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Review of observer coverage in the TCEPR fishery for jack mackerel (*Trachurus* spp.) in JMA 7

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7. Executive Summary

A review of the observer coverage in JMA 7 was carried out based on information from recent research on jack mackerel. Observer coverage is restricted to the deepwater trawl fleet, but is very patchy in time and space, and data collected cannot be used to produce reliable estimates of proportions of the three jack mackerel species in the catch, which are critical for assessment of their stocks.

The current programme collects otoliths from jack mackerel in JMA 7 using a stratified sampling approach. The objective is to use these otoliths for examining the age structure and its annual variability. Work has begun on an MFish project to determine age and growth of the Peruvian jack mackerel in New Zealand waters (JMA2000/02). Sampling designs are presented to maintain the original otolith collection, and to collect otoliths and associated ageing structures for use in JMA2000/02.

A simulation method was developed to investigate aspects of a recent feasibility study where standardised stock indices based on CPUE were used as inputs to a stock reduction model to estimate virgin biomass for the two New Zealand species of jack mackerel (*Trachurus declivis* and *T. novaezelandiae*) in JMA 7. This simulation method is also used in work under MOF1999/04F. It is used in the present study to estimate a level of observer coverage that can provide data that will produce more reliable estimates of species proportions.

Results from the simulation suggest that 30% observer coverage across the fleet will provide a first year of data from which species proportions with an acceptably low level of variability in their *c.v.*s can be estimated.

The following is a summary of the recommended observer coverage.

- Maintain the levels at 330 days per year, split approximately 1:2 between JMA 3 and 7 respectively.
- Increase tow sampling for species proportions data (this does not include measuring fish for length frequency data, only counting and weighing the species sub-samples after sorting) to include sample data from up to 4 tows per vessel per day, and multiple samples from large tows (*see* Appendix 3, "Data collection for species proportions").
- Extend sampling of the jack mackerel catch into the hoki fishery to sample all tows from which a sample of 65 kg can be drawn; one sample in 5 to be sampled for length frequency with fish lengths measured and recorded.

8. Scope of the document and objectives of the project

The scope of this report is to document research carried out under MOF1999/04E. The objectives for MOF1999/04E and MOF1999/04F (*Research to provide further analysis of jack mackerel species proportions data for JMA 7*) are closely associated with outputs from MOF1999/04F feeding directly into MOF1999/04E. The activities carried out in MOF1999/04F, summarising spatial and temporal strata in the data and determining acceptable CVs on the species proportion estimates, are fundamental to determining the amount of observer coverage required under MOF1999/04E. The following were the objectives for MOF1999/04E.

- To examine the present observer coverage in JMA 7 in terms of current needs.
- To provide an appropriate sampling regime and an estimate of the level of observer coverage required to provide data from which species proportions with acceptable *c.v.*s can be estimated.
- To provide sampling instructions for other projects where necessary (i.e., JMA2000/02, *Age and growth of Peruvian jack mackerel*).

This report also includes recommended observer coverage and associated background information for JMA 3, although this Fishstock is not included in the objectives of MOF1999/04E. The recommended coverage has been included to ensure that catch sampling under objective 2, MFish Project JMA2000/01 (*Monitoring the species composition of the commercial catch of jack mackerel*), can be carried out:

- To determine from the catch at sea, the seasonality and species composition of the commercial catches of *T. declivis*, ***T. s. murphyi***, and *T. novaezelandiae* in JMA 3 and 7 in the 2000–20001 fishing year.

9. Background

The commercial fishery for jack mackerels in JMA 7 (Figure 1) is made up of two components: small domestic vessels recording their catch on Catch Effort Landing Return (CELR) forms, and large deepwater trawlers, mainly foreign chartered, who record their catch on Trawl, Catch, Effort and Processing Return (TCEPR) forms. There is little effort targeting jack mackerel in the CELR fishery, although it may reach about 25% of the tow total between February and May (Taylor 1999). In the TCEPR fishery, targeting of jack mackerel occurs throughout the year, with peaks in December–January and June–July. The latter is probably related to activity in the hoki fishery.

Reliable estimates of species proportions are fundamental to jack mackerel stock assessments because the three species (including *T. s. murphyi*) are recorded in catch reports as the single species "jack mackerel". The estimates are used to determine individual catch histories for the three species and to adjust jack mackerel catches for use in catch per unit effort (CPUE) analyses. Species proportions were identified as the greatest potential source of uncertainty in a recent feasibility study using a stock reduction model to assess biomass of *T. declivis* and *T. novaezelandiae* in JMA 7 (Taylor 1999).

Observers currently collect a variety of data and otoliths in the JMA 7 TCEPR fishery, and it is the quality of these data that was the main reason for reviewing observer coverage in this fishery. The observer data used to produce species proportions for the feasibility study were patchy (Taylor 1999). It could be argued that the best time series estimate would be based on tow-by-tow information which could then be applied to the tow catch before CPUE was estimated. Because of the sparse nature of the existing data, the best time series that could be produced was on quarterly basis, with data aggregated over three month periods. However, the variance was high between individual samples, coefficients of variation (*c.v.*s) on the quarterly mean values were unacceptable.

Little is known about the targeting strategy employed in the fishery. Information from Taylor (1999) showed a complex distribution of trawl shots in time and space, with targeting occurring in a number of sub-areas of the Fishstock and proceeding throughout the year, rather than being restricted to the summer months as had been previously described (Jones 1990). Because of the probability that species distributions vary in time and space (Taylor 1999), features of the temporal and spatial variation in tow positions must be more closely defined to summarise strata in the fishery.

The simulation method (described in the work for MOF1999/04F) for determining acceptable *c.v.*s for species composition estimates should produce useful guidelines to the amount of sampling necessary and therefore the level of observer coverage required.

10. Summary of the current programme

Details of the current programme were taken from the March 1994 version of The Scientific Observer Biological Collection Manual. Jack mackerel data are collected under the "Jack mackerel catch sampling programme" (Appendix 1).

10.1 Objectives, sampling, and data recording methods

The stated objectives, sampling methods, data recording, and other details of the "Jack mackerel catch sampling programme" are reproduced in Appendix 1.

10.2 Times series of data available

The MFish database *obs_lfs* contains data collected under the scientific observer programme (SOP) on jack mackerel from 1986 to 2000. The total number of records containing information on the composition of jack mackerel species in the trawl catch is summarised in Table 1. These data have all been collected in the deepwater trawl fisheries (vessels recording data on Trawl Catch Effort Processing Returns; TCEPR) in Fishstocks JMA 3 and JMA 7 (Figure 1).

10.3 Coverage of the jack mackerel fisheries

Scientific observer coverage of jack mackerel fisheries has been restricted to the TCEPR fisheries in Fishstocks JMA 3 and JMA 7. There has been no coverage of the purse-seine or inshore domestic trawl fleets (vessels recording data on Catch Effort Landing Returns; CELR), and no coverage in JMA 1. There is no current catch recorded from JMA 10.

Current observer coverage in the jack mackerel fishery is very patchy. For example, total annual coverage (by fishing year) in JMA 7 for the years from 1990–91 to 1996–97 (Table 2) ranged from 7.8% to 26.8% and showed a large amount of variation between quarters (October–December, January–March, April–June, July–September).

10.4 Potential outputs using the data and otoliths

The patchiness of the observer data restricts their utility in providing estimates of species proportions in TCEPR fisheries in JMA 3 and JMA 7. Monthly summaries are impossible (Tables 3 and 4). Taylor (1999) summarised the data as quarterly means, but needed to interpolate to fill a number of gaps.

Jack mackerel otoliths have been collected by observers in the JMA 7 fishery since 1990, but they have not been used in previous studies. The objective was to use them to "determine the age structure of jack mackerel populations off the central west coast" (Appendix 2). The otoliths collected from *T. s. murphyi* are currently being used in the MFish project JMA2000/02. To illustrate the extensiveness of the otoliths collection, the *T. s. murphyi* otolith collection is summarised in Table 5.

10.5 Current and future needs and objectives

Current needs are different to those discussed above because of the need to provide more comprehensive species composition data using the catch sampling programme described for MFish project JMA2000/01, and more extensive otoliths collection, and other "ageing structures" like pectoral fin rays and operculae, for MFish project JMA2000/02.

10.5.1 Data and biological material requirements

One objective of the JMA2000/01 catch sampling programme is to provide composition data for the three jack mackerel species from which species proportions with acceptable coefficients of variation (*c.v.*s) can be calculated. Determining this required level of observer coverage is an objective of the present study.

Several items of biological material are required for collection. Because of almost complete absence of small ***T. s. murphyi*** in catch records, catch and market sampling data, and fish collections at NIWA and Te Papa, individual specimens of *T. s. murphyi* smaller than 38 cm fork length (FL) are required for examination. Otolith collections from the two "New Zealand species", *T. declivis* and *T. novaezelandiae* should continue as before, but the methods used to collect otoliths from *T. s. murphyi* should change to satisfy the needs of the JMA2000/02 ageing project. This requires the collection of otoliths from 500 specimens of *T. s. murphyi* in both the "summer" and "winter" fisheries, and associated "ageing structures" from a subset of 100 of each of these 500 fish lots.

10.5.2 Revised objectives, sampling methods, data recording

The original objectives, sampling methods, data recording, and other details of the "Jack mackerel catch sampling programme" as shown in Appendix 1 have been modified to incorporate current needs. The modified objectives, sampling methods, and data recording, as instructions to the SOP are shown in Appendix 3.

10.6 Determination of required observer coverage

10.6.1 Links with MOF1999/04F

A simulation method was developed to investigate aspects of the method described by Taylor (1999) where standardised stock indices based on CPUE were used as inputs to a stock reduction model which estimated virgin biomass for the two New Zealand species of jack mackerel (*Trachurus declivis* and *T. novaezelandiae*) in Fishstock JMA 7. A brief summary of the simulation method described by Taylor & Richardson (2000) is included here as Appendix 4.

10.6.2 Estimating observer coverage

a) Determination of total required observer coverage.

Observer coverage was set as a fixed proportion of tows in each of the simulation runs. Eventual choice of the best observer coverage was based on interpretation of the test statistic, given the fixed inputs: the shape parameter (θ) of the negative binomial distribution chosen for each species; sample weight; and observer coverage.

The test statistic is somewhat obscure and requires careful description. It has been named the *diagnostic "noise" figure* and is a measure of how well we know the *c.v.*s on the synthetic species proportions. It is itself a *c.v.*, and features of its estimation are as follows:

- The simulation method comprises 1000 iterations in each "model run". For each of the iterations a set of species proportions is produced, which is accompanied by a set of *c.v.*s.

These are the *c.v.*s on the species proportions, and there are 1000 sets of them, one for each iteration of the "model run".

- The diagnostic "noise" figure has been referred to as the *c.v.* on the *c.v.*s (*see* Appendix 4). It is the *c.v.* based on the mean of the *c.v.*s from the 1000 iterations of a "model run". It is therefore a measure of the variability in the *c.v.*s of the synthetic species proportions and can be referred to as a measure of how well we know the *c.v.*s on the synthetic species proportions.

The simulation was run with the maximum likelihood estimates of θ (0.88, 0.72, and 0.26 for *T. declivis*, *T. novaezelandiae*, and *T. s. murphyi* respectively) from the "real-time" observer coverage. An initial run, based on extreme input values for observer coverage and sample weight (100% and 1000 kg respectively), provided a baseline measure for the test statistic of 14%. This was a measure of the least amount of variability in the *c.v.* of the species proportions that could be attained reasonably at the specified values of θ, and provided a comparison for the test statistic's output by the simulations.

The simulation was run using five levels of observer coverage — 5, 10, 20, 35, and 50% (the current level is about 7%) — and several levels of sample weight (30, 65, and 300 kg). Initial results showed that sample weight had little effect on the test statistic. Plots of absolute values of the test statistic for *T. declivis* and *T. novaezelandiae* against observer coverage for a sample weight of 300 kg (Figure 2) suggests that at an observer coverage of 50% the variability is very similar to the baseline measure and that most of the reduction in the variability occurs at low values of observer coverage.

The simulation was rerun using values of θ that were greater by a factor of 10 (9, 7, and 3 for *T. declivis*, *T. novaezelandiae*, and *T. s. murphyi* respectively) to investigate the difference in response between "low" and "high" values of θ (Figure 3). In this case the test statistic was normalised to 100% observer coverage. There is little difference in the response to the two levels of θ.

From the plots it is clear that uncertainty about the synthetic species proportions is almost halved with an increase of observer coverage from current levels to 20%. By increasing observer coverage still further, to 35%, uncertainty about the synthetic species proportions is reduced to about 15% of its value at current levels of observer coverage. After this there are only small reductions for relatively large increases in observer coverage. A reasonable target for observer coverage would therefore be about 30% coverage of tows.

b) Determination of current and potential coverage of industry observers

A measure of the potential coverage from industry observers was developed in consultation with industry. Industry observers are potentially able to provide about 30% coverage of the TCEPR fleet, but they have demands on their time that will limit their contribution to about 50% of the tows. Thus, their effective coverage is about $\left(\frac{1}{2}\times\frac{1}{3}=\frac{1}{6}\right)$ or a little more than 15% of the fishery. Industry observers will not be required to collect otoliths. They will assist with collection of species-proportions data.

c) Determination of required scientific observer coverage

Overall observer coverage (percentage of tows observed) by scientific observers since 1986 has been about 7%. This level has varied somewhat from year to year (Figure 4). To reach our target of 30% coverage of tows in the fishery, this level needs to be increased by a little more than a factor of 2, thus providing 15%, and a total coverage of tows by scientific and industry observers of around the required target of 30%.

The mean daily number of tows in the TCEPR fishery for jack mackerel is most often 2 (Table 6), although there is variation from 1 to 4 tows. In many cases the mean daily coverage by scientific observers has only been of 1 tow (Table 7) although there are a number of cases where similar mean values are evident in the two datasets (Tables 6 and 7). Nevertheless, during 1997, 1998, and 1999 the mean daily coverage has been significantly less than the mean daily number of tows in the fishery (i.e., 0.77, 0.55, and 0.68 respectively).

11. Conclusions

The results of the simulation suggest that most of the reduction in the diagnostic "noise" figure occurs at an observer coverage somewhere between the minimum value included in the simulation (5%) and a level of 25 to 35%. Setting a target level of 30% based on this result seems reasonable and allows some flexibility, given that there is little difference in the test statistic between 25 and 35%. Some flexibility will be necessary. For instance, scientific observers will be required to provide an audit of industry observers data by sampling some of the tows that the industry observers sample. To provide background information for the auditing process on the variability between samples from the same tow, the sampling method will include multiple samples from single tows.

The estimates of how much the daily observer sampling falls short of the number of daily tows per vessel discussed in the previous section obviously lack any real precision. However, they show that it is possible to increase the level of coverage by at least half of that required to reach the target of 15%, by simply increasing the number of tows sampled. This does not represent an increase in observer days, and therefore, with no additional cost to the scientific observer programme (SOP), coverage could be raised to a level that is within about 3–4% of the required target.

Increasing coverage to make up this shortfall could be accomplished in several ways. The obvious and simple approach would be to simply increase the approximately 220 days that have been allocated for JMA 7 over the last 10 years — regular confirmation of allocations at a level of 330 days, split between JMA 3 and 7 are available until 1996–97; recent confirmation from the SOP was that 220 and 100 days of observer coverage was met in JMA 7 and JMA 3 respectively during 1998–99. Alternatively, sampling could be extended into the hoki fishery.

The latter approach is probably the more acceptable, because it would ensure that of all the strata identified in the present study, all those providing jack mackerel catch should be sampled. Most of the "winter" catch of jack mackerel in the JMA 7 TCEPR fishery is associated with the hoki target fishery, either as bycatch or "by-targeting". There is good coverage of vessels in the hoki fishery and extending the observers' duties to include sampling of the jack mackerel catch has been confirmed as achievable by the SOP. This would undoubtedly ensure that the 15% coverage required of the scientific observers could be met, once again with no additional cost to the SOP.

Eventually it might prove that a lower level of coverage could be allocated to the JMA 7 TCEPR vessels, if the sampling in the hoki fishery proves to be reliable. There are a number of uncertainties associated with sampling the hoki bycatch and "by-targeting" that can only be clarified after a year of sampling is complete. These include the regularity with which samples can be taken and the potential size of samples, which will provide information on how extensive the distribution of samples of acceptable size can be in time and space. This in turn should allow us to determine what trade off can be made with the level of coverage and the distribution of observers on jack mackerel TCEPR vessels.

One issue that has not been dealt with here is observer coverage on TCEPR vessels in the JMA 3 fishery because it was outside the objectives of the present work. Species proportions from JMA 3 mostly contain two species only (*T. declivis* and *T. s. murphyi*) (*see* Table 3) which reduces the complexity of the problem. Future work could be extended to use the simulation approach with data from this Fishstock to determine the level of coverage. In the meantime the increased tow sampling should also apply in this area with the view of examining this area more closely at a later time.

For JMA 7 (and probably for JMA 3 as well) estimated coverage will provide data for the first year, which can be incorporated into the simulation process to refine coverage in subsequent years. Uncertainty in the value of θ is probably a result of the patchiness of the observer data and more complete coverage will help to provide better estimates of θ for the three species, and consequently, a better estimate of the required observer coverage.

Recommended observer coverage

- Maintain the levels at 330 days per year, split approximately 1:2 between JMA 3 and 7 respectively.
- Increase tow sampling for species proportions data (this does not include measuring fish for length frequency data, only counting and weighing the species sub-samples after sorting) to include sample data from up to 4 tows per vessel per day, and multiple samples from large tows (*see* Appendix 3, "Data collection for species proportions").
- Extend sampling of the jack mackerel catch into the hoki fishery to sample all tows from which a sample of 65 kg can be drawn; fish to be measured for one in five samples.

12. Publications

Nil.

13. Data Storage

Nil.

14. References

Jones, J.B. 1990: Jack mackerels (*Trachurus* spp.) in New Zealand waters. *New Zealand Fisheries Technical Report No. 23.* 28 p.

Taylor P.R. 1999: An examination of species proportion estimates, standardised stock indices, and the use of age-structured stock assessment models for jack mackerel, *Trachurus declivis* and *T. novaezelandiae*, in JMA 7. New Zealand Fisheries Assessment Research Document 99/54. 54 p. (Unpublished report held in NIWA library, Wellington.)

Taylor, P.R. & Richardson, K.M. 2000: Determining acceptable *c.v.*s on proportions of *Trachurus* species in the JMA 7 catch. Draft Final Research Report to the Ministry of Fisheries.

Table 1: Number of tows by year for jack mackerel (*Trachurus* spp.) in the database *obs_lfs*

Year	Number of records
1986	288
1987	96
1988	57
1989	172
1990	50
1991	531
1992	228
1993	523
1994	376
1995	381
1996	311
1997	619
1998	341
1999	394
2000	53

Table 2: Number of observed and total (in parentheses) tows by year and quarter in the jack mackerel fishery in JMA 7. (Sources: scientific observer database, MFish catch & effort database)

Fishing year	Quarter				Annual totals (by fishing year)	Coverage as % of annual total
	October–December	January–March	April–June	July–September		
1989–90	21(501)	20(523)	0(567)	0(518)	41(2109)	1.9
1990–91	9(129)	130(465)	217(554)	41(368)	397(1516)	26.2
1991–92	143(1005)	46(500)	12(1040)	28(362)	229(2907)	7.8
1992–93	142(923)	378(775)	71(691)	1(271)	592(2660)	22.3
1993–94	73(891)	150(544)	134(625)	47(490)	404(2550)	15.8
1994–95	47(494)	358(500)	6(571)	2(383)	413(1948)	21.2
1995–96	15(58)	209(357)	71(450)	7(511)	302(1376)	21.9
1996–97	24(217)	283(153)	26(419)	36(587)	369(1376)	26.8

Table 3: Species proportions estimated from scientific observer data for the three *Trachurus* species in JMA 3, for years and months in which sampling data were available; n is the number of trawls in which the particular species was present (Source: Observer database)

		T. declivis		*T. s. murphyi*		*T. novaezelandiae*	
Year	Month	Proportion	n	Proportion	n	Proportion	n
1986	9	0	0	1	1	0	0
1987	1	1	1	0	0	0	0
1987	3	0.77	3	0	0	0.23	1
1987	6	0.78	3	0	0	0.22	3
1988	1	0.19	2	0.79	1	0.02	1
1989	2	0	0	1	1	0	0
1989	11	0.3	2	0.7	2	0	0
1990	10	0	0	1	2	0	0
1991	2	0	0	1	1	0	0
1991	3	0	0	1	4	0	0
1991	10	0.01	2	0.99	6	0	0
1991	11	0	1	1	2	0	0
1992	1	0	0	1	1	0	0
1992	2	0	0	1	2	0	0
1992	3	0	0	1	2	0	0
1992	4	0	0	1	1	0	0
1993	1	1	1	0	0	0	0
1993	2	0	0	1	40	0	0
1993	3	0	1	1	26	0	0
1993	4	0.19	16	0.8	51	0	1
1993	5	0	0	1	2	0	0
1993	11	0	0	1	2	0	0
1994	2	0	0	1	9	0	0
1994	3	0.84	2	0.16	16	0	0
1994	4	0.74	2	0.26	3	0	0
1994	5	0	1	1	6	0	0
1994	6	0	0	1	2	0	0
1995	2	0	0	1	7	0	0
1995	3	0	0	1	4	0	0
1995	4	0.07	1	0.93	3	0	0
1995	5	0.04	1	0.96	1	0	0
1995	12	0.03	7	0.97	8	0	0
1996	1	0.02	17	0.98	22	0	0
1996	2	0	0	1	6	0	0
1996	3	0.01	6	0.99	15	0	0
1996	4	0.01	19	0.99	49	0	0
1996	5	0	0	1	2	0	0
1997	1	0	0	1	1	0	0
1997	2	0	0	1	3	0	0
1997	3	0	0	1	4	0	0
1997	4	0	0	1	5	0	0
1997	5	0.01	1	0.99	2	0	0
1997	12	0.02	10	0.98	15	0	0
1998	1	0.03	16	0.97	20	0	0
1998	2	0	0	1	17	0	0
1998	3	0.01	2	0.99	4	0	0
1998	4	0.04	3	0.96	4	0	0
1999	2	0.15	4	0.85	14	0	0
1999	3	0.15	16	0.85	17	0	0
1999	4	0.16	9	0.84	17	0	0

Table 4: Species proportions estimated from scientific observer data for the three Trachurus species in JMA 7, for years and months in which sampling data were available; n is the number of trawls in which the particular species was present (Source: Observer database)

		T. declivis		*T. s. murphyi*		*T. novaezelandiae*	
Year	Month	Proportion	n	Proportion	n	Proportion	n
1986	9	0.68	3	0	0	0.32	3
1986	11	0.65	49	0	0	0.35	48
1986	12	0.57	92	0	0	0.43	84
1987	1	0.54	32	0	0	0.46	27
1987	4	0.08	1	0	0	0.92	1
1987	5	0.31	12	0	0	0.69	10
1987	11	0.99	1	0	0	0.01	1
1988	1	0.52	6	0	0	0.48	4
1988	2	0.92	3	0	0	0.08	1
1988	3	0.32	3	0	0	0.68	3
1988	12	0.53	18	0	0	0.47	15
1989	8	0.97	3	0.03	2	0	0
1989	9	0.74	7	0.18	3	0.08	2
1989	10	0.48	13	0.2	4	0.32	9
1989	11	0.47	66	0	7	0.52	47
1989	12	0.13	2	0	0	0.87	2
1990	3	0.03	5	0	0	0.97	16
1990	4	0.1	5	0	0	0.9	13
1990	6	0.68	1	0	0	0.32	1
1990	12	0.67	4	0	0	0.33	3
1991	2	0.57	9	0.01	2	0.43	6
1991	3	0.47	51	0	5	0.52	52
1991	4	0.3	89	0	2	0.7	89
1991	5	0.28	18	0	1	0.71	18
1991	7	0.66	3	0.34	3	0	0
1991	8	0.17	3	0.83	6	0	0
1991	9	0.48	13	0.39	9	0.13	4
1991	10	0.48	3	0.02	1	0.5	3
1991	11	0.51	33	0.04	24	0.45	28
1991	12	0.4	16	0.04	8	0.56	16
1992	3	0.33	17	0.02	1	0.65	23
1992	5	0.86	8	0.07	2	0.07	1
1992	7	0.15	6	0.7	6	0.15	6
1992	8	0	0	1	2	0	0
1992	9	0.48	5	0.52	3	0	0
1992	10	0.84	2	0.16	2	0	0
1992	12	0.67	51	0.11	42	0.22	45
1993	1	0.61	58	0.14	56	0.25	52
1993	2	0.5	47	0.21	47	0.3	47
1993	3	0.68	1	0.05	1	0.28	1
1993	6	0	0	1	1	0	0
1993	8	0	0	1	1	0	0
1993	10	0.18	2	0.16	2	0.65	7
1993	11	0.64	25	0	0	0.36	18
1993	12	0.69	11	0.05	1	0.27	5
1994	1	0.54	20	0.07	14	0.39	17
1994	2	0.32	24	0.26	24	0.42	24
1994	5	0.33	17	0.24	13	0.43	15
1994	6	0	29	0	28	0	18

Table 4 — *Continued*

		T. declivis		*T. s. murphyi*		*T. novaezelandiae*	
Year	Month	Proportion	n	Proportion	n	Proportion	n
1994	7	0.08	14	0.92	20	0	0
1994	8	0	0	1	4	0	0
1994	9	0.65	4	0.35	3	0	0
1994	12	0.32	18	0.36	16	0.33	13
1995	1	0.31	98	0.22	84	0.47	92
1995	3	0.29	23	0.5	26	0.21	24
1995	7	0.06	1	0.94	1	0	0
1996	2	0.39	27	0.22	17	0.39	25
1996	3	0.56	31	0.21	19	0.23	24
1996	6	0	0	1	1	0	0
1996	8	0.05	3	0.95	4	0	0
1996	12	0.66	8	0.07	8	0.27	8
1997	1	0.59	53	0.07	49	0.34	53
1997	2	0.64	36	0.06	31	0.3	35
1997	3	0.51	6	0.22	6	0.26	6
1997	6	0.53	9	0.47	9	0	0
1997	7	0.09	1	0.91	2	0	0
1997	8	0.1	3	0.9	3	0	0
1997	9	0.08	12	0.92	15	0	0
1997	11	0.44	45	0.19	45	0.37	43
1997	12	0.38	40	0.12	36	0.5	40
1998	1	0.61	65	0.09	54	0.3	64
1998	2	0.52	18	0.04	13	0.44	18
1998	7	0.17	1	0.83	5	0	0
1998	12	0.44	13	0.15	13	0.41	13
1999	1	0.46	19	0.12	18	0.42	19
1999	4	0.87	11	0	0	0.13	5
1999	6	0.98	48	0.02	17	0	0
1999	7	0.79	23	0.21	15	0	0
1999	8	0	0	1	1	0	0
1999	9	0.41	7	0.26	3	0.33	3
1999	10	0.78	42	0.14	32	0.08	20

Table 5: Summary of otoliths from *Trachurus symmetricus murphyi* collected by scientific observers (SOP) and on research trawl surveys (RES). (Source: Otolith collection database)

Origin	Year & month	Trip number	Area	Fishstock	No. of otoliths
*RES	February 1990	COR9001	WCSI, TKB, TASB	JMA 3 & 7	?
*SOP	June 1990	420	CHA	JMA 7	?
*SOP	December 1990	454	CHA	JMA 7	?
*SOP	July 1991	474	CHA	JMA 7	3
*RES	December 1991	TAN9106	CHAT, MERN	JMA 3	?
SOP	July 1992	549	CHA	JMA 7	3
*SOP	December 1992	571	CEW	JMA 7	10
SOP	Feburary 1993	584	SOU	JMA 3	59
SOP	Feburary 1993	586	SOU	JMA 3	11
SOP	Feburary 1993	589	SEC	JMA 3	5
SOP	February 1993	589	SOU	JMA 3	73
SOP	February 1993	590	SOU	JMA 3	1
SOP	March 1993	596	SOU	JMA 3	30
SOP	February 1994	717	SOU	JMA 3	16
SOP	March 1994	728	SOU	JMA 3	2
SOP	July 1994	776	CHA	JMA 7	7
SOP	December 1994	820	CEW	JMA 7	25
SOP	December 1994	820	CHA	JMA 7	2
SOP	December 1994	822	CEW	JMA 7	9
SOP	January 1995	830	SOU	JMA 3	7
SOP	February 1995	833	CEW	JMA 7	22
SOP	February 1995	833	CHA	JMA 7	10
SOP	February 1995	833	SOU	JMA 3	5
SOP	February 1996	899	CEW	JMA 7	80
SOP	February 1996	899	CHA	JMA 7	30
SOP	March 1996	904	SOI	JMA 3	24
SOP	March 1996	908	SEC	JMA 3	6
SOP	March 1996	908	SOI	JMA 3	56
SOP	March 1996	908	SOU	JMA 3	138
SOP	April 1996	911	SOI	JMA 3	15
SOP	March 1997	985	SOE	JMA 3	66
SOP	March 1997	985	SOU	JMA 3	22
SOP	August 1997	1034	CHA	JMA 7	4
SOP	February 1998	1077	SOU	JMA 3	13
SOP	February 1998	1079	SOU	JMA 3	7
SOP	March 1998	1090	SOU	JMA 3	3
SOP	March 1998	1190	SOU	JMA 3	6
*SOP	December 1998	1179	CEW	JMA 7	289
SOP	January 1999	1192	SOU	JMA 3	2
SOP	January 1999	1193	SEC	JMA 3	3
SOP	March 1999	1209	SOU	JMA 3	9

*Not on database—otolith count not always readily accessible

Table 6: Mean daily number of tows in the JMA 7 TCEPR fishery. Source: MFish catch and effort database

Year/Month	1	2	3	4	5	6	7	8	9	10	11	12
1989					3	2	1	2	2	3	2	3
1990	3	4	3	2	2	3	2	2	3	3	2	3
1991	3	3	3	4	2	2	1	2	2	3	3	3
1992	3	3	3	2	3	3	2	1	2	3	3	2
1993	3	3	4	3	3	2	2	1	2	3	4	3
1994	4	4	1	1	3	3	2	1	2	3	3	3
1995	3	2	4	2	3	3	2	1	2	2	2	2
1996	3	2	2	2	3	2	2	2	2	2	2	2
1997	2	2	2	2	2	2	2	1	2	2	2	2
1998	2	2	2	2	2	2	2	1	2	2	2	3
1999	2	2	2	2	2	3	2	1	2	3	2	3

Table 7: Mean daily number of observed tows in the JMA 7 TCEPR fishery. Blank cells indicate months with no observer coverage. Source: MFish observer database (*obs_lfs*)

Year/Month	1	2	3	4	5	6	7	8	9	10	11	12
1986									1		1	1
1987	1		1	1	1	2					1	
1988	1	1	1									1
1989		1						1	1	2	2	2
1990			1	1		1				1		2
1991		2	2	3	4		1	1	1	1	1	1
1992	1	1	2	1	1		2	1	2	2		2
1993	2	1	1	2	2	1		1		2	2	1
1994	2	2	1	1	1	2	2	1	1			1
1995	2	1	2	1	1		1					1
1996	1	2	1	1	1	1		1				2
1997	2	2	1	1	1	1	2	1	1		2	2
1998	2	1	1	1			1					1
1999	2	1	1	1		2	1	1	1	2	3	

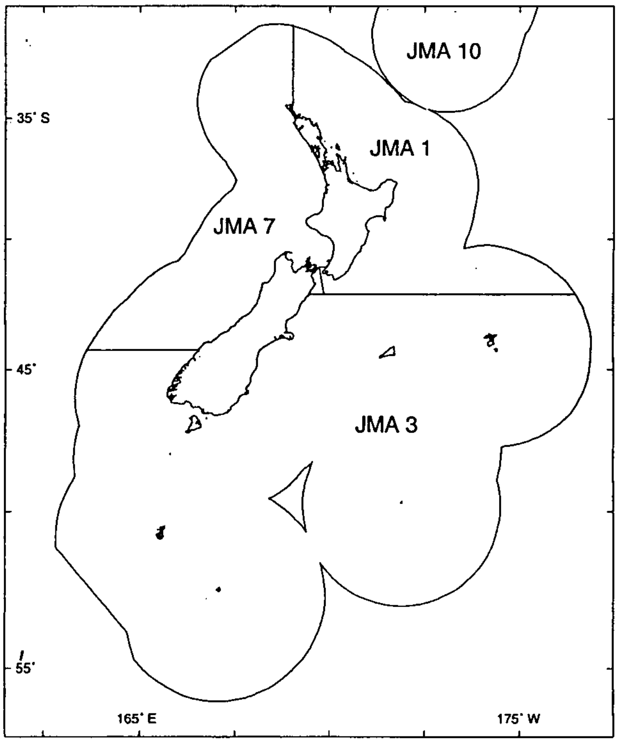


Figure 1: Jack mackerel Fishstocks

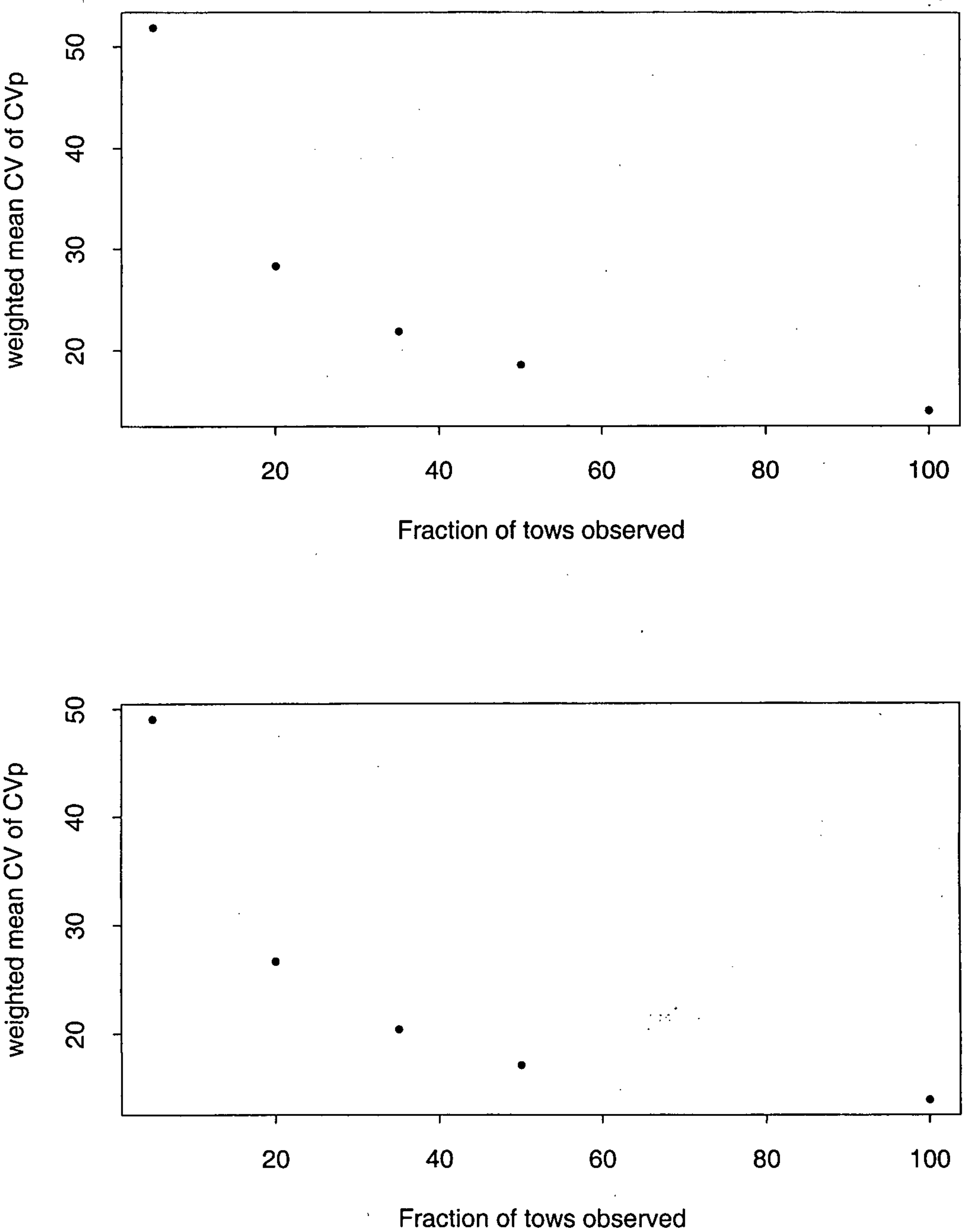


Figure 2: Plots of absolute values of the diagnostic "noise" value (weighted mean *CV* of the *CV*s of the species proportions p — CV_p) from the 1000 iterations of the simulation "model run", against the proportion of observer coverage as fraction of tows observed for *Traccurus declivis* above and *T. novaezelandiae* below; simulation runs were for sample weight fixed at 300 kg.

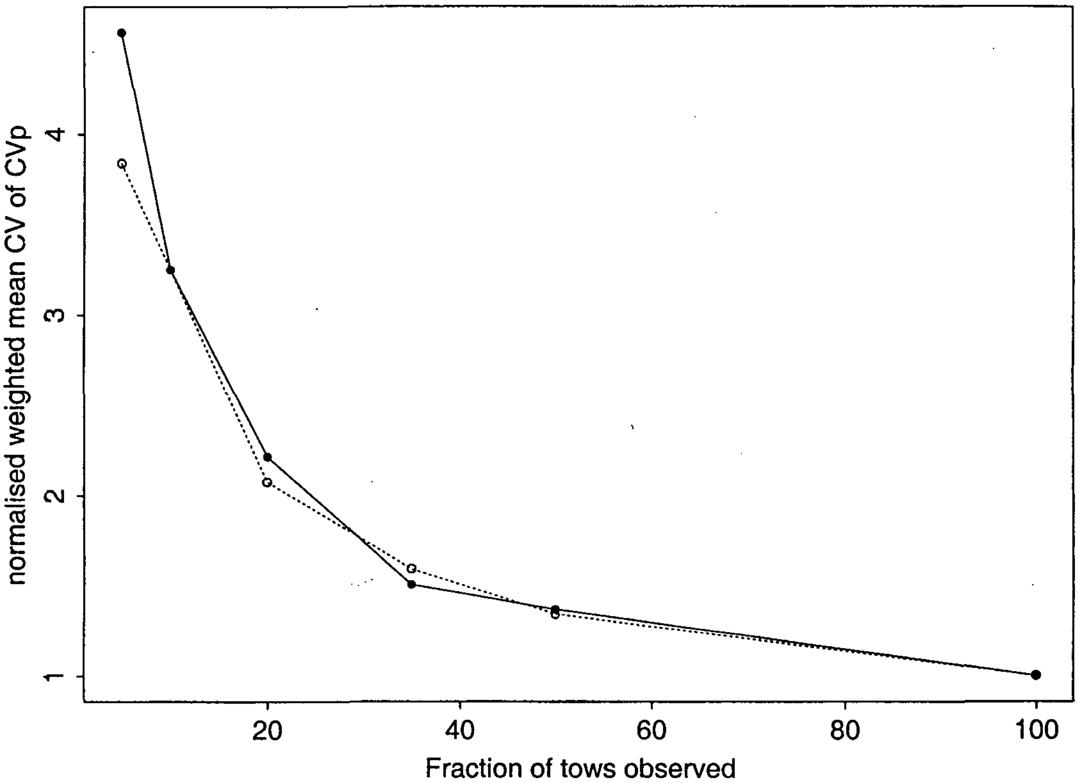


Figure 3: Plots for two series of θ of the diagnostic "noise" figure (*CV* of the *CV*s of the species proportions p — CV_p) from the 1000 iterations of the simulation "model run" normalised to 100%, against the proportion of observer coverage as fraction of tows observed for *Traccurus declivis*. Closed circles indicate "low" values of θ (0.88, 0.72, and 0.26 for *T. declivis*, *T. novaezelandiae*, and *T. s. murphyi* respectively; simulation runs were for sample weight fixed at 300 kg.

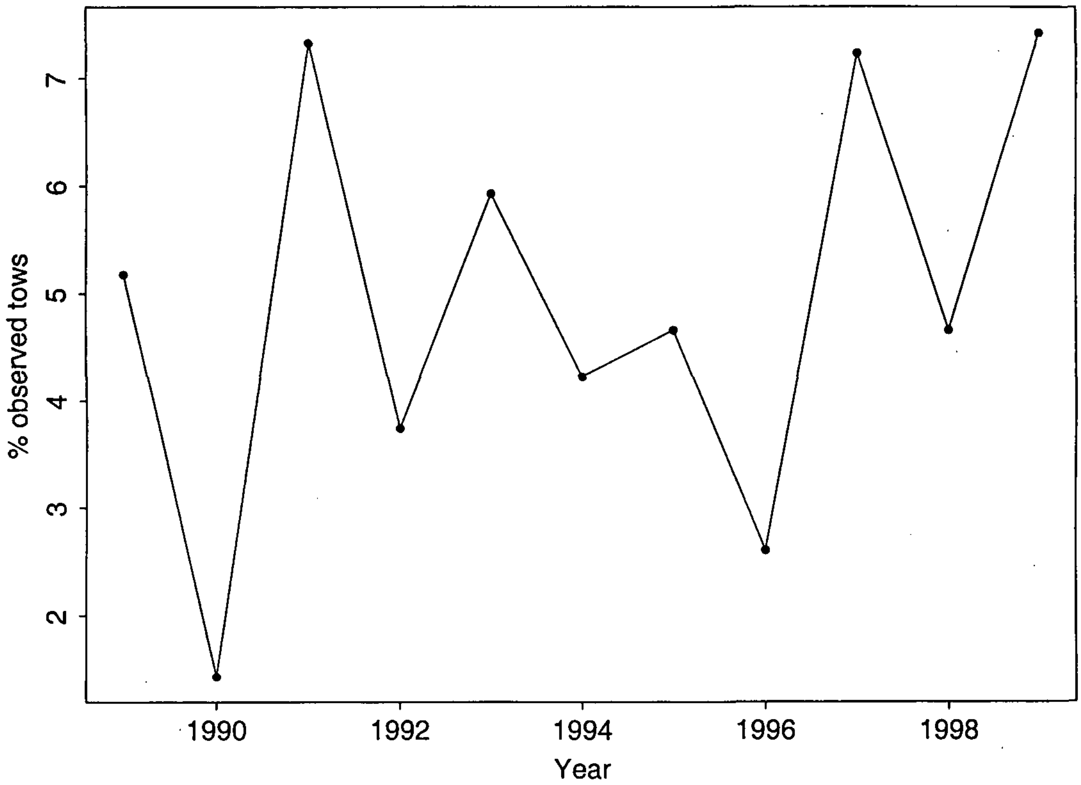


Figure 4: Annual proportions of tows in the JMA 7 TCEPR fishery that were observed.

Appendix 1: Scientific observer jack mackerel catch sampling programme — *from* The Scientific Observer Biological Collection Manual.

JACK MACKEREL CATCH SAMPLING PROGRAMME

Trachurus declivis	**JMD**
Trachurus novaezelandiae	**JMN**
Trachurus murphyi	**JMM**

OBJECTIVES

The objectives of this study are to determine the species composition, and collect data on the length distributions of the commercial catches of jack mackerels during the main trawling season. These data will be used in the stock assessment of jack mackerels.

SAMPLING DESIGN

The target population to be sampled is the jack mackerel catch taken by the commercial fishery. The objective is to estimate the age/length structure of the **catch** and **not** the age/length structure of the population in the sea. All sampling will be carried out on commercial fishing vessels. Therefore, the area fished will be outside the control of the programme. However, within these constraints the sampling will be random and stratified.

SAMPLING POINT

On each vessel a sampling point or points should be determined where samples can be obtained. Record this point at the start of the trip with a brief description of the method used to take samples. This point should not change from day to day, but remain fixed for the whole trip. The essential feature of the sampling point chosen is that jack mackerel **must not be sorted** by size before reaching the sampling point. Fish should be from one tow. All fish coming aboard should pass the sampling point **before sorting** occurs; e.g., fish pond, conveyor belt. Where there are several fish ponds or conveyor belts in use, an equivalent sampling point may be used on the alternative line.

Sampling should be convenient for observer and vessel personnel, easily completed in a short time frame and unambiguous; i.e., sampling point should be pre–determined.

DATA RECORDING

Each observer will be provided with a supply of length frequency forms. The data should be recorded directly onto these forms; no transcribing is required. The following information should be recorded for each sample taken:

(a) Tow Information
Record the date, trip code, initials of sampler and the tow number. The tow number should correspond to the station number in the observer catch effort log book.

(b) Fish Measurements
Fish should be identified to species (**see jack mackerel species identification key**) and measured. **Take a sample of 100-150 fish, then sort by species, weigh the separate samples and record weight(s) on a form per species.** Measure fork length (**FL, code as 1**), from the tip of the closed jaw to the fork (V) in the tail. Measurements should be to the nearest 1 cm below actual fork length; e.g., 40.6 cm is recorded as 40 cm. Sex should be

recorded for all fish. **Female gonad staging is required for *T. murphyi* only**: please use the generic 5 stages in Appendix 1. Damaged fish that cannot be measured should be excluded from the sample and the weight(s) subtracted from the sample weight

OTOLITH SAMPLE

Not to be collected unless specified: one pair of observers per season will collect a stratified sample.

SAMPLE FREQUENCY

Two length frequency samples should be taken per day, preferably one in the morning and one in the afternoon/evening.

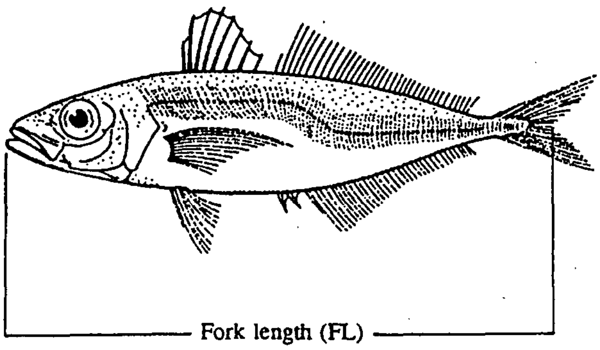
FISHING TECHNIQUES

The trawl fishery for jack mackerel is dominated by Japanese foreign licensed and joint venture vessels. In Japan, jack mackerel can fetch high prices, particularly the smaller fish (about 20 cm FL). Try to determine whether the vessel skipper is targeting small mackerel or simply taking what comes. Such information, although subjective, is useful in interpreting the length frequency data. Please record this information in the **Comments:** on the length frequency form and in your observer report.

CHECKLIST

JACK MACKERELS	
Species code	JMD JMM JMN
Measurement method : code	FL : 1
Sample size	100 - 150
Gonad staging	JMM
Otoliths	Not unless specified

- Select sampling point.
- Begin sampling at selected time.
- Record date, time, trip code, tow number, and initials on length frequency form.
- Draw sample of Mackerels all at one time. Sort by species and weigh, recording details for each species on separate length frequency forms.
- Stage female JMM.



Appendix 2: Jack mackerel otoliths collection instructions —*from* The Scientific Observer Biological Collection Manual.

Jack mackerel otolith collection

This project is to be conducted once in every season by one pair of observers. All other observers on vessels targeting jack mackerels will collect length frequency data, but no otoliths.

These otoliths are used to determine the age structure of jack mackerel populations off the central west coast. A stratified, rather than random, collection of otoliths is made to ensure that older fish are comprehensively represented.

Before beginning to collect otoliths you should be absolutely confident that you can distinguish the different species of jack mackerel. If you have any doubt about the identification of a mackerel. Do not collect its otoliths. Fish for otolith removal do not have to be selected randomly. In fact, you will need to actively search for fish of particular sizes to complete the otolith collection (especially very large and very small fish).

Select one otolith from each fish; it can be either the right or left otolith. Otoliths should be placed in paper envelopes labelled with the species and fork length (cm). All otoliths from a particular species and size class can be placed in one envelope; i.e. the otoliths from 15 *Trachrus declivis* with a fork length of 30 cm can all be placed in one envelope. Do not determine the sex of otolithed fish. The numbers of fish required from each size class are shown on the attached record form; mark individual otoliths on this form as you collect them. Attempt to fill out as many size classes as possible.

This is an exercise separate to the routine collection of jack mackerel length frequency data. Divide your time between collecting otoliths and collecting length data.

Appendix 3: Observer instructions for collection of jack mackerel data and biological material in the 2000–01 fishing year.

Data and biological collections from jack mackerel for 2000–01

Instructions for MFish observers

N.B. Before data or otoliths are collected, the observers involved should be absolutely sure that they can distinguish the different species of jack mackerel.

Collection of data and biological material for ageing *T. s. murphyi* in JMA 7

Sampling is to be carried out by scientific observers in the JMA 7 trawl fishery. The target will be to collect otoliths from 500 *T. s. murphyi*, and pectoral fins, scales, scutes, and operculae from a subsample of 100 *T. s. murphyi*, over the full size range in both the summer and winter fisheries. Unlike the stratified approach described below for other species and/or areas, initial sampling of *T. s. murphyi* in JMA 7 should be random, so that 500 otoliths are collected from a set of tows over some short time frame. The approach here would be to collect otoliths for, say, 50 fish per tow, choosing the fish randomly from each tow.

This randomness satisfies many of the statistical methods that are used. However, otoliths from *T. s. murphyi* present so much uncertainty that all size classes should be made up to thirty otoliths each, using a method similar to that described below for stratified otolith sampling. To ensure that information from the random sampling is not lost, otolith envelopes must be labelled — with an "R" for the randomly collected otoliths, and an "S" for the otoliths that are added later, following the stratified up-weighting of under-represented size classes.

Each fish in the sample is to be measured, weighed and sexed, and the data recorded on the storage envelope(s) — there will be more than one where pectoral fins, scales etc. are collected. Structures for ageing are to be removed from the specimen, with special processing as follows:

- The entire pectoral fin to be removed, dried , and stored in a labelled envelope.
- Several large, symmetrical scutes and scales will be selected, probably from the centre of the side of each specimen, and stored dry in a labelled envelope.
- One operculum from each fish to be removed, cleaned, dried, and stored in a labelled envelope.

N.B. The dryness of the biological material will determine their condition at the time of processing. Damp storage combined with time at sea results in deterioration, which might limit the use of the particular structure in the ageing project.

Otoliths for ageing *T. declivis* and *T. novaezelandiae* in JMA 3 and JMA 7, and *T. s. murphyi* in JMA 3

Otoliths for the two "New Zealand" species of jack mackerel have been collected by scientific observers since 1990 but the instructions need some clarification. These collections can be conducted once each season by one pair of observers. In the past otolith collections have been restricted to JMA 7, and the otoliths were used to determine the age structure of jack mackerel populations off the central west coast. From now on collections need to be carried out in JMA 3 as well, so that we can get some idea of the age structure in that area.

In this case a stratified collection will be made, rather than the random collection that has been defined above for *T. s. murphyi* in JMA 7. For *T. declivis* and *T. novaezelandiae* the otoliths are to be collected according to the following table, so that, for example, otoliths are taken from five specimens of *T. declivis* in all centimetre size classes that are smaller than 28 cm — that is five 27 cm fish, five 26 cm fish, five 25 cm fish and so on; or otoliths are taken from fifteen specimens of *T. novaezelandiae* in all centimetre size classes from 25 cm to 29 cm — that is fifteen 25 cm fish, fifteen 26 cm fish, fifteen 27 cm fish, fifteen 28 cm fish, fifteen 29 cm fish.

Number of fish to be sampled	*T. declivis* size classes	*T. novaezelandiae* size classes
5	< 28 cm	< 25 cm
15	28–37 cm	25–29 cm
30	> 37 cm	> 29 cm

For *T. s. murphyi* in JMA 3, otoliths should be taken from 30 fish for all size classes. This is because there is much more uncertainty in reading the otoliths from this species.

Select one otolith from each fish; it can be either the right or left otolith. Otoliths should be placed in paper envelopes labeled with the species and fork length (cm). All otoliths from a particular species and size class can be placed in one envelope; i.e. the otoliths from 15 *Trachurus declivis* with a fork length of 30 cm can all be placed in one envelope. Do not determine the sex of otolithed fish.

To ensure that the correct number of otoliths from all size classes are collected, otoliths must be recorded on the otoliths check sheet as soon as possible after removal from the fish.

Data collection for species proportions

The current sampling method and data recording is to be continued according to the directions in the section, "Jack mackerel catch sampling programme" in The Scientific Observer Biological Collection Manual. In all cases the minimum sample size must be no smaller than 65 kg. The sampling frequency should be up to 4 times daily, where there are more than two tows, or, where tows are large, more than one sample should be taken from the tow. Where more than two samples are being taken in a day, length frequency data should not be collected for the additional samples. For the additional samples, 65 kg samples should be drawn according to the directions headed "Sampling point" in the section, "Jack mackerel catch sampling programme". They should be sorted by species, and the species' sub-samples so derived should be weighed, the fish counted for each sub-sample, and the data recorded.

Multiple samples from a single tow should be based on the following schedule:

- Tows with jack mackerel catch up to 5 t — 1 sample.
- Tows with jack mackerel catch between 5 and 10 t — 2 samples.
- Tows with jack mackerel catch greater than 10 t — 3 samples.

Sampling on vessels carrying industry observers

Industry observers are assisting with this programme on some vessels. However, MFish observers should always collect data (and otoliths, if required), irrespective of the activities of industry observers.

Appendix 4: The simulation method.

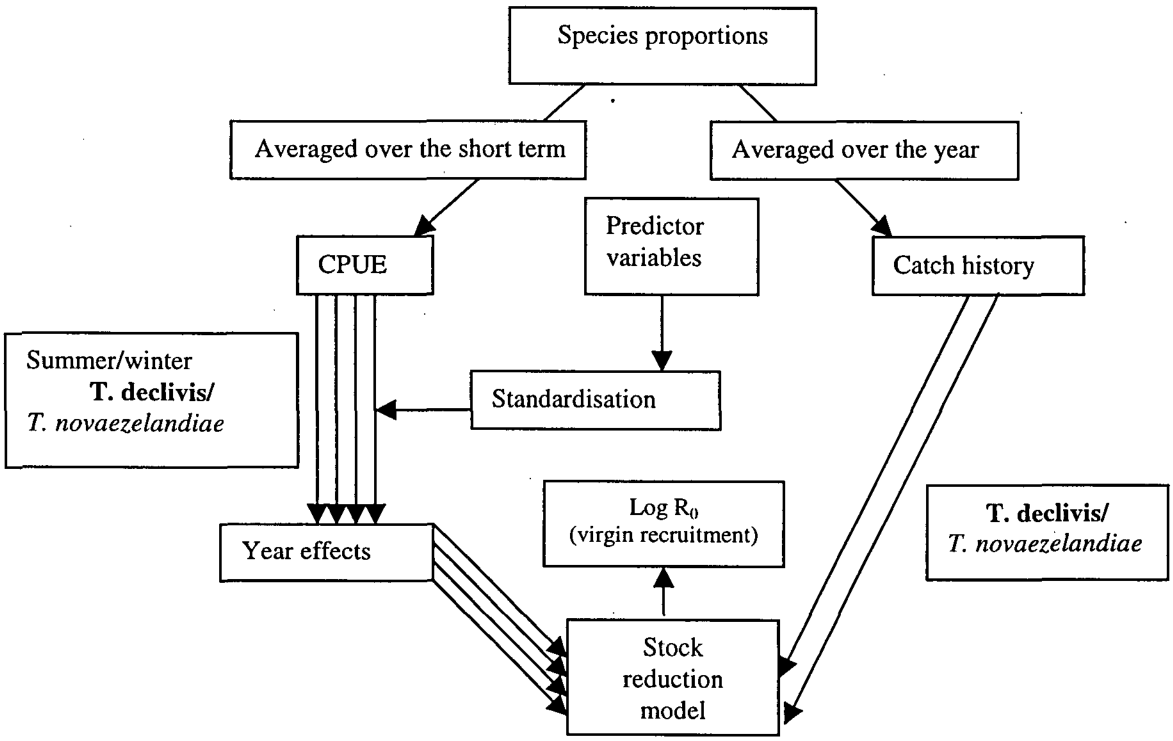
A simulation method was developed to investigate aspects of the method described by Taylor (1999) where standardised stock indices based on CPUE were used as inputs to a stock reduction model to estimate virgin biomass for the two New Zealand species of jack mackerel (*Trachurus declivis* and *T. novaezelandiae*) in Fishstock JMA 7. Development of the simulation method included the following:

1. Automation of Taylor's (1999) method.
2. Determination of an appropriate distribution for drawing the simulated observer samples.
3. Definition of a diagnostic measure of the variability in the synthetic observer species proportions.

Taylor's (1999) method was characterised by

- CPUE derived from quarterly species proportions; catch history based on annual means of species proportions.
- Summer/winter stratification of the catch and effort data.

Taylor's (1999) method can be represented by the following flowchart.



An automated application was written in S-plus. The negative binomial was chosen as the distribution from which the simulated observer samples were drawn because the original observer data appeared to follow this distribution; it also provided the flexibility of testing an approximation to the Poisson. The diagnostic statistic chosen was the variability in the *c.v.*s of the species proportions — specifically, the *c.v.* of the *c.v.*s. This provided a measure of the how the *c.v.*s of the species proportions varied as the inputs to the simulation model (the negative binomial shape parameter θ, observer coverage, and the sample weight) were varied. This statistic indicates how closely mean observed "bin" *c.v.*s reflect the population *c.v.* If it is "small", the observer sampling procedure is performing within acceptable limits.

Main features of the simulation method