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EDITORIAL

Catalogues - The first ten years

Last year we brought out what we hoped was the first in a Series of Catalogues of DoC Science publications covering the years from 1987-1995. This first catalogue was of all the books and reports that we had available for sale to the public. It will be followed by a yearly update of new publications for sale.

In the pipeline is a more complete Catalogue of all science outputs between 1987-1996 which includes books, reports, contract reports, scientific journal papers, and miscellaneous pamphlets and popular articles. Because DoC does not own the Copyright to many of the things listed, such as the scientific journal articles, this will not be a sales catalogue, but rather a reference catalogue. Everything in it should be available in a library, probably your local DoC library, but, if not there, then through interloan from a public library.

As might be expected, a catalogue of our entire output for the first ten years, is much more extensive than the earlier sales catalogue, and it will give a very fair picture of the extent of our scientific and technical investigations. Proposed date for publication is March 1997.

K. Green
Editor

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Conservation Science Newsletter is issued by Science Publications, Science and Research Division, Department of Conservation, P.O. Box 10-420, Wellington. Contributions are invited from our readership, and should be sent to the Editor, at this address.

Department of Conservation
Te Papa Atawhai

CAS PROFILE!

An eternity in the life of the West Coast CAS

For our second CAS Profile in this series we move across the South Island to the wild West Coast, and Craig Miller. . .

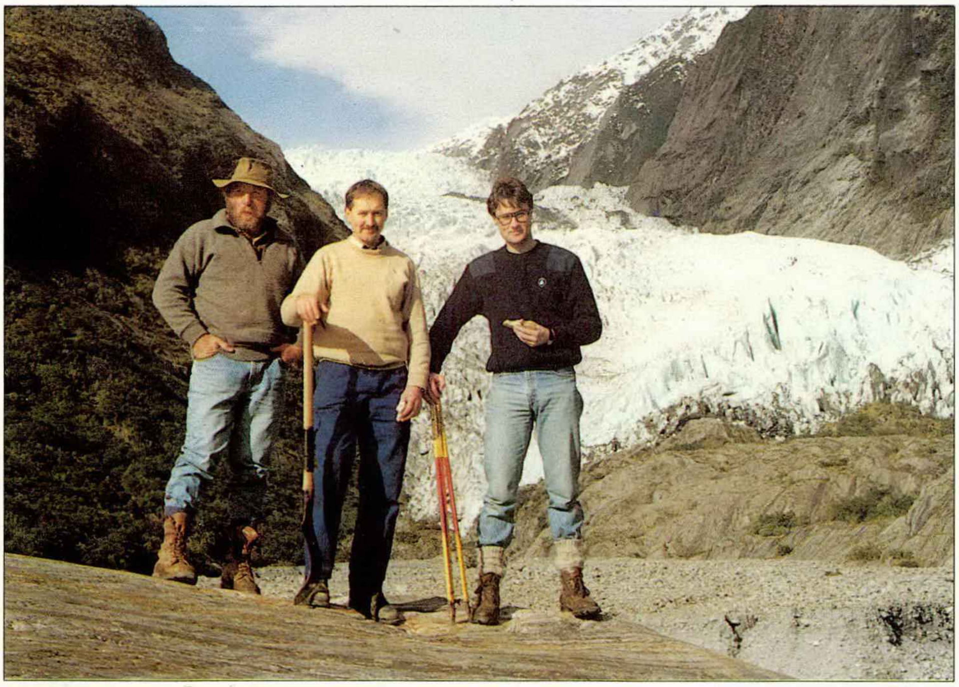
Diversity — biological or otherwise— would be the best descriptor of the job of a Conservancy Advisory Scientist (CAS).

The sheer variety of real and potential tasks of the CAS almost defies the writing of a job description. From providing scientific advice (as the name implies) on all manner of topics to all manner of people, identifying research needs, brokering the provision of research for the conservancy, and giving talks to interested groups, to getting ones hands dirty actually getting out from under the mass of paper and into the field to assist with real conservation projects, and yes, trying to squeeze the allocated 20% personal research time into 5% of real time (and this isn't the half of it!), makes for a job that I'm not tempted to swap for a while.

The "real" conservation projects that I am currently directly involved with include Green Package funded research into the control of stoats, using 1080 laced eggs, over a large area, and the restoration of a diverted stream back into Nikau Scenic Reserve (see Geoff Park's book *Nga Uruora* for an evocative description of this reserve).

The research programme into stoat control has arisen through the need to be able to protect Okarito brown kiwi chicks *in situ* from predation; it would appear that the population, found only at Okarito, is ageing with little or no recruitment of juveniles. The ability to control stoats efficiently and effectively over a large area also has implications for integrated conservation management on the mainland (Mainland Habitat Islands).

Nikau Scenic Reserve is a small but very significant remnant of sand-plain forest on the Barrytown Flats, near Punakaiki. An illegal diversion, in 1978, of a stream feeding this reserve reduced the water flow into it by at least half. Flowing water has a major role in the function of these dune and swale forest-wetland systems, and its reduction is slowly changing the system. I now have agreement from the adjacent landowner, and funding from WWF-NZ, to accomplish the restoration and to monitor this process. A small but significant achievement for conservation.



Craig Miller (on the right) was part of a survey team on the Franz Joseph Glacier in 1994.

The personal research I have planned for the next few(!!) years is a Ph.D. research programme looking at the corridor and habitat function of remnant riparian vegetation. My over-arching hypothesis is that the protection or restoration of riparian vegetation will have a major role to play in the integration of conservation with productive (*sic*) land uses (= ecological sustainability). Obvious, maybe, but largely untested. Most New Zealand research into the riparian zone has focused on the role of the vegetation on protecting or maintaining in-stream values. I suspect that riparian vegetation will have a major role to play in conservation in the terrestrial landscape.

This brief biography has focused on the here and now, and a wee way into the future. To delve into the last three and a half years that I have been in this position would take to long! I include my list of publications, however like most CAS's I have plenty of ideas (and even a bit of data) for writing papers, but the time to write them seems rarely to be available. I promise myself that this will change. Watch this space.

Publications

In preparation

An analysis of 52 years of white heron monitoring data from Waitangi-roto.

Contribution of New Zealand's riparian zones to the conservation of indigenous biodiversity and sustainable landuse.

Comparison of bird diversity and abundance in three West Coast forests.

In press (hopefully!)

Warren, P. & Miller, C. Some issues to be addressed in bryophyte conservation and research. *CAS Notes*.

Miller, C. Himalayan thar control plan: assessment of monitoring 1993-1995. *CAS Notes*.

Miller, C. Ecological restoration: a way forward for conservation. *In* Landcare Research report.

Submitted

Miller, C. & Miller, T. The white heron: *Ardea alba*, *Egretta alba*, or *Casmerodius alba*. *Notornis*.

Published

Miller, C.J., & Miller, T.K. 1995. Population dynamics and diet of rodents on Rangitoto Island, New Zealand, including the effect of a 1080 poison operation. *N.Z. Journal of Ecology 19*: 19-27.

Miller, C.J., Craig, J.L., & Mitchell, N.D. 1994. Ark 2020: a conservation vision for Rangitoto and Motutapu Islands. *Journal of the Royal Society of N.Z. 24*: 65-90.

Miller, C. 1993. Fire for conservation management of pakihi. *Conservation Advisory Science Notes No. 51*.

Miller, C.J. 1993. An evaluation of two possum trap types for catch-efficiency and humaneness. *Journal of the Royal Society of N.Z. 23*: 5-11.

Miller, C.J., & Anderson, S. 1992. Impacts of aerial 1080 poisoning on the birds of Rangitoto Island, Hauraki Gulf, New Zealand. *N.Z. Journal of Ecology 16*: 103-107.

Progress report on fish data entry — mapping project

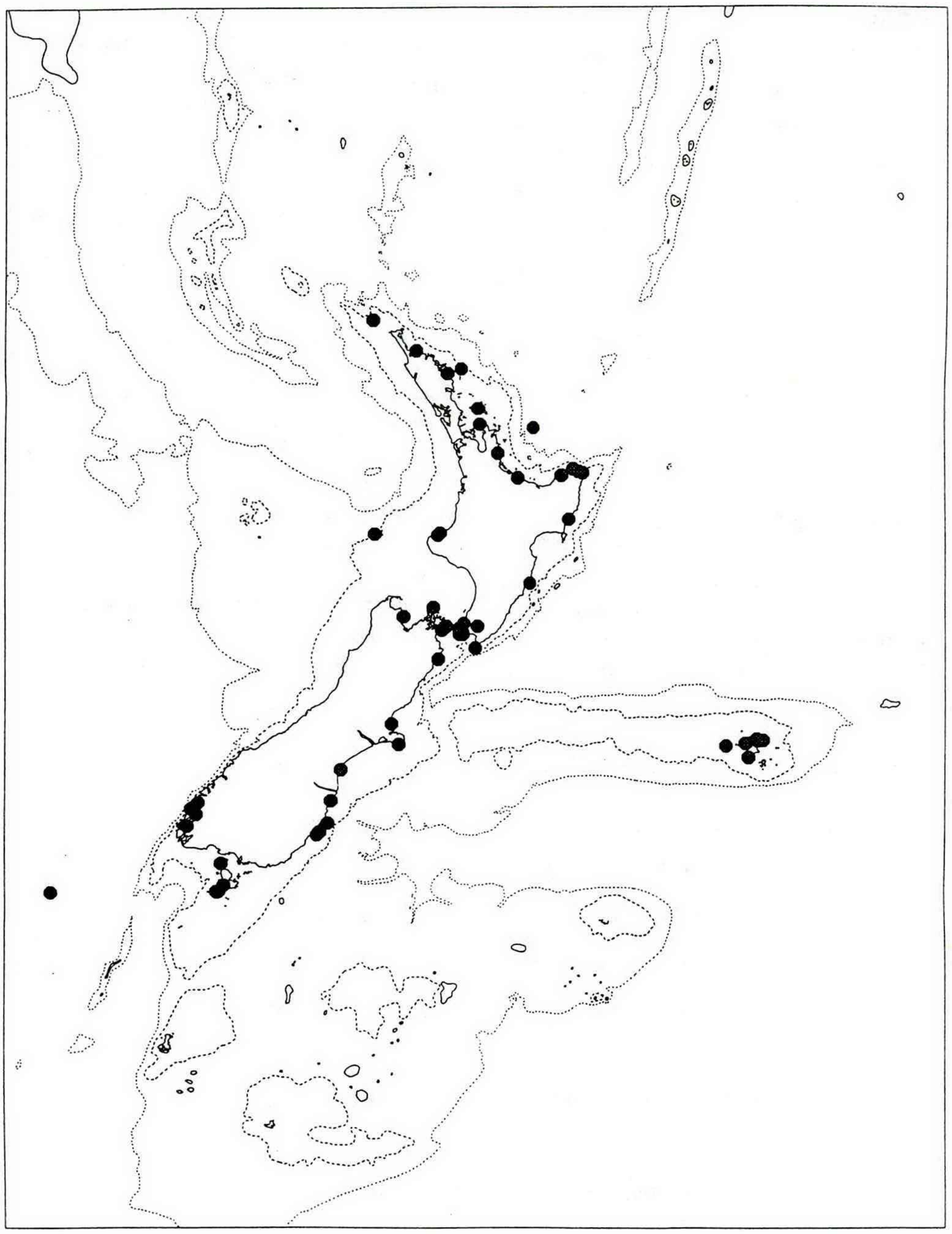
From the Museum of New Zealand Te Papa Tongarewa

Data entry from card index files was completed in April/May 1996 and was followed up by a cross check reference with the departmental registers to ensure all records were entered. This phase was completed in July and checks of data accuracy are ongoing. At present data entry tasks include addition of other information to the database such as illustrations and radiographs. Mapping software has been installed and over the next few months staff will be trained in the use of the system.

The accompanying map shows an initial example of the New Zealand distribution of seahorse (*Hippocampus abdominalis*) from *Te Kahui* database records.

The *Te Kahui* fish collection database contains 33,494 records and can be searched by species or location. Not all identifications and locality data on the database have as yet been verified and requests for information should be directed through fish section staff.

Chris Paulin



RESEARCH IN PROGRESS

Project Crimson — an up-date

This programme is a partnership between Carter Holt Harvey Ltd. and the Department of Conservation. Other companies contribute funding from time to time. The goal of Project Crimson is to restore the coastal pohutukawa tree. Pohutukawa has suffered extreme loss.

Philip Simpson supplied these notes from the paper he presented at the Ecological Restoration Conference in 1996.

Its coastal habitat has been heavily modified by people for agriculture, urban development and roads. More recently, severe browsing by possums has killed many trees. It survives largely as an aging population, with little regeneration because seedlings are palatable to stock. Only on offshore islands does a viable pohutukawa ecosystem exist. It is the loss of many trees over the last few years that has led to Project Crimson.

Project Crimson is serviced by a charitable Trust which is responsible for establishing objectives, assessing projects for funding, preparing an advocacy newsletter and maintaining a network of contacts. The core activity relates to numerous projects undertaken largely by local community groups. Actions include the protection of existing pohutukawa trees, generally by fencing to exclude stock. Restoring land so that it has the potential to support pohutukawa forest, and providing funding for growing and tending young trees is important. The Trust is funding research into the genetic diversity of pohutukawa, using DNA fingerprinting, so that natural variability is not compromised by moving pohutukawa from one district to another. Guidelines for seed collection and propagation are published in the Newsletter.

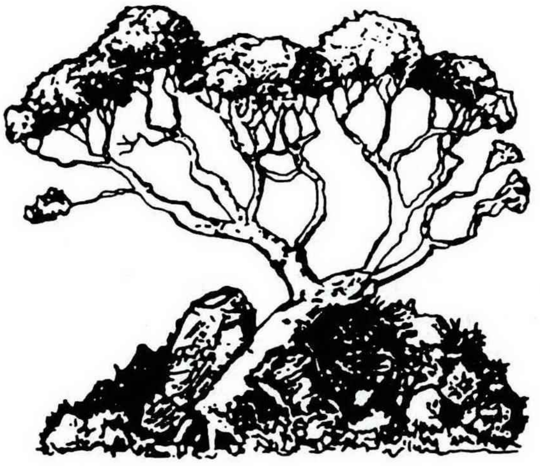
DoC funds a very large possum control programme, usually by aerial poisoning using 1080. Project Crimson operates at a much smaller scale by dispersing and establishing bait "station" - plastic containers attached to tree-trunks above ground level, into which poison bait is maintained by a local person. Project Crimson also supports the "mainland island" concept and has helped fund a fence across the Cape Brett peninsula at the Bay of Islands to exclude all browsing animals. The fence protects 1200 ha of coastal forest, jointly managed by the Department of Conservation and maori land owners.

The Trust has established several community based nursery projects. It assists Rotary N.Z. in their school based nursery growing units to train students in propagation. The New Zealand Crippled Children's Society maintains a nursery training facility which produces pohutukawa seedlings. Paremoremo Prison also maintains a nursery and has become a major provider of seedlings to disperse to community groups. Other prisons are following suit. These are innovative ways of reducing the cost of restoration, of training, and advocacy.

Project Crimson is funding research into pohutukawa. Students' theses at the Masterate and Doctorate level have been partly funded, in areas relating to regeneration, productivity, and variability. A recent field study rediscovered a stand of pohutukawa at the southern distribution of the species' range in Taranaki. The study determined that the stand is distinctive in form and at extreme risk as a result of natural coastal erosion. Its discovery sparked a positive community response in support of "their local pohutukawa", and now restoration is underway, with full community backing.

The Trust fosters an "ecological" approach to pohutukawa conservation. While individual trees are important it is really the coastal forest ecosystem that needs to be understood, conserved and restored. Project Crimson funded a government research agent to identify the range of fungi associated with pohutukawa, as an illustration of biodiversity. The Department of Conservation prepared a poster on "How pohutukawa help others", again advocating the ecological approach by demonstrating interrelationships.

Because the natural distribution of pohutukawa is limited to the northern quarter of the country, only northern communities have an opportunity to get involved in its conservation. Project Crimson has therefore decided to extend its activities to the related rata species, which grow throughout New Zealand and which are also seriously threatened by possums and former land clearance. This will achieve national coverage so that all regions can benefit from the particular brand of conservation fostered by Project Crimson.



The funding for Project Crimson comes from a business and is directed towards the community. Sponsorship contributes significantly to conservation in New Zealand, especially for restoration projects, including threatened species recovery. Although pohutukawa and rata are not threatened with extinction they are significant icons of identity for ordinary New Zealanders, and their loss is unacceptable. The community needs to have opportunities to get involved, actively. Restoration is one of the areas of conservation where this is possible. In fact, because it is no longer practical to greatly expand the protected estate, restoration needs largely to take place on private land, such as riparian zones along rivers and coasts. Community leadership of restoration is essential to ensure that the need is enthusiastically embraced, the scale is adequate, the work is maintained into the future, and the costs are shared. By empowering the community Project Crimson is one way that health is being restored to the ecological landscape. It helps to justify the Department's vision of ecological restoration:

"To restore mauri* by bringing nature and culture together into a healthy indigenous environment through the conservation actions of people everywhere in New Zealand."

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* Mauri — a maori concept meaning the life principle, roughly translating to "health and productivity".

RESEARCH IN PROGRESS

Recent NIWA research has addressed linkages between habitat and fish populations by surveying freshwater fish in medium to large rivers around New Zealand.

How does your catch measure up?

Jody Richardson and Ian Jowett
NIWA, Hamilton, New Zealand

The Resource Management Act now provides DoC fishery managers with unprecedented opportunities to ensure that water users protect and possibly enhance the freshwater fish resource.

To respond properly to proposals to develop or use a natural water in New Zealand, DoC staff must have specific knowledge about the aquatic biota. For fish, obtaining this often means conducting a survey of the river or stream. Electric fishing is widely used for such surveys, and is quite effective for sampling New Zealand's small, cryptic, and benthic freshwater fish in water less than 1 m deep. In fact, it is one of the few quantitative methods we have. Once this information is obtained, what does it mean, and how does it measure up? Is the fish community unusual? Is the density of fish high or low? This article presents a preliminary assessment of these issues, so that DoC staff can begin to evaluate stream fish population data in the context of what is a "normal" population.

Recent NIWA research has addressed linkages between habitat and fish populations by surveying freshwater fish in 38 medium to large rivers around New Zealand. Our initial findings showed that habitat, mainly water depth and velocity, controlled the distribution of fish within a river, and species could be assigned to one of four guilds based on their habitat preferences: edge-dwelling, fast-water, intermediate, and those species that were found in a wide variety of habitats. Secondly, although 20 species were found in total, only eight species were considered as common overall, and rarely were more than five species present at any one site. The distribution and abundance of fish was primarily related to the location of the site, with site elevation being the most important factor, more so than river gradient or distance up stream. In fact, we were unable to find any relationship between fish communities and catchment features, landuse, riparian vegetation, or hydrological characteristics that were not related to the elevation or geographical location of the site.

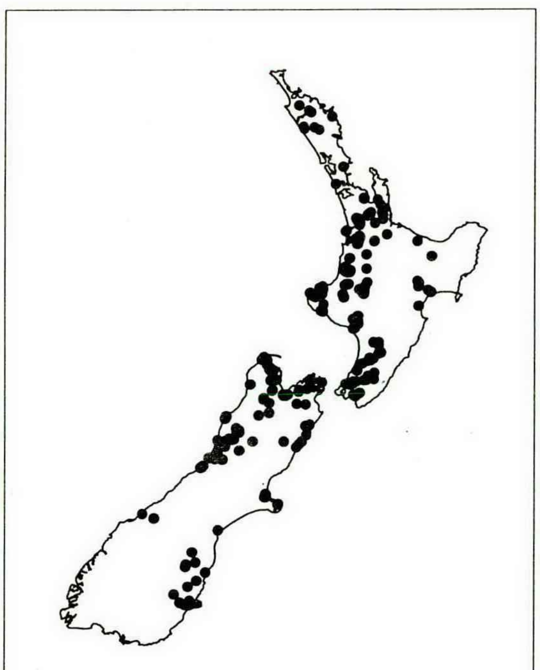


Figure 1 Location of 279 electric fishing records from the NZFFD.

To define what is a "normal" fish population, we augmented our 38 rivers dataset with information from NIWA's New Zealand freshwater fish database (NZFFD). The data we extracted met several criteria to ensure consistency:

- Single pass electric fishing was the method used. The reason for this is that our study showed there was excellent agreement between the number of fish caught on the first pass and populations estimates from multiple passes. On average, about 50% of the fish were caught on the first pass. We believe that multiple pass fishing is unnecessary in resource assessment and good comparative results can be achieved with single pass electric fishing.
- The area fished was larger than 50 m^2.

- All fish caught were identified to species, and counted.
- Sites with known downstream obstacles, such as hydroelectric dams or large waterfalls, were excluded.
- Lake and wetland habitat was excluded.
- Where there were multiple records at the same site, these were combined into one.

This gave a dataset with 279 records, which had reasonable national coverage (Figure 1). One hundred and sixty-seven sites were located in the North Island, with the remainder in the South Island. The elevation at these sites ranged from 0 to 610 m above sea level, with a median value of 90 m. Twenty-two species in total were recorded from all 279 sites (Table 1), but like the results from the 38 rivers survey, only eight species could be classified as common (i.e., more than 5% of total fish numbers); longfin and shortfin eels, torrentfish, brown trout, and all the bully species except giant bully. Only eels and brown trout were present at more than 30% of sites.

Fish density

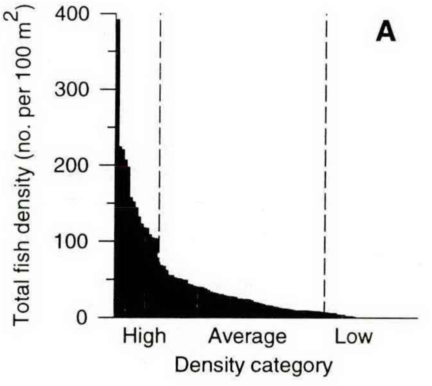
As a preliminary assessment of what is a "normal" fish population, we ex-

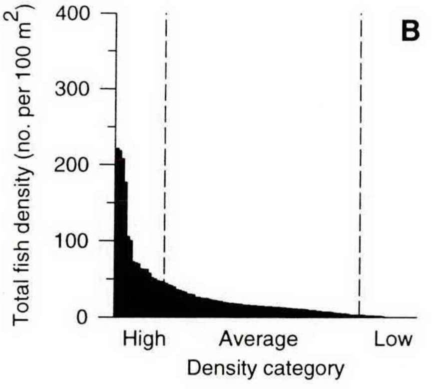
TABLE 1 ABUNDANCE OF 22 FISH SPECIES RECORDED FROM 279 ELECTRIC FISHING SITES FROM THE NZFFD.

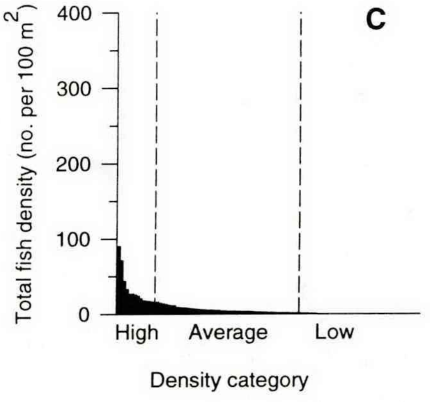
SCIENTIFIC NAME	COMMON NAME	% OF SITES WHERE PRESENT (N=279)	% OF TOTAL FISH DENSITY (N=7895.2)
Anguilla dieffenbachii	Longfin eel	81.7	18.9
Salmo trutta+*	Brown trout	39.4	6.2
Anguilla australis	Shortfin eel	35.1	13.5
Gobiomorphus huttoni	Redfin bully	28.3	11.5
Cheimarrichthys fosteri	Torrentfish	27.9	5.0
Gobiomorphus breviceps+	Upland bully	22.2	9.8
Gobiomorphus cotidianus	Common bully	20.1	5.1
Galaxias brevipinnis	Koaro	14.3	1.6
Gobiomorphus hubbsi	Bluegill bully	11.8	7.9
Galaxias fasciatus	Banded kokopu	10.7	3.4
Gobiomorphus basalis+	Crans bully	10.0	7.6
Galaxias maculatus	Inanga	10.0	2.2
Retropinna retropinna	Common smelt	7.9	3.2
Geotria australis	Lamprey	6.4	0.4
Galaxias postvectis	Shortjaw kokopu	5.0	0.1
Galaxias divergens+	Dwarf galaxias	4.3	1.3
Onchorhynchus mykiss+*	Rainbow trout	4.3	0.3
Galaxias vulgaris+	Common river galaxias	3.9	0.7
Galaxias argenteus	Giant kokopu	3.2	0.2
Gobiomorphus gobioides	Giant bully	1.8	0.1
Carassius auratus+*	Goldfish	0.4	0.1
Gambusia affinis+*	Mosquitofish	0.4	0.9
No fish present		1.8	-

+ = non-diadromous; * = introduced species

Figure 2 Histograms of total fish density for site (A) less than 50 m a.s.l., (B) between 50 and 150 m a.s.l., and (C) more than 150 m a.s.l.







amined three population characteristics: the number of fish per 100 m^2, the number of species caught at any one site, and the diversity index, a single value which encompasses both abundance and variety. Data were sorted in numerical order and divided into low, average, and high categories (e.g., Figure 2). The average range for "normal" fish populations was considered to be that which encompassed the central two thirds (66%) of the data. The low and high ranges encompassed the 17% lowest and 17% highest values respectively.

Fish density (single pass electric fishing), ranged from 0 to almost 400 fish per 100 m^2, with a mean value of 28.3 fish per 100 m^2. Total fish density and the density of just the diadromous* species were **negatively** correlated with elevation (Spearman rank correlation coefficient r = -0.44 and -0.57 respectively, $P < 0.001$), whereas the density of non-diadromous species was **positively** correlated with elevation ($r = 0.22$, $P < 0.05$). The strength of these relationships suggested that "normal" fish populations varied with elevation, so fish density data were separated into three elevation categories for further analysis; sites less than 50 m above sea level (n = 92), sites between 50 - 150 m (n = 107), and sites located above 150 m (n = 80). Although the density of non-diadromous species was correlated with elevation, there was no significant difference between the density means for the three elevation classes (Tukey test, $P > 0.05$), and they were considered as one elevation category. Total fish and diadromous fish densities approximately halved between each of the elevation categories (Table 2). At elevations less than 50 m above sea level, total fish densities of less than 6 fish per 100 m^2 may be classified as low, 6 to 100 fish average, and densities greater than 100 fish per 100 m^2 high.

Number of species

The number of species caught at any one site ranged from 0 to 8 species, with a median value of 3. This population characteristic also varied with elevation, although not quite as strongly as fish density. The total

* Diadromous—an animal which migrates between fresh and salt water.

TABLE 2 CLASSIFICATION OF TOTAL, DIADROMOUS, AND NON-DIADROMOUS FISH DENSITIES INTO LOW, AVERAGE, AND HIGH CATEGORIES. ALL DENSITIES ARE EXPRESSED AS THE NUMBER OF FISH CAUGHT PER 100 m^2 BY SINGLE PASS ELECTRIC FISHING.

CATEGORY	TOTAL FISH DENSITY			DIADROMOUS FISH DENSITY			NON-DIADROMOUS FISH DENSITY
	<50 m	50-150 m	>150 m	<50 m	50-150 m	>150 m	0-610 m
Low	<6	<3	<2	<6	<2	0	0
Average	6-100	3-45	2-16	6-60	2-30	1-5	1-9
High	>100	>45	>16	>60	>30	>5	>9

number of species and number of diadromous species were **negatively** correlated with elevation (Spearman rank correlation coefficient r = -0.40 and -0.57 respectively, $P < 0.001$), and the number of non-diadromous species **positively** correlated with elevation (r = 0.23, P < 0.05).

Data on the number of species was divided into the same elevation categories as before, but there were not always significant differences between these groups. Table 3 shows the number of species in each elevation category where there were significant differences. Not surprising, the number of diadromous species was most highly correlated with elevation, with significant differences between all three elevation categories. However, when non-diadromous species were included, there was only a clear difference between low and high elevations.

At high elevation sites (>150 m), 2-3 species were normally found, whereas at lower elevations, 3-5 species were average. Fewer diadromous species were found at high elevations (>150 m), where more than 2 species could be classified as above average. Few non-diadromous species occurred at low elevations; more than one was classified as above average.

Diversity index

A diversity index was calculated for each site based on the following equation:

$$D = 1 - \left(\sum_{i=1}^{S} (Pi)^2 \right)$$

where S is the total number of species

TABLE 3 CLASSIFICATION OF THE NUMBER OF TOTAL, DIADROMOUS, AND NON-DIADROMOUS FISH SPECIES INTO LOW, AVERAGE, AND HIGH CATEGORIES.

CATEGORY	TOTAL NUMBER OF SPECIES		NUMBER OF DIADROMOUS SPECIES			NUMBER OF NON-DIADROMOUS SPECIES	
	≤150 m	>150 m	<50 m	50-150 m	>150 m	<50 m	≥50 m
Low	<3	1	<3	<2	0	0	0
Average	3-5	2-3	3-5	2-4	1-2	1	1-2
High	>5	>3	>5	>4	>2	>1	>2

in the community, and *Pi* is the proportion of the total sample that a species represents in that community. This index takes into account both the species richness and the evenness (equitability) with which individuals are distributed among the species, and varies in value between 0 and 1. The diversity index varied between 0 and 0.82 for this group of rivers, and as expected, was **negatively** correlated with elevation (Spearman rank correlation coefficient $r = -0.30$, $P < 0.01$). At low to moderate elevation sites (<150 m), a diversity index of less than 0.28 was classified as below average, and sites with an index greater than 0.69 as having high diversity (Table 4). Index ranges within the three categories were lower at the higher elevations.

Application

How do you carry out an electric fishing survey and place it in a national context? We recommend following these steps:

- Single pass electric fish at least 50 m^2 at your site, making sure that you measure the area fished reasonably accurately.
- Identify and count every fish caught, and calculate total fish density, as well as the density of the diadromous and non-diadromous species separately. Convert these measures to fish per 100 m^2 units.
- Determine the elevation of your site from the appropriate map sheet (NZMS260, 1:250 000). Generally elevation can be estimated to the nearest 10 m.
- If desired, calculate the diversity index from the equation given in this article.
- Compare your density calculations with Table 2, the number of species with Table 3, and diversity index to the data presented in Table 4.

TABLE 4 CLASSIFICATION OF DIVERSITY INDEX INTO LOW, AVERAGE, AND HIGH CATEGORIES FOR TWO ELEVATION CLASSES.

CATEGORY	ELEVATION	
	≤150 m	>150 m
Low	0-0.28	0
Average	0.28-0.69	0.01-0.60
High	>0.69	>0.60

As an example, we present information from a site in the Wairoa River catchment on the east coast of the North Island south of Gisborne. Data from this site was not included in the 279 sites already used to develop our low, average, and high categories. The site elevation was 60 m, and 120 m^2 were single pass electric fished. The catch was 12 longfin eels, 14 shortfin eels, 23 unidentified elvers, 18 Crans and 5 common bullies, and 1 torrentfish. It was not possible to calculate a diversity index for this site as not all the eels were identified to species. Classification into the appropriate categories shows that this site had high total fish density, as well as a high density of diadromous fish (Table 5). Otherwise, the site was unremarkable, with average categories being given to the rest of the population characteristics.

Summary

This analysis of data from the NZFFD has provided a means of placing rivers and streams within a national context, and we hope the concept of establishing such guidelines provokes discussion and feedback among fisheries managers. This analysis could be extended to provide similar information on a regional and species specific basis, but we require more quantita-

TABLE 5 RESULTS AND CLASSIFICATION OF FISH POPULATION INFORMATION FROM A SITE IN THE WAIROA RIVER CATCHMENT. ALL DENSITIES ARE EXPRESSED AS THE NUMBER OF FISH CAUGHT PER 100 m^2 BY SINGLE PASS ELECTRIC FISHING.

POPULATION CHARACTERISTIC	RESULT	CATEGORY
Total density	60.8	high
Diadromous fish density	45.8	high
Non-diadromous fish density	15.0	average
Total number of species	5	average
Number of diadromous species	4	average
Number of non-diadromous species	1	average

tive data. Electric fishing data submitted for inclusion in the NZFFD which meets the first three criteria listed previously (single pass, area fished measured, and all species identified and individuals counted) can be incorporated into further analyses. We would urge you to record all this information next time you are conducting an electric fishing survey so that the NZFFD accurately represents New Zealand's fish communities, and provides a wide cross-section of data for establishing guidelines.

Chilled bats! Conserving short-tailed bats in the 'fridge

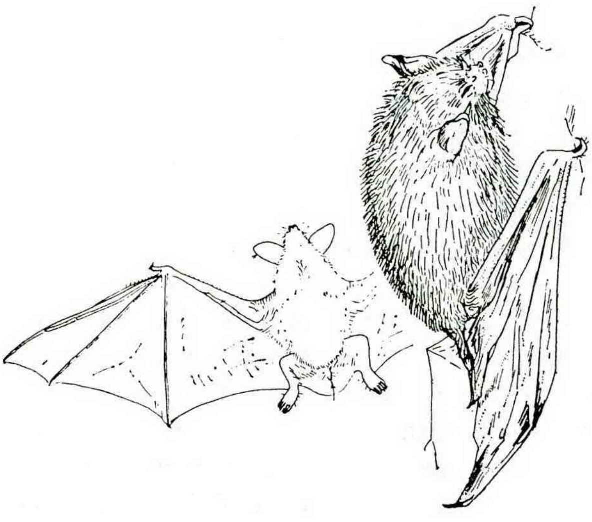
In 1992 Molloy and Davis ranked *Mystacina* as one of a group of New Zealand species with the highest priority for conservation action. At that time only two viable populations of *Mystacina* were known, one on Codfish Island, off the north west coast of Stewart Island, and the other on Little Barrier Island in the Hauraki Gulf in the north of North Island.

Short-tailed bats Mystacina tuberculata *are one of only two species of bats found in New Zealand.*

Since then several populations have been discovered throughout central North Island, as well as one in the northwest of the South Island. In 1992 the Department of Conservation decided to attempt to eradicate introduced rodents from Codfish Island by broadcasting a second generation anticoagulant rodenticide. These rodenticides are relatively persistent in the environment and act cumulatively in mammals over a period of many months. Because short-tailed bat's feed on ground dwelling invertebrate such as weta and cockroaches which feed on rat baits, Lloyd (1992) suggested that the bats might be susceptible to secondary poisoning.

A programme of research was begun to assess the risk of poisoning short-tailed bats and to develop methods to protect the Codfish Island bat population during a rodent eradication. Two methods for protecting the bats were considered, translocation to establish a second population, and temporary captivity of a portion of the population over winter during the rodent eradication.

Translocation was attempted in September 1994 but failed. Fifty bats were transferred from Codfish Island



to Ulva Island, a distance of 40 kilometres (Lloyd, 1994). The transferred bats weren't impressed with their new island and left (for home we hope) on the night they were released. Fortunately the captive option proved more promising. A small group of short-tailed bats was taken into captivity in December 1992 and have been held at Wellington Zoo since then. The bats settled into captivity easily, survival has been good and there have been two births in the zoo, but unfortunately no recruitment. Southland Conservancy decided to carry out a trial to see whether short-tailed bats could be held in captivity temporarily over winter and then released back into wild. This trial was undertaken this winter on Codfish Island and proved extremely successful.

Although Daniel (1990) and some other workers believe that short-tailed bats don't hibernate, our own work has shown conclusively that short-tailed bats resemble most other temperate bat species and do hibernate. During winter and early spring individual bats routinely remain in torpor for periods of 6-10 days. These periods of torpor alternate with periods of activity which last from only a few hours to 3 or 4 nights. Barnard (1991) describes a method to hold captive temperate bats in induced hibernation. Induced hibernation has the potential to make holding several hundred bats in captivity on Codfish Island a more manageable proposition therefore the Bat Recovery Group recommended that we test the method for short-tailed bats

Twenty short-tailed bats (*M. t. rhyacobia*) from Rangataua Forest in central North Island were taken into captivity during May 1996. Initially we kept them in a specially prepared bat-room for 25 days to settle them into captivity. One bat died during this settling in period. When we were confident the remaining bats had settled into captivity we began an induced hibernation trial. During the trial the bats were kept in a domestic fridge at temperatures between 4 C & 6 C for six periods ranging from 3 to 11 days. Between periods of induced hibernation the bats were returned to the bat-room for at least a week to recover condition. Sixteen surviving bats were released in early September after 123 days in captivity, including 40 days in the fridge.

The bat-room was an unheated spare bedroom (3.6 x 2.2 m) specially prepared for them. During the bats active periods in the bat room we provided food nightly on a feeding tray 1.7 m above the floor. The diet comprised mealworms, locusts, and honey water supplemented with huhu (larvae of the longhorn beetle *Prionoplus reticularis*), and a variety of insects caught in a light trap. Fresh water was available at all times. Despite a selection of wooden roost boxes, the bats usually roosted under two layers of polar-fleece hung on the wall. Shortly after capture we marked the bats individually with black hair dye (Wella Bellalady) for identification, and dosed them orally with Ivermectin (0.1 ml per bat, 0.4%w/v diluted 1:1 in honey water) to eliminate parasitic mites (*Chirolaelaps mystacinae*). These mites have previously caused secondary infections and death in captive short-tailed bats (Blanchard, 1996). Most of the bats either maintained or gained weight in captivity, after 18 days in captivity the average weight had increased by 0.9g, or 6%, to 16.3g . Only one bat consistently lost weight .

During the periods of induced hibernation in the fridge the bats were kept in a small box (200 x 150 x 280 mm), lined with and subdivided by slabs of bark. There were ventilation holes in the box and the air in the fridge was refreshed daily by opening the door briefly. A dish of water covered with gauze was placed in the fridge to maintain a high humidity level. The temperature in the fridge was recorded on a Hobologger and monitored with a digital thermometer with an audible alarm set for 3°C and 7°C.

The first period of induced hibernation was encouraging. The temperature alarm sounded repeatedly as the fridge temperature lurched around erratically. Fortunately the bats all survived and we were able to identify the fridge's problem. We shouldn't have de-iced it. The fridge thermostat monitored the temperature of the ice-box. As long as the ice-box was iced up the fridge cabinet temperature was relatively stable (as I had found with preliminary temperature monitoring) but when the ice-box was de-iced temperatures lurch erratically. The solution: we replaced the thermostat with one which measured the cabinet temperature. The new thermostat was set to maintain the cabinet temperature between 4°C and 6°C which it did effectively.

The rest of the trial went relatively smoothly. During each period of induced hibernation the bats lost on average 1-2 g of body weight but regained it within a week (probably less, as food consumption declined within 3 days of the bats being returned to the bat-room). Sadly three bats probably died as direct result of induced hibernation. One died overnight following the second hibernation period. This bat was the smallest bat and the only one which had consistently lost weight in captivity. This death confirmed Barnard's (1991) recommendation: "Never refrigerate injured, dehydrated or thin bats". Two bats died overnight following eleven days of induced hibernation, confirming another of Barnard's recommendations: "Do not refrigerate bats for more than 10 days". All autopsy results were inconclusive but the two bats that died after 11 days of hibernation had stomachs distended by gas. We assumed the gas was from post-mortem fermentation of honey water, but, as there is a possibility that it could have could have been the cause of death, we subsequently didn't provide honey water on the first night after induced hibernation.

With three out of twenty bats dying we can't claim complete success for the induced hibernation trial. Despite that we believe that periods of induced hibernation lasting less than 10 days can be used safely with short-tailed bats in good condition. During these trials we were relatively conservative and only kept the bats in induced hibernation for one third of the captive period. We have little doubt that a shorter habituation period of 10-14 days could be safely followed by a more aggressive schedule of 6-7 days of hibernation alternating with 3-4 days of activity, similar to the pattern observed in the wild. Such a schedule would make the task of holding 300-400 short-tailed bats in captivity over winter on Codfish Island an easier one.

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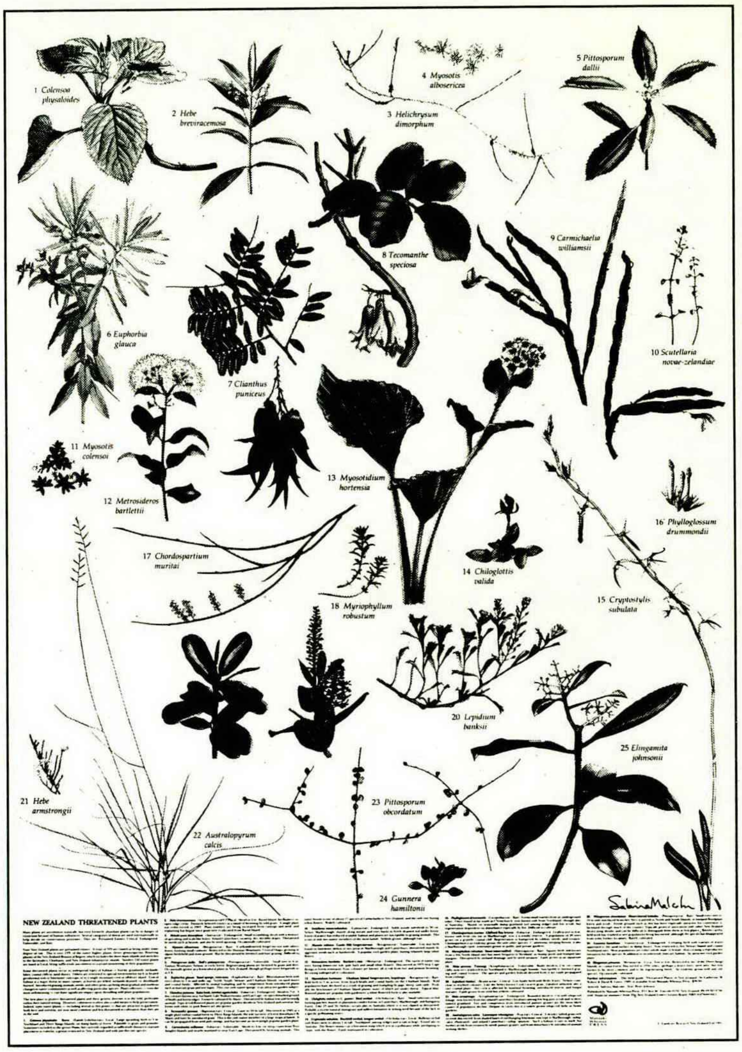

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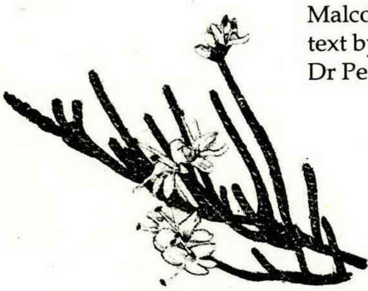

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