the physical and biological characteristics of control sites should be as similar to the protected sites as practicable.

It is not necessary for the same sites to be used for all species, but the number of sites should be equivalent, and once selected the same sites should be used on repeat surveys. Therefore, detailed records should be kept to ensure that each site can be accurately relocated. These records should include: marking the positions of the sites on a navigational chart; and recording depth details and GPS co-ordinates. Marking of the sites with a moored buoy is also recommended.

2.3 SELECTION OF INDICATOR SPECIES

Recent studies on marine reserves have revealed several species which are likely to be good indicators of protection effects. These include: snapper *Pagarus auratus*, blue cod *Parapercis colias*, the lobster *Jasus edwardsii*, the urchin *Evechinus chloroticus*, and a variety of reef-dwelling gastropods.

The species selected for monitoring in the Sugar Loaf Islands Marine Protected Area Monitoring Programme were:

- Blue cod (*Parapercis colias*).

- Lobsters (*Jasus edwardsii*).

- Urchins (*Evecbinus chloroticus*).

Blue cod are a relatively territorial species which have increased in mean size within the Leigh Marine Reserve (Willis & Babcock 1997), suggesting they may be useful indicators of protection effects. However, it is extremely difficult to obtain unbiased abundance estimates of mobile fish species such as blue cod. One of the more significant problems is that their behaviour can differ between locations (Willis & Babcock 1997). For instance, high counts in some areas may reflect diver-positive fish behaviour, while low counts in other areas may be due to diver-negative behaviour (Cole 1994). Care must therefore be taken in the interpretation of results, and an independent method such as catch sampling may be required to verify the results of visual censuses.

Lobsters are an ideal species to include in a marine protected area monitoring programme because of: their ecological, cultural and commercial importance; the fact that sampling is not affected by behavioural biases; they are relatively common; and they are known to respond positively to protection (Cole et al. 1990, MacDiarmid & Breen 1993, Kelly 1999).

Sublittoral urchins are easy to sample, and recent studies have indicated that they may be an indirect indicator of protection effects, with changes in their population size structure and abundance reflecting changes in the abundance of higher-level predators (Cole 1993, Keuskamp 1998).

2.4 TIMING OF SURVEYS

The exact time selected for the surveys to be conducted is not critical, and all three species need not be sampled at the same time. However, sampling of individual species must occur at a similar time of year on consecutive surveys to minimise seasonal effects. This is particularly important for lobsters which undergo seasonal changes in depth distribution (MacDiarmid 1991, Kelly 1999).

2.5 SAMPLING UNITS

The size and shape of sampling units should be appropriate for the species being sampled. From a logistic perspective the sampling unit should allow a reasonable number of samples to be taken within the allocated time in high-abundance areas, and minimise the number of zero counts in low-abundance areas. There are analytical methods for optimising sample unit size and replication level (Andrew & Mapstone 1987, Manly 1992), but the optimal sample size in one area may be inappropriate in another where densities are different, and replication level is typically limited by logistic constraints. In view of this the replication level was set based on the maximum number of samples that could realistically be taken given logistic constraints, and sampling unit was selected based on experience and a review of similar studies (MacDiarmid 1991, Cole 1993, Willis & Babcock 1997, Kelly 1999). However,

the choice of both should be reassessed after the first survey has been completed.

3. Sampling methods

3.1 LOBSTERS

Fifteen haphazardly placed 30 x 5 m transects will be censored for lobsters at each site. The starting position of each transect will be determined by the censors closing their eyes and swimming in a haphazard direction for a predetermined time (approx. 15-20 seconds). However, censors will ensure that transects do not overlap and are kept predominantly over reef. The transect will be discarded and re-run if more than 15 m of the tape goes over sand. The censors will search for lobsters out to 2.5 m down one side of the tape. They will then return, searching up the other side of the tape. Two and a half meters approximately corresponds to the extended body length including fins of a diver, but checks should be carried out to ensure that censors can estimate this distance accurately.

Within each transect the size and where possible sex of every lobster will be estimated and recorded on a slate. An underwater torch will be used to ensure all lobsters within crevices are counted, and to aid in size and sex estimation. The sex of lobsters shall be determined by the presence or absence of chelae (pincers) on the fifth walking legs (female - chelae, males - no chelae) and/or the presence of biramous (paired) or uniramous (single) pleopods (females - biramous, males - uniramous). The pleopods are leaf-like appendages, located beneath the abdomen of the lobster, which females use to hold the external egg mass during brooding. If it is not possible to determine the sex of a lobster it shall be recorded as "unknown". Size estimates of lobsters will be to the nearest 10 mm carapace length.

To check the accuracy of the censors at estimating lobster sizes it is necessary to calibrate size estimation techniques. As handling lobsters may affect their abundance during subsequent sampling, the sites used for these practice runs will be remote from those to be surveyed. During these practice sessions the size and sex of individual lobsters will be estimated, the lobsters will then be caught by hand with the aid of a lobster "lasso", and true sex and carapace length size will be determined with vernier callipers. The censors will ensure a range of lobster sizes are checked in this fashion (e.g. 50 - 180 mm carapace length) and aim to estimate the sizes of over 30 lobsters. The average absolute difference between the actual and estimated carapace length for each lobster should be <10 mm. All estimate data should be retained and presented in the monitoring programme report.

3.2 BLUE COD

Willis & Babcock (1997) found both visual surveys and baited video stations to be effective methods for censoring blue cod. Video censoring is relatively expensive to set up so density and size estimates of blue cod will be made by visual surveys using 25 m x 5 m transects. Fifteen haphazardly run transects will be censored for blue cod at each site. The starting position of each transect will be determined by the censors closing their eyes and swimming in a haphazard direction for a predetermined distance or time. At least 30 m should be allowed between consecutive transects to reduce the possibility that individual fish following divers are repeatedly sampled (Willis pers. comm.). To further avoid counting fish attracted by diver activity, counts should only be made while the transect line is being run out, and as an additional precaution censors will swim 5 m from the start of the transect prior to starting their counts. All blue cod within 2.5 m either side of the transect will be counted and have their size estimated. Size will be estimated to the nearest 50 mm. All censors will undergo training prior to conducting blue cod surveys to ensure this level of accuracy is achieved.

Training will involve estimating the size of plastic cut-outs of blue cod placed in similar conditions to where sampling will take place. Various sized cut-outs should be randomly placed along a transect line which censors will swim during training. The distance the cut-outs are secured from the tape should also be randomly varied. Censors will record the size of each cut-out, its distance along the tape, and its distance from the tape. The average absolute difference between the estimated and actual size of the cut-outs should be less than 50 mm for each censor taking part in the survey. Checks should also be made to ensure that each censor can accurately estimate 2.5 m either side of the transect line by comparing their estimated distance of cut-outs from the transect line with the actual distances.

3.3 URCHINS

The test diameter and number of all urchins within 50 1 m x 1 m haphazardly placed quadrats will be measured at each site. Test diameter will be determined to the nearest millimeter with vernier callipers. Sampling will be restricted to shallow urchin barrens, and the position of each quadrat shall be determined by the censors swimming with their eyes closed in a haphazard direction for a predetermined time, then dropping the quadrat before opening their eyes.

3.4 SURVEY EQUIPMENT

General

- Boat
- Safety equipment

- Dive equipment
- Minimum of 3 divers
- Slates
- Waterproof paper - recommend Xeroperm 31196094 which can be put through a photocopier and is available from Rank Xerox.
- Pencils - recommend Unlimited@ plastic push-through pencils available from the Warehouse
- Rubber bands (for holding the paper to the slates)

Lobsters

- 50 m tape for each diver
- Underwater torches
- Spare batteries
- 200 mm vernier callipers
- Lobster lasso

Blue cod

- 50 m tape for each diver
- Plastic cut-outs of blue cod ranging in size from 100 to 500 mm in 50 mm increments.

Urchins

- 1 m x 1 m quadrat for each diver
- Vernier callipers for each diver

3.5 DATA COLLATION

Hard copies of the data should be stored in a dedicated survey journal, and photocopies of the original field records should also be securely stored. In addition the data should be stored on computer and removable disk in Microsoft Excel or tab delimited text files. There should be 8 files in total:

1. Lobster size calibration data contained under the column headings,

Date	Censor	Estimated Size	Actual Size	Estimated Sex	Actual Sex

2. Lobster counts with the data contained under the column headings,

Year Location Site Replicate Censor Count

3. Lobster sizes with the data contained under the column headings,

Year Location Site Replicate Censor Sex Size

4. Blue cod size calibration data contained under the column headings,

Date Censor Estimated Size Actual Size

5. Blue cod counts with the data contained under the column headings,

Year Location Site Replicate Censor Count

6. Blue cod sizes with the data contained under the column headings,

Year Location Site Replicate Censor Size

7. Urchin counts with the data contained under the column headings,

Year Location Site Replicate Censor Count

8. Urchin sizes with the data contained under the column headings,

Year Location Site Replicate Censor Size

Definitions:

- "Location" is either the fisheries conservation zone (FCZ), outer protected area (OPA), or unprotected area (UA).
- "Site" is the name or number of each site within each location.
- "Replicate" is the transect or quadrat number within each site.
- "Count" is the number of lobsters, blue cod, or urchins within each replicate.
- "Size" is the size of each individual animal.
- "Censor" is the person who recorded the data.

3.6 DATA ANALYSIS

Analysis of the data will allow the results to be assessed, determine if the survey design is adequate to answer the questions of interest, and highlight any changes that may be required to achieve the objectives of the monitoring programme. A common failing of monitoring programmes is that the data are

collected and left unanalysed. If data are not going to be analysed the effort expended on collecting the information cannot be justified. To prevent this, data analyses should be carried out immediately after completing each survey.

Stewart-Oaten (1996) argues that confidence intervals are often preferable to hypothesis tests, and a major advantage of this form of analysis is that it is quick and easy to do. Accordingly, all data shall be presented as means (+ 95% confidence intervals) in table and chart form, grouped by location and year.

Statistical analyses of size and count data shall be in the form of generalised linear models or analysis of variance (ANOVA) after suitable transformation (e.g. *log* x+1), and checking that the data meet the assumptions of the analyses. Initially the model for the analysis shall be;

Count (or size) = Location. Site(Location)

with location as a fixed factor and site as a random factor. Year can be added as an additional factor in future surveys.

Other forms of data presentation and analysis can be included as required.

3.7 REASSESSMENT AND REVIEWS

It is envisaged that the monitoring programme will be a long-term project. The methodology should therefore be critically reassessed after each survey for the first three years, and improvements incorporated into the design. After every five years of sampling the data should be independently reanalysed and reviewed to ensure that the objectives of the programme are being met.

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