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**In-season estimation of Hooker's sea lion
incidental captures in the 2001/02 southern
squid fishery (area SQU6T) — annual report on
Objective 2**

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**Final Research Report for
Ministry of Fisheries Research Project ENV2001/02
Objective 2**

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Final Research Report

- Report title:** In-season estimation of Hooker's sea lion incidental captures in the 2001/02 southern squid fishery (area SQU6T) — annual report on Objective 2.
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 2. **Contractor:** NIWA
 3. **Project title:** Estimation of *Phocarctos hookeri* (New Zealand or Hooker's sea lion) incidental captures in New Zealand fisheries
 4. **Project code:** ENV2001/02
 5. **Project leader:** S. Baird
 6. **Duration of project:**
 - Start date: 1 October 2001
 - Completion date: 30 September 2004

Executive summary:

The squid season in SQU 6T started in February and the last data were collected on 14 April 2002. Data were collected on a weekly basis by companies and collated by the Seafood Industry Council (SeaFIC). In-season estimates of total kills were estimated using the fraction of observed tows that caught Hooker's sea lions. Observed tows were defined as those tows that were observed by an MFish observer and which either did not use a sea lion exclusion device (SLED) or, if a SLED was used, then it was with a closed cover net. SLEDs are devices fitted to nets through which animals can potentially be ejected from the trawl net. SLEDs have a cover net at the exit site, which can be left open for animals to escape through, or closed so that no animals can escape. SLEDs were used on some tows in SQU 6T with both open and closed cover nets. No discount factor was applied to the encounter rate for using SLEDs with an open cover net, i.e., the kill rate was taken to be the same as the strike rate which was used for all tows, whether they used a SLED or not. The final in-season estimate of total kills of Hooker's sea lions in the squid management area SQU 6T was 84 with a c.v. of 26% and 95% confidence limits of 59–119.

Sex of the observed captures of dead animals were not reported, so no within-season estimates of female sea lions are provided here.

Objectives:

Programme Objectives:

1. To estimate the level of *Phocarctos hookeri* incidental capture in New Zealand fisheries.

2. To recommend appropriate levels of observer coverage for estimation of incidental capture of *Phocarctos hookeri* in New Zealand fisheries.

Specific Objectives:

Objective 2: Each year, to provide weekly within-season estimates (with confidence intervals) of total captures, releases, deaths by sex and area for *Phocarctos hookeri* taken in the southern squid fishery (area SQU6T) beginning two weeks after the start of the 2001/02 fishery until 30 May 2002, two weeks after the start of the 2002/03 fishery until 30 May 2003 and two weeks after the start of the 2003/04 fishery until 30 May 2004.

Introduction

The squid season in the southern waters of New Zealand operates on the shelf around the Snares Islands and the Auckland Islands. The fishery runs from either January or February to April or May, which overlaps with sea lion breeding for which the adult sea lion population concentrates at the rookeries. A 12 nautical mile exclusion zone around the Auckland Islands (in SQU 6T) prevents fishing close to the primary breeding rookeries.

Breeding begins in late November when adult males establish territories. Males leave in February, but females stay on to suckle their pups during which about 50% are foraging at sea at any one time. The foraging area overlaps with squid fishing on the Auckland Islands Shelf and results in incidental captures of sea lions. To restrict the impact of squid fishing on the population size of sea lions, the squid fishery is closed when the total number of sea lion deaths from incidental capture in squid trawls exceeds a level set before each squid season (currently 75). To monitor the total number of deaths, an estimate is made weekly during the season from observer data and company reports of total trawls all of which are collated by SeaFIC (Seafood Industry Council).

As part of the process of reducing kills of sea lions, a sea lion exclusion device (SLED) can be fitted to nets to allow the potential ejection of animals from the trawl net. There is a cover net at the exit site and, when this is left open, animals can escape. Following the trials of SLEDs in the 2000 season, all vessels in SQU 6T used SLEDs in the 2001 season. For 2002, only vessels collecting data from video cameras filming in closed cover nets were to use SLEDs and these vessel were all observed. The animals caught by these vessels were to be applied to these vessels only and they were not to be used to estimate a strike rate for the rest of the fleet.

For the rest of the fleet, the operational plan called for a strike rate to be estimated from a set of observed vessels so that about 20% of the total tows could be observed. No tows were to be done with a SLED. In practice, non-video vessels used SLEDs and some observed non-video vessel even used SLEDs with the cover net open. Because the observed coverage on tows that could be used to estimate the strike rate for the non-video fleet was below 20%, the data from the video vessels was combined with the data from the non-video vessels and one strike rate estimated for the whole fleet. Data to be used in the strike rate calculations were from observed vessels that

did not use a SLED and also those that used a closed cover net on the SLED. No discount factor was applied to the strike rate for animals that may have escaped the SLED alive.

This report summarises the method and results of the in-season estimation of the total number of deaths of Hooker's sea lions from squid trawling.

Methods

Data

All vessels in the southern squid trawl fishery report daily captures of Hooker's sea lions to SeaFIC weekly. The following attributes from the SeaFIC database were used to categorise the data:

- date
- area (SQU 1T or SQU 6T)
- used a SLED
- used a SLED with a closed cover net

For each category, the following data were collected:

- number of tows in a day
- number of tows that captured a sea lion
- number of sea lions captured and released alive
- number of sea lions captured and dead

The Ministry of Fisheries receives the following information on the numbers of Hooker's sea lions captured in the southern squid trawl fishery:

- daily reports of captures from MFish scientific observers on board squid vessels
- daily reports of captures from vessels carrying industry observers.

This information was received on a weekly basis and compared with the SeaFIC data, where possible. The data were checked and converted into a form suitable for the in-season analysis.

In-season calculations

At the end of each week t , total number of Hooker's sea lions killed (T_k) was estimated using MFish observer data:

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

where N_t is the total number of tows up to week t , and $p_{k,t}$ is the fraction of the tows in which Hooker's sea lions were killed (the strike rate), that is,

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

where m_t is the number of observed tows by MFish observers up to week t and $a_{k,t}$ is the number of observed Hooker's sea lion deaths by MFish observers. For SQU 6T, m_t and $a_{k,t}$ refer to observed tows that used a SLED with a closed cover net or observed tows where a SLED was not used.

Random sampling in the observer data, if this occurred at all, was in the choice of vessel to observe and when to observe it, not with individual tows. Thus, tows were observed in clusters, i.e., all tows for a vessel over some time period. This would not matter if consecutive tows were independent, and although this cannot be assumed automatically, it is assumed here

because data are not available by tow or by clusters of tows. Thus, the sampling distribution was approximated by the binomial model. This was considered appropriate because generally only one Hooker's sea lion is caught in a single tow, but if any large serial correlations are present for consecutive tows, then the variance estimate will be biased. For positive correlations, the estimate is biased low, but it is biased high if the correlation is negative.

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

$$\text{c.v.} = \sqrt{\frac{1-p_k}{mp_k} \left(1 - \frac{m}{N}\right)}$$

where the t suffix has been suppressed for clarity. Confidence limits were estimated using the method of Wendell & Schmee (2001) which is based on random sampling from a finite population using a hypergeometric distribution and under such conditions it gives the exact bounds with the shortest length. Because the actual sampling was by clusters, these estimated bounds may be too tight. Again, these bounds make no allowance for the error in the estimation of the discount rate, if used.

Weekly within-season estimates were submitted to the Manager of Science Policy, MFish, within two working days of receipt of the within-season Hooker's sea lion capture data from the SeaFIC.

Results

Ten reports were made (Table 1); the first reported on data up to 16 February 2002 and the last on data up to 14 April. The last day that fishing occurred was around 12 April when the fishery was closed. For SQU 6T, MFish observer coverage was 26% and the total estimated number of kills of Hooker's sea lions was 84 (c.v. = 26%). The 95% confidence limits were 59–119. The strike rate was 5.1 per 100 tows (c.v. 26%). One sea lion death was observed in SQU 1T.

Table 1: In-season calculations of kills (no discount rate applied) of Hooker's sea lions over the 2002 squid season in SQU 6T from data collated by SeaFIC. "Observed" refers to MFish observers. The strike rate was estimated using observed data on tows that used a closed cover net or tows where no SLED was used. Reported total kills is the number reported to SeaFIC which includes kills observed by MFish and industry observers and those observed by vessel captains.

Data to date	Closed cover net on SLED		Total tows	Estimated total kills	Reported total kills
	Observed kills	Observed tows			
16 February ^{†1}	3	74	365	16	3
23 February ^{†2}	4	100	463	19	4
2 March	5	118	542	24	5
9 March	5	132	658	25	5
17 March	6	180	837	28	6
23 March	8	263	1112	33	8
31 March	8	317	1294	32	8
7 April	14	357	1463	57	14
10 April ^{†3}	22	370	1514	91	22
14 April	22	434	1653	84	22

^{†1} Data from 3 vessels were missing, including 1 sea lion death.

^{†2} Adjustments made to data to account for missing data from 3 vessels.

^{†3} There were 8 kills since 14 April which were reported by C. Blincoe, MFish. The extra tows done since 14 April were estimated from the trend in the last 3 weeks.

Acknowledgements

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References

Wendell, J.P.; Schmee, J. (2001). Likelihood confidence intervals for proportions in finite populations. *The American Statistician* 55. 55–61.