NIWA

Taihoro Nukurangi

Estimation of sealion captures in southern fisheries in 1998

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Objective 2

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Final Research Report

Report Title: Estimates of sealion captures in southern fisheries in 1998

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2. **Contractor:** National Institute of Water and Atmospheric Research Limited

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5. **Project Leader:** S. Baird

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   Start Date: 1 October 1997
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7. **Objectives:**

This report described work produced as part of Objective 2 of Project ENV9701: To provide weekly within season estimates of total captures, releases, and deaths by sex and area for New Zealand sea lions taken in the southern squid trawl fishery beginning two (2) weeks after the start of the fishery until 15 May 1998. Estimates of the confidence intervals and coefficient of variation of the point estimates must also be provided.

8. **Executive Summary:**

The squid season in SQU 6T started in February and finished at the end of March. Four in-season reports were provided to the Ministry of Fisheries (MFish). In-season estimates of total kills were estimated from the fraction of observed tows that caught New Zealand sea lion (using MFish observers' data) times the total number of tows. The data were collected on a weekly basis by companies and collated by Seafic. The final in-season estimate of total kills of New Zealand sea lions was 62 with a *c.v.* of 23% (13 female, *c.v.* 51%).

The strike rate (kills per 100 tows) reported by company observers (0.46) was substantially lower than that reported by MFish observers (4.44) and this difference was greater than in previous years.

The in-season method seems adequate when checked retrospectively with TCEPR and observer logbook data from February to March 1997 squid season in SQU 6T along with the final corrected total of New Zealand sea lions killed from audits of species identification done on carcasses (both sea lions and seals) brought back to New Zealand. The latitude profiles of the frequency of tows were similar for the observed tows and for tows from the whole fleet. Thus, no gross biases are present in the observer data from over-sampling atypical areas in SQU 6T. Spatial atypical areas are a potential problem because the 1997 data showed a reduced strike rate of New Zealand sea lions in the extreme north and south parts of SQU 6T.

Observed captures were of dead animals so only within season estimates of deaths are provided here.

9. Methods:

Data

For the in-season calculations, data were provide by Seafic in the form of weekly reports collated from company reports. The data included the number of observed tows by MFish observers and company observers, the total number of tows for the fleet, and the number of kills of New Zealand sea lions. Sea lion kills are counted against MFish observers and company observers when both are present on a vessel.

Sources of February to March 1997 data used to check the in-season method were:

1. observed New Zealand sea lion capture data:
    - EMPRESS database *obs_lfs* developed and administered by NIWA
2. observed fishing effort data:
    - MFish Observer EMPRESS database *obs*
3. total fishing effort data
    - MFish Trawl Catch and Effort database
    - EMPRESS database *squid* developed and maintained by NIWA from TLCER records in the MFish Catch and Effort database

In-season calculations

Three variables were to be estimated for males and females separately at the end of each week t:

- total captures (T_c)
- total number of New Zealand sea lions released (T_r)
- total number of New Zealand sea lions killed (T_k)

The method described below was used to estimate these variables.
For example, to estimate the number killed:

$$T_k = N_t \, p_{k,t}$$

where N_t is the total number of observed tows up to week t, and $p_{k,t}$ is the fraction of the tows in which New Zealand sea lions were killed, that is,

$$p_{k,t} = \frac{a_{k,t}}{m_t}$$

where m_t is the number of observed tows up to week t and a_k is the number of observed New Zealand sea lion deaths.

Because data are not available on the clustering of observers on vessels, the sampling distribution will be approximated by the binomial model. This is considered appropriate because generally only one New Zealand sea lion is caught in a single tow.

Thus, the coefficient of variation of T_k is given by:

$$c.v. = \sqrt{\frac{1-p_k}{mp_k}(1-\frac{m}{n})}$$

where the t suffix has been suppressed for clarity.

No formula can be expressed for the 95% confidence intervals, so these are estimated by a simulation procedure in which the true value of p_k is made to equal to the estimated one. This procedure incorporates the effect of the sampling fraction (that is, the proportion of tows which are observed) and is equivalent to the $(1-\frac{m}{m})$ term in the *c.v.* formula. The bootstrap also incorporates the fact that a_k New Zealand sea lions have been observed to be killed, so that the lower confidence limit cannot be lower than a_k.

Checking the in-season method

The total kills for the 1997 squid season in SQU 6T were estimated from TCEPR and observer logbook data for the same period as the 1997 in-season calculation were. Total number of tows and observed tows by MFish observers were also compared. The logbook data is considered more accurate because it is filled out at the time of each tow and gives the position of the tow. Discrepancies in the total kills between the two data sources, logbook against company reports (which are verbal and are collected each day), will show the accuracy of the in-season method.

Another important aspect is the spatial coverage of the observed tows. This should be in the same proportions as that for the fleet in case there are spatial differences in strike rates in the area, e.g., the strike rate may be reduced when fishing takes place further away from the rookeries. This was investigated in a simple way by comparing the latitude profile of the positions of tows for the fleet with that for MFish observed tow positions. The analysis used the same TCEPR and observer logbook data as used above.

10. Results:

In-season calculations

Four reports were made (Table 1); the first reported on data up to the 1 March 1998 and the last on data up to 23 March, when the squid season in SQU 6T was closed. The total estimated number of kills of New Zealand sea lions was 62 (*c.v.* = 23%) , of which 13 (*c.v.* = 51%) were female. The 95% confidence limits were 35–93 for all sea lions, and 4–31 for female sea lions. MFish observer coverage was 22.6 %. No captures were reported for the Snares Island part of the squid fishery.

Table 1: In-season calculations of kills of New Zealand sea lions over the 1998 squid season in SQU 6T from data collated by Seafic. "Observed" refers to MFish observers. Reported total kills` is the number reported to Seafic which includes kills observed by MFish and company observers and those observed by vessel captains

Data to date	Observed kills	Observed tows	Total tows	Estimated total kills	Reported total kills
1 March	7	199	622	22	7
8 March	10	261	979	38	11
15 March*	–	–	–	–	–
22 March	14	315	1386	62	15
23 March	14	315	1394	62	15

* No data were received for the week ending 15 March 1998.

Comparison of MFish and Company observer strike rates

The strike rate reported by MFish observers was 4.44 sea lions per 100 tows. Company observers (31% coverage) reported a strike rate of 0.46, which is 10.3% of that for MFish observers. This is substantially worse than in the previous 5 years (Table 2).

Table 2: Reported strike rates of New Zealand sea lions (kills per 100 tows) for MFish (or MAF) observers and company observers in SQU 6T during the squid season, and the ratio of strike rates, company/MFish. Data are from Seafic collated reports

Year	MFish observers	Company observers	ratio (%)
1993	2.0	0.8	40
1994	0.7	0.4	57
1995	2.9	1.0	34
1996	2.3	0.9	39
1997	3.7	1.2	32
1998	4.4	0.5	10

Differences in strike rates were tested for statistical significance using a *t*-test, assuming that animal captures in a tow are binomially distributed so that the estimate of the strike rate has a normal distribution when sample sizes are large, as is the case here. The strike rates were statistically significantly different at the 5% level for each year, 1996–98, but not significantly different for the years, 1993–95. Low MFish observer coverage in 1993–95 meant that the chance of detecting significant differences was low; but combining the 1993–95 data does give a significant difference. Combining data assumes that the strike rate was the same over these years.

Checks on the in-season method

For the 1997 squid season in SQU 6T, the number of tows, total and observed, were about 6–7 % greater than in the in-season data (Table 3), but the estimate of observer coverage was the same. There was no change to the number of kills seen by MFish observers after audits of the species identification of carcasses brought back to New Zealand so this number (25) was the same for both calculations. Therefore, the in-season estimate of total kills was about 6 % too high. This difference is well within the 18% *c.v.* for the estimate so this bias is inconsequential compared with sampling error and can be ignored.

Table 3: For the squid fishery in SQU 6T, 1997, the number of tows observed by MFish observers, the number of tows in the fishery, and MFish observer coverage to 16 March by the two sources of data: Seafic, and TCEPR and observer logbook data (MFish)

Source	Number of observed tows	Total tows	Observer coverage (%)
MFish	673	3326	20.2
Seafic	716	3585	20.0

The distribution of observed tows with latitude showed no gross differences to that for the fleet (Figure 1). Thus, at this crude level, the observed data approximately covered the area in the same proportion as the fleet data and so there should be no overt bias in the estimated strike rate. Figure 1 also shows the latitude where kills were observed; there is a lack of kills in the extreme north and south regions of the SQU 6T area despite similar proportions of tows, which means that the strike rate was lower there. Therefore, the proper spatial distribution of observer effort is needed to estimate mean strike rate for the area.

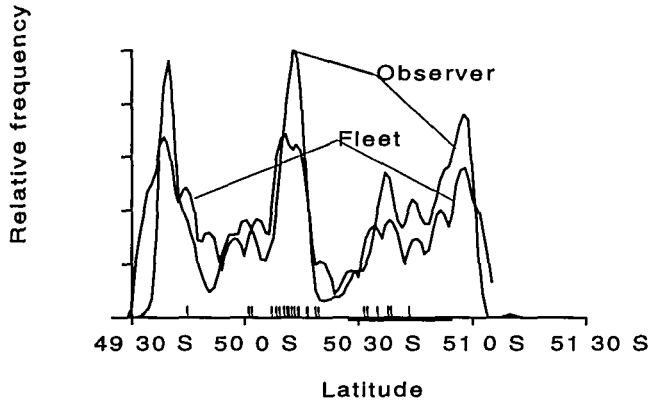

Figure 1: **Check of observed tows over the fleet's tow distribution: for SQU 6T in the 1997 squid season (January to March), the latitude profile of MFish observed tows and the fleet's latitude profile. The profiles have been normalised so that the area under each is 1.0. Short marks just above the x-axis show the latitude where sea-lions were observed by MFish observers to be caught. Solid bar shows the latitude extent of the Auckland Islands.**