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MARINE RESERVES MONITORING WORKSHOP, 24 -25 FEBRUARY 1994

compiled by

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MARINE RESERVES MONITORING WORKSHOP,
24 -25 FEBRUARY 1994

Meeting notes compiled by
Chris Pugsley and Jane Turnbull
Department of Conservation, Head Office, Wellington

Present: Jane Turnbull (Convenor, DOC Coastal Section, Head Office), Chris Pugsley & Eduardo Villouta (Science Research Division, DOC) Ian Stewart (24th), (Manager, Coastal Section, Head Office, DOC), Murray Hosking (24th), (Deputy Director General, Head Office, DOC), Kathy Walls (Coastal Section, Head Office, DOC), Fred Brook (Northland Conservancy, DOC), Lyndsay Chadderton (Southland Conservancy, DOC), Rob Davidson (Nelson/Marlborough Conservancy, DOC), Andy Garrick (Bay of Plenty Conservancy, DOC), Alistair MacDiarmid & Mark Hadfield (24th), (NIWA, Greta Point), Paul McShane (MAF Fisheries, Greta Point), Chris Paulin & Clive Roberts (Museum of NZ), Russ Babcock & Brian McArdle (Auckland University), Dave Schiel (Canterbury University), Russell Cole (Waikato University), Eddie Grogan (Auckland Regional Council).

Venue: Stella Maris Retreat, Seatoun, Wellington.

Subject: Priorities for the Biological Monitoring of Marine Reserves.

DAY ONE

1. Introduction

Murray Hosking: Introductory opening. This current financial year DOC spending on marine reserve monitoring is $250,000 or 5000 person/hrs. DOC, as a relatively new organisation has made good progress in setting up new marine reserves. National standards and consistency are important. Murray saw the merits of a centrally based team, and thought it important for the workshop to recommend what should be monitored, and how monitoring should interface with research.

Ian Stewart: Introduction. Interested in measuring changes in populations; both statistical power (predicting with how much reliability we can measure a given % change) and confidence (how well do the data reflect the truth) needed. Need for more consistent effort both scientifically (methods) and institutionally. Lots of ways of achieving monitoring goals.

2. General Discussion

Dave Schiel: Presented an overview, model -biological v sociological i.e. science v "feel good" approaches to monitoring. Biological includes baselines (what's there -almost any methods will do; how much and where; need good experimental designs and statistics), monitoring (what changes -species over time), dynamics (process orientated experimentation). Sociological work relates to human needs/impacts, e.g. car parks, information, loos, picnic areas, trampling intertidal areas etc. Impacts need to be tied back to the dynamics of how the system functions.

Skilled people needed to undertake monitoring work as many spot decisions often need to be made to predetermined plans depending on weather, team skills, time available, unexpected biological or physical changes e.g low visibility underwater. Need a series of fallback positions. Need experience of monitoring sites from baseline surveys. Baselines can often be very ad hoc but better to link with future quantitative monitoring. Skill needed to select control areas, appropriate spatial scales (e.g. scales differ for different species), there is a trade off between fieldwork load and experimental designs etc.

Need more process orientated research to understand what's happening. Monitoring should be very directed and never open ended.

Clive: Need to take care with species lists. Cannot describe ecosystems properly if you don't collect all species present, and identify them correctly.

Dave: Better to do base surveys on a few clear species than attempt to identify everything.

Paul I: DOC management is about people impacts. Don't monitor things that management actions can't resolve/fix.

Dave: Changes caused by the creation of a marine reserve usually happen slowly. Aim to set up one process related research project per reserve to understand why changes happen - not just monitoring numbers, etc.

Paul I: Need to know what's going on inside the marine reserve "fence".

Paul McS: Before baselines etc. need to know more about processes.

Ian: What does change mean in regard to monitoring programmes.

Dave: Larger spatial scales increase variability; despite this we don't usually get gross changes over time, although an exception is the speed at which "urchin barrens" can form from kelp forest.

Russ: Disagree with Paul Mc. -aim of monitoring is to see if the predicted trajectories are true by monitoring.

3. Discussion on reasons for monitoring marine reserves
(Refer to Attachment 1)

Brian: Why's: why is DOC going to monitor marine reserves? 1st -what is being preserved? 2nd -after installing a marine reserve, has it an effect? 3rd - once installed and changes measured then DOC needs to monitor for management purposes. The 2nd "why" is needed by DOC to justify new marine reserves. The 3rd depends on whether DOC intends to actively manage the marine reserve, an equivalent then of industrial quality control monitoring.

Ian: Two other "why's" -how much marine reserve (i.e. size, shape) do we need to achieve the desired effect? How translocatable are the results of protection? Can we use to justify setting up of other marine reserves?

Ken: Monitor processes not simply repeat baseline surveys.

Alistair: 6th "why" -how is fished population responding to exploitation? Use of a marine reserve as a control area to study a commercially fished species e.g. crayfish at Leigh.

Dave: FRST (Foundation for Research Science and Technology) doesn't fund monitoring, so DOC is the only organisation that has a continuing interest in monitoring marine reserves.

Rob: 7th reason for doing monitoring "quest for knowledge"

Dave: Sedimentation, sewage etc. major impacts for coast not solved by creating marine reserves -suggest that changes to fishing techniques may have more conservation value than marine reserves.

Ian: Marine reserves are "icons" which when situated within exploited areas, serve as advocacy tools to reduce impacts across the rest of the coast. DOC's job is to manage the area for science, and therefore it is unnecessary to monitor unless the information is needed for management purposes.

Dave: DOC has moral responsibility to lead in the "quest for knowledge" aspect of monitoring, not just to tread on others coat tails!

4. Monitoring new and existing marine reserves

Existing and pending marine reserves were listed on the whiteboard and the suggested foci for monitoring of each one was discussed, and the table on page 5 was developed.

Brian: Monitoring must check to see if rehabilitation is effective. If preservation main aim then must do regular surveys to see if areas are being maintained or becoming threatened.

Dave: Marine reserves may in fact increase impacts cf. before marine reserve created, e.g. Kaikoura. Monitor prior to human impacts to assess level of future impacts.

Brian: Monitoring allows DOC to carry out management under the Marine Reserves Act, i.e. human impacts.

Discussion: Areas with high human impact: Kaikoura, Great Barrier, The Gut, Poor Knights, Nuggets, Leigh, Milford, Raoul Is. (specific areas).

Brian: Don't monitor if cannot do anything to manage/restore, although information can be used to educate.

Dave: Need to target species to monitor human impacts, e.g. Kaikoura/seagrass.

Suggested foci for biological monitoring in marine reserves

There are three potential foci:

1. Preservation: Are the features, flora and fauna that the marine reserve was set up to create, continuing to be preserved?

2. Rehabilitation*: Has there been an increase in the size/abundance of species that were previously harvested?

3. Impact monitoring: In specific locations, we may wish to monitor impacts of certain activities, need to predict what are the likely impacts and what they are likely to affect. It is more powerful to monitor both the impact and its biological effect.

Brian: Targeting species/sub-communities part of posing questions about why we monitor.

Paul: Baseline/temporal variations -how do we measure change?

Ken: Select only a few species most vulnerable

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* The word "rehabilitation" has been substituted for "restoration" as used during the workshop. "Rehabilitation" is considered by the Department of Conservation, and by international conservation organisations (e.g. IUCN) to more accurately reflect the aims of "natural heritage programmes". It is defined as meaning "**to return a degraded ecosystem or population to an undegraded condition, which may be different from the original condition**". "Restoration", by contrast, means "**to return a place to an earlier known condition**", and is only to be applied when the meaning is exactly that.

Summary of Discussion (see also list on p.14)
Suggested foci for monitoring in each current and prospective marine reserve (somemay need to be refined once further discussions have taken place with Conservancies).

1. Preservation

The Gut/Te Awaatu C.	Physically fragile (preservation), visitor impact needs to be monitored
Kermadecs	Unique and fragile environment, preservation in present state, needs an inventory before monitored.
All fiords	Preservation – hold decline
Whanganui inlet	Preservation of entrance inlet?
Kaikoura	Cf. Nuggets, advocacy to promote tourism, need to monitor tourism impacts. Rehabilitation?
Great Barrier	Preservation
Poor Knights	Preservation of unique biota

2. Rehabilitation

Nuggets	Rehan? – Paul McShane disagreed as no visible sign of subtidal damage. Advocacy.
Long Island	Representativeness
Paterson Inlet	Rehabilitiation (implies a before/after comparison) – some preservation
Tonga (Abel Tasman NP)	Rehabilitation
Kapiti	Rehabilitation
Te Angiangi, Hawkes Bay	Rehabilitation
Tuhua	Maori – rehabilitation of fishing around reserve, DOC – representative coastline
Te Whanganui a Hei	Rehabilitation
Leigh	"Originally a private pond for scientists", restoration (overfished) rehabilitation, "advocacy for other marine reserves".
Okura/Long Bay	Rehabilitation, and stopping developers
Pollen Island	Rehabilitation

3. No monitoring by DOC anticipated

Sugar Loaf Is.	MAF administers all fisheries matters
Tawharanui & Mimiwhangata Marine Parks	Fisheries regulations not administered by DOC

Brian: Preservation main goal then need to detect change i.e. ensure we don't lose what we've got.

Paul: Rehabilitation then need to measure if firstly we can hold level of damage by decreasing/stopping extraction. Main impacts intertidal, difficult to measure sub-tidal impacts. Can we simply measure change? But if find change occurs how can we be sure it would not have happened anyway?

Russ: Compare same methods across lots of reserves to give replication.

Brian: If say all fish numbers increase over 10 different marine reserves, then without any statistical rigour, most people would believe there had been a "reserve effect". Increase in fish may have been in fact because of people feeding them and not because of no-fish area/preservation management i.e. we can demonstrate "rehabilitation" but not the process that causes it.

Paul I: Public expects each marine reserve to demonstrate a "good" change.

Dave: Monitor a few marine reserves well not all of them poorly!

Brian: Doing only one thing in each marine reserve "well" is very limiting; need a structure so we can say with confidence that marine reserves work.

Alistair: Need a centrally budgeted, coordinated approach; danger of focusing on clear water "beautiful places".

Paul McS: Need more work in grubby, difficult places e.g. West Coast, not benign, accessible places. Don't let the difficulty of exposed coasts prevent investigations. Agree with Alistair re. central organisation, consistent survey standards, data storage etc.

Brian: Who will be the judge of the success of rehabilitation -the public? Need to prioritise these judges or get sufficient to collect data on a number of different levels to please all of them!

Paul: DOC should be the main judge.

Dave: Only a few species of public interest, also need to look at the whole habitat i.e. algae.

Paul: If DOC can't do anything about something, e.g El Nino events, then don't bother monitoring for it.

Rob: Frequency of monitoring - does it depend on human impacts etc.?

Lindsay: Focus on impacts etc. and tailor programme to management.

Brian: Single "omnibus test" if independent significance tests with the same hypothesis even if species, designs, localities different -Fishers Omnibus Test. Need a minimum baseline at each place i.e a pilot survey but over the full range of spatial mapping, habitat types, populations etc. - can then tailor to lower nos. of targeted species at a later date then.

Paul: What is the impact date -establishment of the marine reserve i.e. enforcement date?

Brian: Looking at "trajectories" not at one before one after (BACI) design.

Paul: Frequency of monitoring is an experimental design issue - it will vary place to place.

Summary

A quantitative survey is needed for all marine reserves to identify what's there, before any monitoring programme is considered.

1. Monitoring to ensure preservation: is the marine reserve preserving the flora and fauna the reserve was set up to protect?

(i) Trend monitoring; doesn't require controls. If the 'warning light' is triggered, then the cause should be investigated (if necessary set up a null hypothesis to test).

(ii) Could be done as controlled experiment if appropriate.

2. Monitoring to ensure that rehabilitation is being achieved: "are marine reserves working?" Has there been an anticipated increase in numbers of a previously harvested species?

(i) Treat each marine reserve as it's spatial controls as a replicate i.e. same design incorporated into all reserves to be monitored.

(ii) If there is no before data to show that the controls are suitable/working, then there needs to be monitoring over time.

(iii) Fisher's Omnibus Test was suggested as a way of testing all the data.

Notes: replicated blocks: ensure that there is no systematic bias in choice of controls to get around time problem. If you don't have before data to show your controls work you need a time dimension to your data. In some circumstances, you could have controls inside the marine reserve e.g. to test the effect of trampling of shore platforms.

Summary of issues needing to be addressed by DOC

1. Planning and central coordination needed for:

- National Marine Reserve Monitoring Unit
- Educated guesses have to be made in the field, so only one national team which is statistically sophisticated should undertake the work.
- Centralised priority setting.
- Storage of data.
- Liaison with outside agencies and interagency cooperation.
- Contracting
- Intergration with other DOC work e.g. research into better understanding of ecological dynamics
- Quality control and how we achieve it.

2. Methodology/design – matters needing consideration:

- Consideration of appropriate spatial and temporal scales.
- Precision, power, resolution, cost, effectiveness, thresholds for index of change – what degree of change are we interested in?
- Does the proposed monitoring have sufficient precision to detect the level of change we are interested in monitoring? Do we need the same level of precision at each marine reserve?
- Cost effectiveness of the precision of our estimates.
- Taxonomic resolution.
- New technologies, testing methods.
- Using overseas models and literature.
- Involvement of public.
- Ethics of using controlled perturbations i.e. killing things in marine reserves to monitor i.e. "sampling without replacement".
- Weather constraints and effect on priorities.
- Design of a pilot study, what questions should it address?

3. DOC's resource constraints.

- Need better awareness of the cost of intended work.
- How to get the right people for the job.
- How to use skills we have in the Department more effectively.
- What quality of monitoring can DOC afford; how much work can we manage natioanally?

4. Communication

- Publication of results in arrange of media; transferring the information to our audience(s).
- Internal promotion/communication of MR monitoring to both fieldn managers and top level management (EMT).

5. Customary knowledge

- How to incorporate this?

DAY TWO

(Discussions followed the structure/groupings decided yesterday)

1. Design methodology

(a) What degree of change are we interested in?

Dave: What people does DOC have on it's staff? You don't necessarily need scince/scientists to show impacts! Not trying to design a "buy/sell" type of trigger programme like the Stock Market.

Paul: What yardstick do we measure against?

Russ: Trend lines important.

Brian: What is a "significant difference" from a biological point of view? Is it social or scientific significance?

Dave: Target a few species e.g Nuggets could be paua; target percentage change in paua number.

Paul: How do we tell when to build a boardwalk over an impacted area? Science or best guesses?

(b) Does the proposed monitoring programme have significant precision to detect this change?

Brian: Variances are very unreliable if large difference between a small pilot study and a main study cf. reliability of means, which by contrast to a variance estimate, get very accurate as you increase scale of the monitoring effort. Suggest look at extremes of confidence intervals in power calculations to get a max/min estimate i.e. put both maximum and minimum estimates through a power analysis to get better picture of prediction.

A pilot study isn't really a very good estimator of variances e.g. if aggregated data then variances even worse. Do a confidence interval on an estimate after power analysis.

Paul: Can pool data from different times if 'n' too small.

Dave: Time series data, statistics get better the more data we have.

Paul: Commitment to repeat surveys must be maintained.

(c) Pilot study design

Pilot study has to cover a broad no. of species. Strata, main species, habitat mapping all from baseline survey not pilot survey - baseline first.

Brian: Regression always more powerful than ANOVA e.g. sediment impacts set up design to identify where impacts occur and how much rather than let ANOVA do it. Care with sample size/shape.

(d) Spatial temporal scales

Paul McS: Existing marine reserves usually too small to influence some species crayfish. Need appropriate spatial scales to suit each species.

Paul I: Can't infer Leigh results nationally.

Paul McS: Temporal scale needs to fit life cycle e.g. six monthly samples of phytoplankton useless.

Brian: Auto-correlation effects not removed by random time period sampling. How do you remove seasonal effects? Regular sampling easier to handle. Irregular periodicities - how often to sample? Sample scale should be less than the period of the "complete cycle", or sample at the same point in the cycle each time. If random sampling period chosen get an "average" over the whole cycle. Identify most interesting or important part of cycle and always sample at this point in cycle.

Dave: Can use change indices as variables to look at a number of reserve trajectories.

Brian: Variance will always increase with mean.

Ken: Variance very low if few animals e.g. crayfish.

Dave: Data transforms are dangerous if on wrong scale, ad hoc transforms to reduce variance are dangerous as they generate spurious interaction terms i.e they have no biological meaning. Go with non-parametric or if log scales (always O.K.) generalised linear modelling.

Dave: If you do an X+1 log transform. This is **not** the same as a log transform (X log) if you have lots of zeros in you data set. Need to stratify your sampling design if getting lots of zeros.

Brian: Can data into classes say >1000=5, >100=4, >50=3, >10=2, >1=1. This type of recoding can be applied in the field if too many animals to count -need to have experts in field to make this type of decision. This and other "contingent" decisions argument for central unit.

(e) Testing methods

Absolute differences versus trends.

Rob: Rob doubts that fish counting methods give reliable results.

Brian: Inter-observer variability solved by randomising sampling over all of them not same person sampling same depth range, etc., each time. Use non-replacement sampling. Need to validate your technique, whatever it is. Need training for dive team and pairwise comparisons of two divers. Randomise quadrats. Fix data sheets, collect voucher samples, assign people to particular groups.

Ross: What is the variance between people? Is it greater than change to be detected?

Brian: Presence/absence, a quick and dirty method i.e. "low resolution" - easier, but need more sample units. Extra precision of counting not useful.

Paul I: Danger of specialists (in a particular taxa), because they can ignore other species completely. Can use members of the public if need non-specialists. Can we use fishers to sample Long Bay for fish counts. Is this a suitable technique? Yes.

Brian: Bellamy in UK, scheme to collect data using British Sub Aqua Club.

(f) New Technologies

Ken: Side scan sonar, GPS "mesotech" for mapping -can run these from small boats now.

Paul I: Remote cameras to prevent problem of tame fish/frightened fish when doing diver counts. Sonar image signal at 3-5 m not visual image.

Russ: Use old technology i.e fishing lines!

Ken: Video cameras on time lapse.

(g) Ethical questions

Paul I: Suggests a maximum 5% allowable take in a marine reserve if using rotenone. Also question if it has to be done in the reserve? In terrestrial reserves can't do anything unless the work has direct relevance to the reserve or DOC -nothing to do with the scientific quality or importance of the work. Problems of one scientist disrupting the work of other scientists in a marine reserve.

Paul McS: Marine reserves not suitable for controlled experiments in fisheries research as spatial scale of existing reserves is too small.

Dave S: Suggest each marine reserve has a panel to oversee science and $$'s to spend on research cf. Leigh. Visible peer review of science projects for each marine reserve.

Andy: Suggests DOC sets up a marine reserves liaison group to discuss these issues.

Kathy: Will investigate science review committees as a mechanism for resolving difficult ethical and other issues.

(h) Rotenone - Chris Paulin

(See Attachment 2 for more detailed information; the following is a brief summary)

Rotenone is a South American tree root, traditional way of gathering fish for food. 1-4 hours breakdown in sun. Works by suffocating fish by stopping oxygen uptake. Because of this fish come to the surface in search of air i.e. easy to net cf anaesthetics which often put fish to sleep in cracks on the bottom. Need perfectly calm conditions, six divers for sub-tidal stations which takes 3-4 hours.

-Rotenone not recommended in estuaries - too warm.
-After 12 stations usually don't get any more new species - usually about 50 species in any area although can get up to 180 at a site. 75% of fish caught found throughout NZ.
-Need a MAF permit and RM Act resource consent.
-Hard to quantify catch, cover a large area of microhabitat, although can sometimes enclose an area. Also a size specific (catch only small fish) sample bias e.g. Bay of Plenty 10 species seen but not caught with rotenone (which collected 50 species).

2. Data management

(a) Publication

Must allow time to write up, peer review before publish, baseline surveys not appropriate (maybe selected parts could be) to publish in alpha literature, but all other monitoring results should be published in alpha literature and not only in DOC internal reports.

Consider Seafood NZ, Royal Forest and Bird magazines for baseline and other survey information.

(b) Access to data/results

Must be considered

(c) National database

Auckland Conservancy used Excel spreadsheets for Great Barrier Is. data. Standards badly needed. National Museum collections database just become operational. Will take many years to enter all card file data -2 yrs to get 30,000 fish records entered for example.

(d) Voucher specimens

Very difficult to identify marine biota as NZ still in early stages of taxonomic development

Preservation – marine reserves and suggested target species/features	
Great Barrier	Red moki
Kaikoura	Zostera, golden limpets
The Gut	Red corals
Piopiotahi	Black coral
Poor Knights	Reef fish, archway fauna
Leigh	Rock lobsters, shore platform
Nuggets	Seals

[NB – These are examples only – not a final list].

4. National Co-ordination

Brian: Central team best for training.

General Discussion: National team has the following advantages

- Need to implement/modify statistical design, techniques in field.
- These need to be made by experienced people
- Need to be able to plan for a "disaster" e.g. bad weather.
- Team would have to be kept together and be self contained once in field.
- Regional Conservator support needed for marine work or cross-conservancy team work
- Need to allow sufficient time for planning and write-up.
- Flexibility compromise continuity of work.
- Central team needs to link into experience available regularly
- Statistical expertise ideally in-house
- Training and assessment of teams skills – how will it be done?

Brian: Long term trends could be monitored using general public, say one long weekend "CoastWatch" type programme as used in the UK to monitor plastic pollution. In NZ Kapiti dive boat operators keep data sheets, six dive clubs in Auckland do this also. Roger Grace has 15 yrs of photographic monitoring data.

- Need to have voucher specimens. Museum of NZ will identify most groups but not sponges, polychaetes. About two weeks turnaround time. All surveys should have a well-curated set of voucher specimens stored somewhere accessible.

- Some conservancies already have voucher collections, Auckland inverts and seaweeds, Nelson inverts. NIWA large database (ecological) and collection.

- Local collections useful e.g. reference collection in each DOC office. If a national team then maybe not so important that conservancies keep reference collections and voucher specimens -responsibility of the national team, who would have the necessary taxonomic expertise.

3. Monitoring Goals and Appropriate Approaches

Rehabilitation versus preservation

Monitoring of impacts -known impacts e.g. Raoul Is. moorings, The Gut black coral diver damage -need to identify which species impacted.

Same null hypothesis over all marine reserves for preservation/rehabilitation?

Rehabilitation hypothesis "positive change for certain species", Fishers Omnibus Test can be used but need to have something in common with each reserve e.g. shared most common species. Simultaneously sample each site, or at least over similar time period. Need to target species so more practical to sample simultaneously. Time since reserve declared ok to use as a variable.

Brian: Have to defend choice of controls e.g. no statistical difference during the reserve or baseline survey. Time series data a useful fallback. Models won't fit trajectories as they will be too complicated, i.e., won't be able to smooth curves -so ANOVA only way to go.

Brian: If no baseline then need to use controls, must compare controls more than once with marine reserve to justify choice of controls. Impact studies may have to be added to "trend" monitoring. Preservation - doesn't necessarily have to have any controls

Brian: Don't have to have full scientific evidence -need to sound alarms for managers, so maybe we don't always need controls to "prove it". For preservation monitoring can have controls inside of the site, i.e., "no go" areas for people to monitor trampling impact. Pseudo-replication = to what population are you trying to generalise.

Alternative is to forget controls and only set up trend monitoring programme with "whistle blowing" thresholds.

Brian: Preservation = to maintain existing "pristine" conditions cf. Rehabilitation = improvements.

Brian: Trends -tend not to believe your latest survey. If no controls poaching looks the same for some species as a storm!

Further recommendation

- Nationally co-ordinated approach to monitoring, flexible but consistent, is needed.
- Continuity of individuals so skill and experience can be developed.
- Training experience is the key to success.
- Links to outside expertise regularly.
- Central team/plan needed to implement the "plan".
- Central team with good expertise so can make decisions in the field – self contained.
- Willingness to support this is needed from Regional Conservators.
- Good time allocation needed including time for planning and write up.
- Statistical advice ideally in-house but if necessary could contract out.

ATTACHMENTS

1. **Biological Monitoring Programmes Initiated in Marine Reserves and 1993/94 Business Plan Commitments for Marine Reserve Monitoring** by Jane Turnbull

2. **Monitoring Marine Reserves -A Fish Eye View** by Chris Paulin and Clive Roberts

ATTACHMENT 1

BIOLOGICAL MONITORING PROGRAMMES INITIATED IN MARINE RESERVES

by Jane Turnbull

SUMMARY AS AT FEBRUARY 1994

This summary is likely to be incomplete. Please advise me of any amendments/updates.

A. Gazetted Marine Reserves

1. Te Awaatu Channel (The Gut. Doubtful Sound)

No programme established; Southland Conservancy has made a commitment to establish photopoints to record any impact occurring as a result of diver activity.

2. Piopiotahi (Milford Sound)

Baseline established October 1992, one month prior to reservation. Joint Southland Conservancy and S&R Directorate undertaking.

Focuses on: rock lobster, black coral, selected benthic species; twelve permanent sites.

Euan Harvey (Otago University) is trialling suitable methodology including using videod quadrats to count benthic species, and fish counts.

Draft report available; to be published in CAS Notes Series in 1994.

3. Tonga Island

Most of baseline data collected December 1993; the completion of fish visual transects is awaiting an improvement in water clarity.

Nelson Conservancy undertaking.

Focuses on: conspicuous invertebrates (site, density) and fish; 17 sites established.

Davidson, R J and Chadderton, W C in press: Marine reserve site selection along the Abel Tasman National Park, New Zealand: consideration of subtidal rocky communities. Aquatic Conservation (contains some of the baseline data).

Davidson, R J (1992): A report on the intertidal and shallow subtidal ecology of the Abel Tasman National Park, Nelson. Nelson/Marlborough Occasional Publication No. 4. 161p. Department of Conservation Nelson.

4. Long Island - Kokomahua

Baseline established March 1992, March 1993, September 1993.

Nelson Conservancy undertaking.

Focuses on:

- 53 species of conspicuous invertebrates at 29 stations
- paua, cats-eye, Cooks turban, kina, rock lobster (size measurements and densities)
- fish
- blue cod (catch -measure -release).

(All initial were transects were in March 1993).

In future, blue cod will be tagged to investigate spill-over and fish movement.

Davidson R J (1994): Long Island – Kokomohua Marine Reserve monitoring: subtidal baseline data. Nelson -Marlborough Occasional Publication. Department of Conservation, Nelson.

5. Kapiti Island

Baseline established in 1990.

NIWA undertaking, under contract. (Chris Battershill).

Focuses on: key harvested species and fish counts.

Report not yet completed.

6. Tuhua (Mayor Island)

Baseline established in late March/early April 1993.

Bay of Plenty Conservancy undertaking.

Focuses on: size frequencies of rock lobster, paua, kina and reef fishes.

Grange K R (1993): An analysis of fish abundance and distribution data. Mayor Island (Tuhua) marine reserve baseline survey, 1993. Unpublished report by NIWA Oceanographic for the Department of Conservation. Held by Bay of Plenty Conservancy Office, Rotorua

7. Te Whanganui-a-Hei

No programme established; the Conservancy has made a commitment to initiating one and intends starting field work in March/April 1994.

Coffey B T (1990): Proposed marine reserve, Hahei: A pre,iminary assessment and habitat inventory. Unpublished report prepared by B T Coffey and Associates Ltd. for Department of Conservation, Hamilton. 63pp. Held by Waikato Conservancy.

8. Cape Rodney to Okakari Point

No programme established although several related investigations are of relevance including:

Cole R G, Ayling T M & Creese R G (1990): Effects of marine reserve protection at Goat Island, northern New Zealand. New Zealand Journal of Marine and Freshwater Research 24: 197 -210.

9. Poor Knights Islands

Baseline established in 1984 for management committee.

Focuses on: benthic organisms (including algae) and fish for reefs at five localities, three of which were totally protected.

Schiel D R (1984): Poor Knights Islands Marine Reserve: A biological survey of marine reserves. University of Auckland Marine Laboratory, Leigh. 93pp.

Choat et al (1988): Demersel and spatial variation in an island fish fauna. Journal of Experimental Marine Biology 121: 91-111. (Labrid and black angel fish monitoring 1985-86; subsequent surveys as yet unpublished.)

10. Kermadec Islands

No programme established.

Various studies by Schiel (1980s) or Cole (early 1990s) may be relevant.

Schiel D R, Kingsford MJ and Choat J H (1986): Depth distribution and abundance of benthic organisms and fishes at the subtropical Kermadec Islands. New Zealand Journal of Marine and Freshwater Research Vol. 20: 521-535.

B. Proposed Marine Reserves

11. Whanganui Inlet

Baseline established January 1989.

Nelson Conservancy undertaking.

Data from 50 stations (intertidal and subtidal).

Focuses on: macroinvertebrates

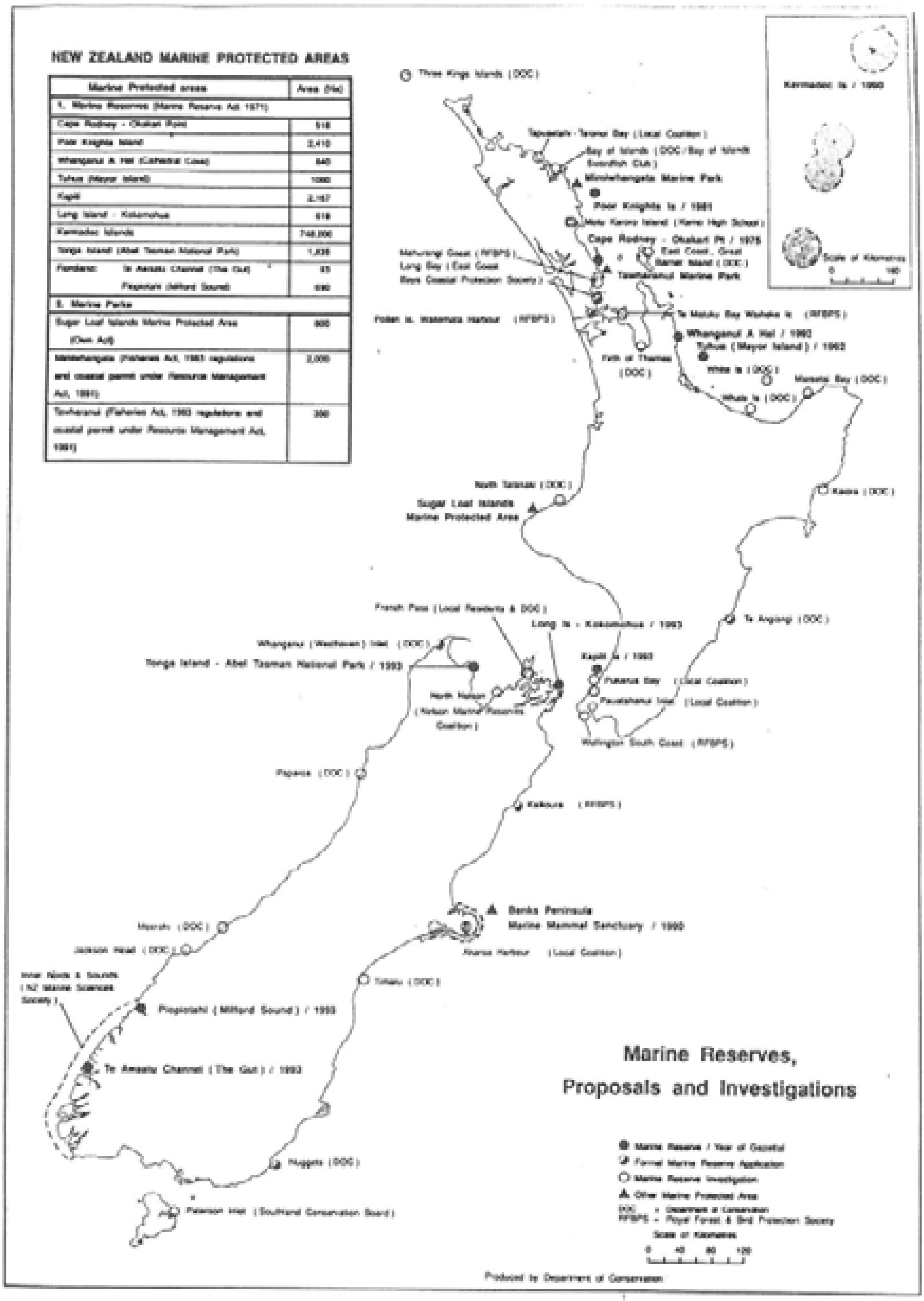
Davidson, R J (1990): A report on the ecology of Whanganui Inlet, North-west Nelson. Nelson-Marlborough Occasional Publication No. 2. 133pp. Department of Conservation, Nelson.

12. Te Angiangi (Aramoana-Blackhead, Central Hawkes Bay)

Hawkes Bay Conservancy has made a commitment and establishing a programme, prior to gazettal of this reserve. However, unsuitable weather delayed its implementation planned for February 1994.

13. Surveys of proposed marine reserve sites may provide useful baselines in some cases e.g. Great Barrier Island.

I J Tumbull
21 February 1994



Marine Protected areas	Area (Ha)
1. Marine Reserves (Marine Reserve Act 1971)	
Cape Rodney - Okakari Point	518
Poor Knights Island	2,410
Whanganui A Hei (Cathedral Cove)	840
Tuhua (Mayor Island)	1060
Kapiti	2,167
Long Island - Kokomohua	619
Kermadec Islands	748,000
Tonga Island (Abel Tasman National Park)	1,835
Fiordland: Te Awaatu Channel (The Gut)	93
Piopiotahi (Milford Sound)	690
2. Marine Parks	
Sugar Loaf Islands Marine Protected Area (Own Act)	600
Mimiwhangata (Fisheries Act, 1983 regulations and coastal permit under Resource Management Act, 1991)	2,000
Tawharanui (Fisheries Act, 1983 regulations and coastal permit under Resource Management Act, 1991)	350

1993/94 BUSINESS PLAN COMMITMENTS FOR MARINE RESERVE MONITORING

PROJECTS MARINE RESERVE MONITORING 1993/94	Direct Operating	PUA Hours	OP Hours	Conserv O/Heads	HO O/Heads	Total Costs
SOUTHLAND Milford Sound marine reserve monitoring	12,400	240	200	13,576	2,185	28,161
Paterson Inlet subtidal monitoring	10,600	120	680	23,622	4,034	38,256
Diving Support	3,800*	40	80	3,617	601	8,018
(* also supports projects in other K.O.s) **Total:**	26,800*	400	960	40,815	6,820	74,435
OTAGO Monitoring plan (estimates only)	9,000	40	200	10,000	0	19,000
NELSON-MARLBOROUGH Marine reserve monitoring (Havelock)			100	4,158	0	4,158
Marine reserve monitoring (Protection)	5,500	736	155	32,178	0	37,678
Marine reserve monitoring (Takaka)			24	998	0	998
Total:	5,500	736	279	37,334	0	42,834
WELLINGTON Monitoring Plan (costs are estimate only)	50	10		315	0	365
WANGANUI						
$30,000 for monitoring Sugar Loaf C.A. baseline identified as activity that cannot be undertaken with existing funding						

HAWKES BAY Marine Reserves Baseline Survey	5,400	275		12,355	0	17,755
Marine Reserve Survey (Napier)	600		220	8,376	0	8,976
Marine Reserves Survey (Onga onga)			70	2,665	0	2,665
Total:	6,000	275	290	23,396	0	29,396
BAY OF PLENTY Marine Reserve Monitoring (Tauranga)	6,000		624	20,753	0	26,753
Marine Reserve Monitoring (Protection)	2,000	200		10,823	0	12,823
Monitoring Marine Reserve (Use & Adv)	500	40		2,165	0	2,665
Total:	8,500	240	624	33,741	0	42,241
WAIKATO Te Whanganui-a-hei monitoring (The Conservancy has also submitted a S&R bid)	6,100	320	80	19,400	0	25,500
AUCKLAND (Develop monitoring plan for CROP marine reserve)	-	?	?			
HEAD OFFICE	4,000	250				4,000
TOTAL:	65,950	2,271	2,433	165,001	6,820	237,771

ATTACHMENT 2

MONITORING MARINE RESERVES: A FISH EYE VIEW

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Establishing baselines: what is the best method of census?

Prior to any monitoring work a *baseline* of all fish species present must be established. Repeated counts may be necessary to obtain reliable data. Large, pelagic and schooling fish species, even on small areas of reef, pose special difficulties in sampling, and visual counts may be the only practicable method for estimating their numbers, however, species avoidance of, or attraction to divers distort data. Community studies over large areas of reef pose greater difficulties: visual censuses are often limited by the sheer diversity and numbers of fishes.

Direct observation is non-destructive, but visual counts seriously under-estimate numbers of species and individuals. Rotenone collections are necessary to provide a comprehensive picture of the fish community: Schroeder (1989) found rotenone stations yield approximately 30% more species than visual counts, Christensen & Winterbottom (1991) show that for social open water species the mean visual accuracy is about 89%. but estimates of secretive and cryptic species range in accuracy from 0.16-33.0%. Rotenone is particularly useful in sampling isolated patch reefs: 75% of species present are taken in a single sampling and two or three applications of rotenone a few hours apart, will effectively sample of all fishes present (Smith 1973). The most accurate results combine both visual and rotenone surveys. Neither method will sample large "transitory" species effectively. Over larger areas of reef explosives probably yield the most consistently reliable results.

Examples:

Most studies of local fish faunas neglect small, cryptic epibenthic fishes altogether. Ecologically these cryptic fishes may be as important as the larger species, and perhaps more importantly, they are the most diverse group. Furthermore, visual surveys carried out in northern New Zealand waters at offshore islands or at exposed headlands, appear not to be representative of true mainland fish faunas. Species diversity is lower and species composition is different because of a higher component of subtropical "immigrants."

1. Jeffs & Irving (1993 -Auckland Conservancy Technical Report Series No.5). Twenty eight fish species were recorded during a 1990 visual survey of northeast Great Barrier Island from a total of 73 species known within the study area. National Museum rotenone stations from Coromandel to Northland, including offshore island sites typically yield 16-35 species collected (with an average of around 28-30) per site, with around 80-100 species recorded in total over a 10 day survey combining a variety of sampling methods.

2. Francis & Ling (1985 - MAF Internal report No.32) recorded 3-12 species per station in visual survey of fishes. Museum rotenone stations in Fiordland yield 14 – 35 species (with an average around 25) per site, of a total known fauna of 180 species. Although Francis & Ling observed other cryptic species, these were not recorded.

3. Baxter (1987) recorded 27 species of fish from Kapiti Island. Museum of New Zealand data indicates that more than 30 species have been recorded from the zone alone in cooler Cook Strait waters, and over 160 species have been recorded in Wellington Harbour.

Rotenone

A few concerns have been expressed about rotenone sampling, especially in regard to toxicity and effects on non-target organisms. Studies overseas (listed below) and from experiments here in New Zealand (Williams & Roberts in prep, Paulin & Roberts pers. obs.) show that the direct effects of rotenone are short *term* and do not cause permanent changes in the fish community: application of lkg of dry rotenone powder will effectively sample fishes over a maximum 5 X 5m area in calm, current-free areas, for a period of 1-4 hours, depending upon water temperature. Recolonisation is rapid with fishes that do not come into contact with the concentrated rotenone observed moving back into the area as soon as the rotenone has dispersed (15-20 minutes) - In fact removal of poisoned fishes by other larger species, such as blue cod (*Parapercis colias*), can be a problem.

Rotenone works by preventing oxygen uptake across the gill lamellae, effectively suffocating the fish. As the rotenone takes effect fish emerge from weed or crevices and move towards the surface. Other anaesthetics (eg. Quinaldine, 2-Phenoxyethanol) tend to immobilise fish while hidden and are potential health risks being carcinogenic and cytologenic.

Rotenone has a number of advantages, it:

- provides verifiable species lists through reference collection of voucher specimens;
- shows low toxicity tomammals and most other marine organisms other than fishes (Marking 1988);
- is photochemically unstable and degrades rapidly in sunlight (Wingard & Swanson 1992, Post 1958, Gilderhaus 1972, Gilderhaus *et al.* 1988);
- is easy to apply and is predictable in effect;
- can provide quantifiable data from suitably designed experiments (Willis & Roberts *in prep*); and
- enables collection of small cryptic species that visual surveys or other methods may omit

Problem in fish monitoring

Monitoring reef fish diversity can be and highly misleading. Fish are mobile and respond rapidly to changes in their physical environment. This rapid change can be used to advantage for monitoring provided all factors which may complicate sampling are minimised. Distribution and abundance is directly linked with habitat and food requirements, and the spatial distribution of many species varies according to the nature of the sea bed, the state of the tide, or sea conditions. There is a pressing need to adopt [standard] sampling throughout the conservancies. Diver observational skills and ability to accurately identify species varies.

Community Structure vs Indicator species

Focusing on regionally rare or unique species as "indicators" may be unsatisfactory and attention to significant "representative" species may be better. Rare stragglers respond to and are limited by catastrophic events rather than long term trends. *e.g.* the distribution of Antennarid anglefishes in New Zealand, is linked with the number of late summer cyclones. With the exception of the Three Kings Islands and subantarctic islands, few marine fish species are locally restricted i.e. 60-75% of marine fishes are found throughout New Zealand, of the remainder 25-30% are "northern"and will be found from North Cape to East Cape; 5-15% are "southern" and will be found from Stewart Island to East Cape. Small cryptic fishes comprise the majority of the endemic species and, therefore, are the group most in need of monitoring for protection and conservation.

Any index should be capable of multispecies assessment (e.g. Karr 1991: Biological integrity: a long neglected aspect of water resource management. *Ecological Applications* 1: 66-84).This approach has been used in assessing the integrity of fish communities in polluted streams by investigating species richness and composition, trophic composition and fish abundance and condition. Monitoring of marine reserves differs in that most are in areas that are close to pristine conditions (partly because of the selection process in establishing the reserves) and there is a lack of baseline data. Paulin & Roberts (1994: Proceedings of the 2nd Temperate Reef Symposium 1990) provide broad distributional data for around 80 species which could be used to develop a monitoring programme.

Voucher specimens

In addition to the requirements for scientific research carried out in marine reserves (Part II, Marine Reserves Regulations 1993), voucher specimens of all taxa collected from the reserves (including all unsorted or unidentified material), during the course of scientific research or monitoring, must be made available for future reference by being lodged in a publicly accessible collection which, like the reserve itself, has statutory protection. Recently significant (DSIR) collections housed in CRI's (eg. soil science; ecology division) have been disposed of because they are not seen as being of "immediate economic" significance and have failed to attract FoRST funding.

Rotenone in fish sampling: abstracts from selected references.

Beckley, L.E., 1985. Tide-pool fishes: recolonisation after experimental elimination. *J.Exp.Mar.Biol.Ecol.* 85: 287-295.

Recolonisation of tide-pools by fishes, after periodic rotenone poisoning, was examined over 2yr in the East Cape, South Africa. Rapid recolonisation occurred with species of Clinidae, Gobiidae, Sparidae and Cheilodactylidae constituting the bulk of the recolonisers. There tended to be lower densities of recolonisers in winter than in summer. Repopulation of pools was not exclusively by juvenile recruits and it is suggested that the larger recolonisers were fishes from adjacent pools whose homeranges overlapped with the study areas.

Grossman, G., 1982. Dynamics and organisation of a rocky intertidal fish assemblage: the persistence and resilience of taxocene structure. *The American Naturalist* 119:611-636.

A series of tidepools were defaunated 15 times over 29 months. Sampling did not grossly affect taxocene structure in the study site and recolonisation from surrounding areas was rapid. The test of taxocene persistence and resilience showed that this assemblage was both persistent and resilient over the course of the study, despite repeated defaunation. These results are consistent with the predictions of the deterministic model of community organisation and contradict those of the stochastic model. Consequently, this taxocene is probably successional or persistent. This result is surprising because studies of algal and invertebrate assemblages occupying this habitat indicate that these assemblages are stochastically regulated. Thus the environmental pressures affecting the evolution of assemblage regulation have had different effects on these three taxocenes.

Kulbicki, M., 1990. Comparisons between rotenone poisonings and visual counts for density and biomass estimates of coral reef fish populations. *Proc. Int. Soc. Reef Studies.*

Rotenone poisonings and visual counts were conducted simultaneously on 10 stations. A total of 352 species were collected by rotenone in the Chesterfield islands and 434 species were collected similarly in New Caledonia. Visual counts indicated 200 species in the Chesterfields and 344 in New Calodonia. For a given station rotenone poisoning yielded significantly more species than visual counts. In particular most small species such as Gobiidae, Blenniidae, Apogonidae, small Labridae and cryptic or nocturnal species such as Scorpaenidae, Holocentridae and Muraenidae were better sampled by the rotenone poisonings than by visual counts. On the opposite large and mobile species such as Acanthuridae, Scaridae, Serranidae, large labridae were better estimated by visual counts. Density estimates were not significantly different between the two methods. Biomass estimates were significantly larger with visual counts, this being due to the larger size of the fish taken into account by this method. It is suggested that the two methods should be combined in order to get a reasonable account of the whole reef population on a given station.

Lardner, R., Ivanstoff, W. and Crowley, L.E.M., 1993. Recolonization by fishes of a rocky intertidal pool following repeated defaunation. *Australian Zoologist* 29: 1-2.

An intertidal rock pool at seal rocks, New South Wales was repeatedly defaunated during summer or autumn between 1969 and 1987 using the ichthyocide rotenone. The fish assemblage was of moderate diversity, dominated by juveniles of subtidal species. Changes in the composition and numbers of species of this assemblage were assessed on both long term and short term basis. The long-term study covered a period of 19 years; the short term study was from March to May 1986. While considerable variation was observed in the numbers of the component species over the long-term collections, species composition remained relatively consistent. In short term studies recolonisation of the area was initially rapid. Initial recolonization was dominated by intertidal species, such as *Torquigener pleurogramma*, while subtidal species were more numerous in the long term.

Paulin, C.D. & Roberts, C.D., 1994. Biogeography of New Zealand intertidal reef fishes. *In*: Battershill, C.N. *et al.* (eds), *Proceedings of the Second International Temperate Reef Symposium, University of Auckland 7-10 January 1992*. NIWA Oceanographic, Wellington.

The New Zealand fish fauna comprises over 1,000 species and of these, 94 (9.3%) are found living in rockpools. Most (73.7%) non-rockpool New Zealand fish species have wide distributions beyond Australasia, 12.8% are Australasian, and 5.7% are endemic. In contrast, only 4.2% of rockpool species have wide distributions, 29.8% are Australasian, and 61.7% are endemic. Within New Zealand waters the majority of rockpool species (59.6%) are distributed widely from North Cape to Stewart Island, with smaller components restricted to northern (29.8%) and southern (10.6%) regions. Major differences occur among rockpool fish faunas of offshore islands, and these also differ from the New Zealand mainland fauna. At the Chatham Islands, the rockpool fish fauna is essentially New Zealand in character, but with notable absences and no endemics. In contrast, the Kermadec and subantarctic islands, which are closer to New Zealand, have reduced fish species diversity, increased endemism and low affinity with mainland New Zealand, most probably because they are located in different water masses to that surrounding the Chatham Islands.

Smith, C.L., 1973. Small rotenone stations: a tool for studying coral reef fish communities. ***American Museum Novitates*** **2512: 1-21.**

Fish populations of 10 shallow water stations were sampled repeatedly using small quantities of emulsified rotenone. Taking small samples is not unduly destructive and a complete kill is never obtained. Sampling errors appear to be random. Analysis of the collections indicates that approximately 75 percent of the species present are taken in a single sampling. Repopulation begins immediately and the effects of sampling disappear four to nine months later. Repeated samplings can be used for Leslie-Davis population estimates. Resemblance indexes for samples from the same and different stations show that each area has a specific array of resident species. Transient species are less consistent in their occurrence. Sampling errors make it difficult to distinguish between transient and low-density resident species.

Thomson, D.A. and Lehner, C.E., 1976. Resilience of a rocky intertidal fish community in a physically unstable environment. ***J.Exp.Mar.Biol.Ecol.*** **22: 1-29.**

A 7-year census of intertidal fishes has been made by repeated defaunations of tide pools in the northern Gulf of California. The intertidal fish community showed long term resilience, and hence stability, under a rigorous, unstable physical environment. Although the majority of fishes have tropical affinities (76%), warm temperate species (24%) constitute 33% of total numbers and 69% of total biomass of the entire intertidal fish community. Short term seasonal fluctuations in species diversity and population numbers of temperate fishes were in better synchrony with the annual light regime and sea temperature cycles than those of tropical species.

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