TROPHIA

REPORT

Surveys of pre-recruits of *Jasus edwardsii* in CRA 8 using modified commercial pots – a pilot study

Anthony M. Hart

Trophia Ltd.

PO Box 60

Kaikoura

EXECUTIVE SUMMARY

Hart, A.M.; Surveys of pre-recruits of *Jasus edwardsii* in CRA 8 using modified commercial pots – a pilot study.

A pilot study was undertaken in the CRA 8 *Jasus edwardsii* fishery to investigate the feasibility of measuring pre-recruit abundance and size using modified commercial pots. Five rock lobster vessels set experimental pots from August to November 2001 at 14 sites between mid-Fiordland and eastern Stewart Island. At each site, pots were set in pairs of one normal commercial pot (N) and one without escape gap (WE) pot, and lifted between 5 (Site 10) and 29 (Site 3) times. All lobsters were counted; their tail width measured and sex status identified, and the data recorded on data sheets adapted from the logbook program. The catches of WE and N pots were compared statistically using 10 abundance and 10 size indicators, which included total number caught, overall average size, number of pre-recruits (under 54mm Tail Width [TW]), average size of pre-recruits and average size of large lobsters (over 60mm TW).

A total of 6592 lobsters between 28 and 90mm TW were sampled, measured and sexed. Of these 4528 (69%) were caught in pots without escape gaps (WE), and 2064 (31%) were caught in normal pots (N). The difference in numbers caught between the two pot types was due to the pre-recruit portion of the population, which were caught in far greater quantities by WE pots. WE pots sampled animals as small as 28mm TW and clear differences in size-frequency between sites were evident.

There was no statistical difference between pot types in estimating parameters of the post-recruited population; the WE pots caught similar numbers and sizes of post-recruits, berried females and large lobsters (greater than 60mm TW). The difference in average size of large lobsters measured by the two pot types was 0.4 mm. Post-hoc power analysis revealed that all tests were sufficiently powerful to detect small differences. For example, minimal detectable difference (between WE and N pots) in numbers of post recruit (above 54mm TW) lobsters was 1.1 lobsters per pot (19% of a mean of 5.7); the minimal detectable difference for average size of post-recruits was 1 mm (2% of a mean of 57.9 mm).

Commercial pots with closed escape gaps provide substantial potential for monitoring the abundance and size of pre-recruit *Jasus edwardsii* in CRA 8. Optimal sampling analysis determined that a pre-recruit monitoring program with 120 sites and 3 potlifts per site, would achieve desired levels of precision for about the same cost (effort) of the pilot study. A site allocation regime is necessary to ensure these sites are representative of the population. If a pre-recruit index of abundance is required for management of the CRA 8 fishery, a monitoring program using WE pots could be implemented, with due consideration to quality control issues as discussed within the report. Further tests of the sampling efficiency of WE pots would be advantageous, and detailed recommendations are provided.

1. INTRODUCTION

Measuring recruitment strength in lobster fisheries is a valuable tool. A measure of the strength of upcoming year classes presents options for management not available when only the relative abundance of the fished stock is known. An index of pre-recruit abundance can be used to forecast changes in the abundance of the recruited population, and consequently, the appropriate annual catch. The relative strength of settlement can be used as a predictor of subsequent recruitment in lobster fisheries (Booth & Phillips 1994), and the relative abundance of the first settlement stage, puerulii, has been used successfully in the West Australian lobster fisheries to predict catch (Caputi et al. 1995). However, in the CRA8 fishery there is a large time lag (6-8 years) between settlement and recruitment, and logistical difficulties of obtaining settlement data. Dive surveys of pre-recruits at Stewart Island have detected 2 and 3 year olds (Breen & Booth 1989), however the surveys were discontinued in 2000 because of the prohibitive cost of running the program alongside puerulus collectors.

Surveys to measure the relative abundance of organisms over time should be optimised by the use of pilot studies to collect information about the efficiency of the sampling gear and the spatial and temporal variability inherent in the population under consideration (Snedecor & Cochran 1989). This information can be used in cost-benefit analyses to determine optimal levels of replication in long-term monitoring programs and allow *a priori* decisions to be made about what level of precision is required and what level of precision is possible from any proposed sampling designs (Montgomery 2000).

This pilot study examined the feasibility of obtaining a pre-recruit abundance index with a modified pot design in CRA8. It complemented objective 8 of the 2000-01 Ministry of Fisheries rock lobster research project, which was to examine the relationship between recruitment indices derived from puerulus collectors, juvenile dive surveys and the observer and logbook catch sampling programmes and make recommendations on the most appropriate way of predicting recruitment to the fishery.

Information gained from this study was used to design a long-term monitoring program for pre-recruits in CRA8. The objectives of the study were:

Objective 1: to identify appropriates sites for monitoring pre-recruit abundance.

Objective 2: to identify a pot design suitable for pre-recruit surveys at each site.

Objective 3: to carry out a pilot survey of pre-recruit rock lobsters in CRA8.

Objective 4: to design a long-term pre-recruit monitoring program.

2. METHODS AND RESULTS

2.1 Study Sites

The participating fishers (Jerry Excell, Brett Hamilton, Colin Hopkins, Mark Peychers, Peter Young) selected a total of 14 sites for the pilot study (Table 1, Figure 1) based on prior knowledge of distribution of pre-recruits of *Jasus edwardsii*.

2.2 Pot types

Following initial discussions, the consensus was that pot design be kept simple and logistically feasible (i.e. be able to be incorporated into normal fishing activity). Two types of pot were compared in this study: normal commercial pots (N) and pots with escape gaps closed up (WE). Pots varied slightly in size between sites (Stewart Islands pots are generally larger than those used in Fiordland), however within sites, WE pots were exactly the same as the N pots. Special permits were obtained from the Ministry of Fisheries to allow escape gaps to be closed during the experiment.

2.3 Experimental design.

Pots were baited in the normal manner at each site, set in pairs (WE/N), and lifted between 5 (Site 10) and 29 times (Site 3). The experiment was carried out between 9th August and 1st November 2001, and each participants used their local knowledge of the 'biting phase' to determine time of sampling. At each potlift, all lobsters were counted and sexed, their tail width (TW) measured, and data were recorded on data sheets modified from those used in the logbook program (Starr & Vignaux, 1997). Participants were given appropriate codes for recording their information.

2.4 Data analysis

Twenty abundance and size variables were statistically compared between the pots types. These were: 1) Total number caught, 2) number of pre-recruits (under 54 mm TW), 3) number of post-recruited lobsters (over 54 mm TW), 4) number of large lobsters (greater than 60 mm TW), 5) total number of males, 6) total number of females, 7) number of male pre-recruits, 8) number of male recruits, 9) number of female pre-recruits, 10) number female recruits (greater than 57 mm TW), 11) average size caught, 12) average size of pre-recruits, 13) average size of recruited lobsters (over 54 mm TW), 14) average size of large lobsters (over 60 mm TW), 15) average size of males, 16) average size of females, 17) average size of male pre-recruits, 18) average size of males recruits, 19) average size of female pre-recruits, 20) average size of female recruits (over 57 mm TW).

Data were analysed by a paired t-test to determine the effect of pot design on abundance and size. Post-hoc power analyses following the procedures of Zar (1984) were carried out where appropriate. Evidence for 'biting phase' was examined by Pearson correlation analysis of catches of pre- and post-recruits.

2.5 Optimal monitoring design

Equations for estimating variance and cost-benefit analysis to optimise sample design are found in Horppila & Peltonen (1992), Montgomery (2000), Snedecor & Cochran (1989), and Underwood (1981). To obtain values of $\hat{S}_2^2$ and $\hat{S}_2^1$ (see Table 2 for explanations of these variables) for calculating optimal number of sites and pot lifts at given cost constraints, the original data was sub-sampled. Final estimates of $\hat{S}_2^2$ and $\hat{S}_2^1$ were made from a data set with 11 sites and 13 potlifts per site. A 1-way ANOVA estimated MSEffect and MSError so that $\hat{S}_2^2$ and $\hat{S}_2^1$ for the different size-classes could be calculated. These values were used to determine optimal sample sizes in a pre-recruit monitoring program (Table 2).

3. RESULTS

A total of 6592 lobsters were caught, measured, and sexed (Table 1). Of these, 4568 (69%) were caught in WE pots, and 2064 (31%) in N pots.

3.1 Analysis of lobster abundance

3.1.1 Differences between pot types

Pots with closed escape gaps caught significantly more lobsters overall, pre-recruits, males, females, male pre-recruits, and female pre-recruits (Table 3).

3.1.2 Similarities between pot types

There was no significant difference between pot types in numbers of post-recruited lobsters (above 54 mm TW), numbers of large lobsters (above 60mm TW), number of post-recruited males (above 54mm TW), number of post-recruited females (above 57mm TW), or number of berried females (Table 3). The average difference between WE and N pots for total number of post-recruits was 0.02 (Table 3); for total number of post-recruit males, the average difference was –0.13 lobsters; for total number of post-recruited females, the average difference was –0.05 lobsters; for number of berried females, the average difference was 0.19 lobsters.

Power analysis revealed that for the non-significant results, all tests had sufficient power to detect biologically relevant differences (Table 4). For example, the minimum detectable difference in numbers between pot types for total numbers of post recruit lobsters (over 54mm TW) was 1.1 lobsters at a power of 0.8; for post-recruited males it was 0.4 lobsters; for large lobsters and berried females it was 0.4 and 0.5 lobsters respectively.

3.1.3 Temporal variation in catches

Figures 2 and 3 show the daily catches (number per pot) during sampling at Sites 2, 3, 6, 11 and 13. These figures are representative of all sites and include a site with a small number of WE/N potlifts (Site 11 – 8 potlifts) and the site with the greatest number (Site 3 – 29 potlifts). At each site there appears to be a cyclical pattern over 10-14 days. The pattern is of sharp increases in catches followed by declining catches then sharp increases, and is similar for pre-recruits and recruits. At most sites, catch rates of pre-recruits were significantly positively correlated with catches of post-recruits (Table 5).

3.2 Analysis of lobster sizes

3.2.1 Differences between pot types

Compared to N pots, WE pots caught lobsters with significantly lower overall average size, lower average size of pre-recruits, lower average size of males, lower average size of females, lower average size of male pre-recruits, and lower average size of female pre-recruits (Table 3).

3.2.2 Similarities between pot types

There was no significant difference in average size of post-recruited lobsters, post-recruited males, post-recruited females, berried females, or large lobsters between pot types (Table 3). The average difference in lobster tail width between WE and N pots was 0.02 mm for all post-recruited lobsters, 0.4 mm for post-recruit males, 0.3 mm for commercial sized females, 1.9 mm for berried females, and 0.08mm for large lobsters (Table 3).

Power analysis revealed that for the non-significant results, all tests had adequate power to detect biologically relevant differences (Table 4). For example, the minimum detectable difference for size of post-recruit males was 0.9 mm at a power of 0.8. For post-recruit females, the minimal detectable difference was 1.5 mm at a power of 0.8; for berried females the MDD was 3.3 mm.

3.2.3 Size-frequencies of lobsters caught

Figures 4 to 7 show the size-frequency comparisons for different combinations of pot design, sex, and sites. Distinct pre-recruit size-classes are evident at some sites (Figure 7e).

3.2.4 Estimates of optimal sample sizes

Sampling many sites (120) and minimizing the effort per site (3 potlifts per site) will maximise the power of the monitoring program to detect changes in abundance of pre-recruits under 49mm TW at a cost equivalent to undertaking the pilot study (Table 6). For lobsters of 49 to 53 mm TW, maximum power will be achieved from 250 sites and 2 potlifts per site.

However, there is a trade-off between maximising precision and minimising costs that affects estimates of within-site replication. An n of 3 potlifts for pre-recruits (the size class under 49mm TW) was obtained by assuming that the average cost of visiting one site (nominally assumed at 10 minutes - estimated by the participants in the pilot study) will not change. If the average cost of visiting one site is 5 minutes, then the optimal number of potlifts will be 2, and optimal number of sites will be 170 (Table 6). If the average cost of visiting a site rises to 20 minutes, then the optimal design will be 4 potlifts and 84 sites (Table 6).

4. DISCUSSION

The closing of escape gaps on commercial pots resulted in successful sampling of pre-recruits (< 54mm TW) of *Jasus edwardsii*. The WE pots appear to be sampling a number of pre-recruit size classes, although this figure varies between sites and sometimes 4 size classes are evident in the data (West Stewart Island – Site 11 and 12). Whether these correspond to age classes is undetermined. These results confirm the hypothesis, namely that WE pots can be a useful sampling tool for monitoring the abundance and size of pre-recruit *Jasus edwardsii* in CRA8.

There are a number of issues to be considered in designing a long-term pre-recruit monitoring program. The discussion below makes the assumption that commercial industry vessels would be available to undertake pre-recruit sampling in a manner similar to that achieved during the pilot study.

First, the objective(s) of the program needs to be clearly specified, as it (they) will influence the sampling design and data analysis. In CRA 8, the objective is likely to be something like: 'To obtain an index of pre-recruit abundance of rock lobster for the purpose of feeding into a decision rule process for TACC setting.'

Second, what is to be the index of pre-recruit abundance? Consideration of the likely index (e.g. should it be a specific size range, or all lobsters below 54mm TW) has important implications for the placement of sampling sites – some sites may be more representative of certain year classes.

Third, how will the index be measured? In most monitoring programs, the objective is to measure temporal variation, and not to confound spatial variation with this measure. Consequently, fixed sites are usually recommended, however they need to be representative of the population distribution. Changes in lobster habitat and distribution over time will also affect site allocation and the program may need to adapt to these changes. In CRA 8, there is also a biological imperative to ensure sampling coincides with the biting phase of pre-recruit lobsters, which is known to vary between areas. This can be controlled to some extent by fishers using local knowledge on which to base their decisions to commence sampling. It would be prudent to formalise a site allocation process that deals explicitly with these considerations.

Fourth, what level of between-site and within-site replication is appropriate, given cost constraints? The goal is to maximise precision and minimise cost, and the estimates presented in the results (120 sites and 3 potlifts per site) assume a cost constraint similar to that put into the pilot study. This should be considered as a guide rather than an absolute recommendation. Obviously more sites can be sampled if cost is not limited. The main point to note is that the general conclusions of this pilot study (many sites, minimal replication per site) are supported by theoretical studies on optimal designs of monitoring programs for fisheries and the marine environment (Van der Meer 1997; Warren 1994).

Given the long-term nature of monitoring programs, there is a need for quality control of logistical variables influencing the integrity of the data. These include: 1) site location and integrity, for example, ensuring that GPS locations are adequately protected; 2) standardisation of pot design - the ideal is to have the monitoring pots all one design, which is not feasible in CRA 8 because the optimal pot design for catching lobsters differs between locations. However, pot design can be standardised for individual sites, as was the case in this study. 3) Recapture of lobsters previously measured. If the sampling strategy at sites is sequential (i.e. 1 x WE pot set 3 times, rather than 3 x WE pots set simultaneously), a potential bias in the data arises if lobsters get recaptured. Factors such as distance between sites, lobster migration, and duration of sampling period will affect short-term recapture rates, which can be quickly investigated using a short-term marking technique, such as oil crayons.

For each site or groups of sites, a data sampling protocol that details all the requirements for that particular site will need to be developed, so that as participants change over the long-term, the data is still being collected accurately and with sampling gear that is comparable. A technician is likely to be necessary to oversee the program.

4.1 Other implications

The paired pot comparison yielded some interesting results not forecast by the design, but of relevance to designing a monitoring program.

WE pots proved equally as effective as normal commercial pots in estimating abundance and measuring the size of the recruited portion (over 54 mm TW) of the lobster population. This was true for all lobsters greater than 54mm TW, and subsections of the recruited population, such as males only, females only, berried females, or large lobsters. Thus, they could be used to monitor the overall *Jasus edwardsii* population and not just the pre-recruits, although sampling would need to account for differences in spatial distribution between pre- and post-recruits.

The WE/N comparison presented a good test of the effectiveness of the escape gaps in allowing escapements of undersized lobsters, and there is a possibility that the N pots could be made more effective at reducing under-size catch by the building of more escape gaps within them. This observation was made by one of the participants in the pilot study and further tests would be advantageous.

The ‘paired pots’ experimental design demonstrated itself as a useful experimental tool that can be used to improve sampling efficiency. A question to be resolved is, what is the selectivity of the WE pots at the smaller size classes (< 45mm TW)? This could be addressed by comparing WE pots with a pot design that has closed escape gaps and a modified entrance funnel that allows only lobsters under, say 48 mm TW, to be caught. Such an experiment may yield even more data on pre-recruit abundance and hence improve the possibility of gaining a predictive index.

5. ACKNOWLEDGEMENTS

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Table 1: Site names, location, depth and number of *Jasus edwardsii* caught. WE – Commercial pots with escape gaps; N – Normal commercial pots; *n* – sample size (number of paired potlifts)

Site	Site Name	General Location	Depth (m)	WE	N	*n*
1	South Point	Mid-Fiordland (Charles/George)	46	304	97	15
2	House Roof Rock		46	563	155	24
3	Yogi Hut	South Fiordland (Chalky/Dusky)	55	866	357	29
4	Weather Station		46	105	42	12
5	Steveys		73	622	264	19
6	West Point Coal Island	South Shore (Foveaux Strait)	30	337	120	16
7	South – East Chalky		40	287	216	25
8			65	86	54	8
9			50	70	84	9
10			75	33	13	5
11	Jackson's River	Stewart Island (West)	64	150	89	8
12	Little Patch		46	166	106	8
13	Breaksea Islands	Stewart Island (South-East)	64	511	238	15
14	Lords River		73	428	229	15
		TOTALS		4568	2064	206

Table 2: Equations and variables used in calculating optimal sample sizes for a *Jasus edwardsii* pre-recruit monitoring program in CRA 8. Data on costs obtained from the participants in the pilot study, and are expressed as time spent on collecting data. Equations from Snedecor & Cochran (1989).

Equations	Variables
<u>Optimal potlift per site (n)</u>	
	C_S = cost per site (travelling and positioning); fishers suggest it was negligible, hence set at 3 different values (5, 10, 20 minutes)
$n = \sqrt{\dfrac{C_S S_2^2}{C_P S_1^2}}$	C_P = cost per potlift (time to haul pots, record data, and reset). Average haul time = 5 minutes, average catch = 23, average record time = 10 seconds per animal; total = 0.147 hours per pot.
	$\hat{S}_1^2 = (MSEffect - MSError) / n_2$ (MS - from ANOVA)
	$\hat{S}_2^2 = MSError$
	n_2 = 13 (replicate number of potlifts from pilot study)
<u>Optimal number of sites (k)</u>	
$k = \dfrac{C - C_p n}{C_S n}$	C = total cost of the survey; constrained to 48 hours which is the estimated total cost of travelling, positioning, lifting and processing pots during the pilot study.

Table 3: Results of paired *t*-test comparison between WE and N pots for estimating number and size of *Jasus edwardsii*. H_0: the mean of the difference (WE – N) was not significantly different from 0.

	df	Difference (WA-N)	t-statistic	p-value	#Result
Abundance					
Total numbers	206	12.3	11.7	0.001	***
Number of post-recruit lobsters (≥ 54mm TW)	206	0.02	0.054	0.96	ns
Number of pre-recruits (< 54mm TW)	206	12.3	13.9	0.000	***
Number of large lobsters (≥ 60mm TW)	206	-0.04	-0.25	0.80	ns
Total number of males	206	4.97	10.1	0.002	**
Number of post-recruit males	206	-0.13	-0.89	0.37	ns
Number of pre-recruit males	206	5.10	11.7	0.002	**
Number of females	206	7.35	11.4	0.001	***
Number of post-recruit females (≥57mm TW)	206	-0.06	-0.21	0.83	ns
Number of pre-recruit females (< 54mm TW)	206	7.20	13.7	0.000	***
Number of berried females	206	0.19	1.08	0.28	ns
Size					
Overall tail width	186	-4.3 mm	-12.8	0.000	***
Tail width of post-recruit lobsters (≥ 54mm TW)	169	-0.02 mm	-0.05	0.96	ns
Tail width of pre-recruits (< 54mm TW)	155	-2.9 mm	-12.0	0.000	***
Tail width of large lobsters (≥ 60mm TW)	70	0.08 mm	-0.08	0.93	ns
Tail width of males	155	-4.1 mm	--11.1	0.000	***
Tail width of post-recruit males (≥ 54mm TW)	83	-0.4 mm	-1.25	0.22	ns
Tail width of pre-recruit males (< 54mm TW)	129	-3.2 mm	-10.5	0.000	***
Tail width of females	178	-4.4 mm	-13.5	0.000	***
Tail width of post-recruit females (≥ 57mm TW)	108	0.3 mm	-0.5	0.62	ns
Tail width of pre-recruit females (< 54mm TW)	98	-2.8 mm	-11.3	0.000	***
Tail width of berried females	43	-1.9 mm	-1.63	0.11	ns

* for size variables, df's are different because the comparison was possible only for potlifts where both WE and N pots caught the target size class, and this varies for each size class.

ns – non-significant result, * p<0.05; **p<0.01, ***p<0.001

Table 4: Power analysis results. Minimum detectable differences (MDD's) for abundance and sizes of *Jasus edwardsii* for non-significant effects of pot design. MDD's are calculated at a power (1-β) level of 0. 8, and expressed as units (numbers/size), and % of overall mean.

Variable	MDD
<u>Abundance</u>	
Number of post-recruit lobsters (≥ 54mm TW)	1.1 (19%)
Number of post-recruit males	0.4 (28%)
Number of post-recruit females (≥ 57mm TW)	0.6 (29%)
Number of berried females	0.5 (45%)
Number of large lobsters (≥ 60mm TW)	0.4 (35%)
<u>Size</u>	
Average tail width of post-recruit lobsters (≥ 54mm TW)	1 mm (2%)
Average tail width of post-recruit males (≥ 54mm TW)	0.9 mm (2%)
Average tail width of post-recruit females (≥ 57mm TW)	1.5 mm (3%)
Average tail width of berried females	3.3 mm (5%)
Average tail width of large lobsters (≥ 60mm TW)	2.6 mm (4%)

Table 5: Pearson's correlation coefficient (r) between catches of pre-recruits (<54mm TW) and post-recruits (≥ 54mm TW) in WE pots at each site. *n* – number of potlifts

Site	*r*	Result	*n*
1	0.75	**	15
2	0.47	*	24
3	0.46	*	29
4	0.78	**	12
5	0.75	***	19
6	0.44	ns	16
7	0.51	**	25
8	0.29	ns	8
9	0.86	**	9
10	0.98	**	5
11	0.7	ns	8
12	0.32	ns	8
13	0.53	*	15
14	0.54	*	15

Table 6: Estimates of optimal number of pot lifts (*n*) per site that minimize both variance and cost, and optimal number of sites (*k*) to visit at 3 levels of C_S (cost per site). Total cost *(C)* is constrained by the cost equivalent to that put into the pilot study (see Table 2). Data are presented for total numbers and various size-categories.

	Size Categories (Tail Width)				
	<49mm	49-53mm	54mm+	60mm+	Total numbers
	C_S = 5 mins (0.083 h)				
n	2	1	1	1	1
k	170	320	280	242	239
	C_S = 10 mins (0.167 h)				
n	3	2	2	2	2
k	120	250	200	170	170
	C_S = 20 mins (0.333 h)				
n	4	2	3	3	3
k	80	180	140	120	120

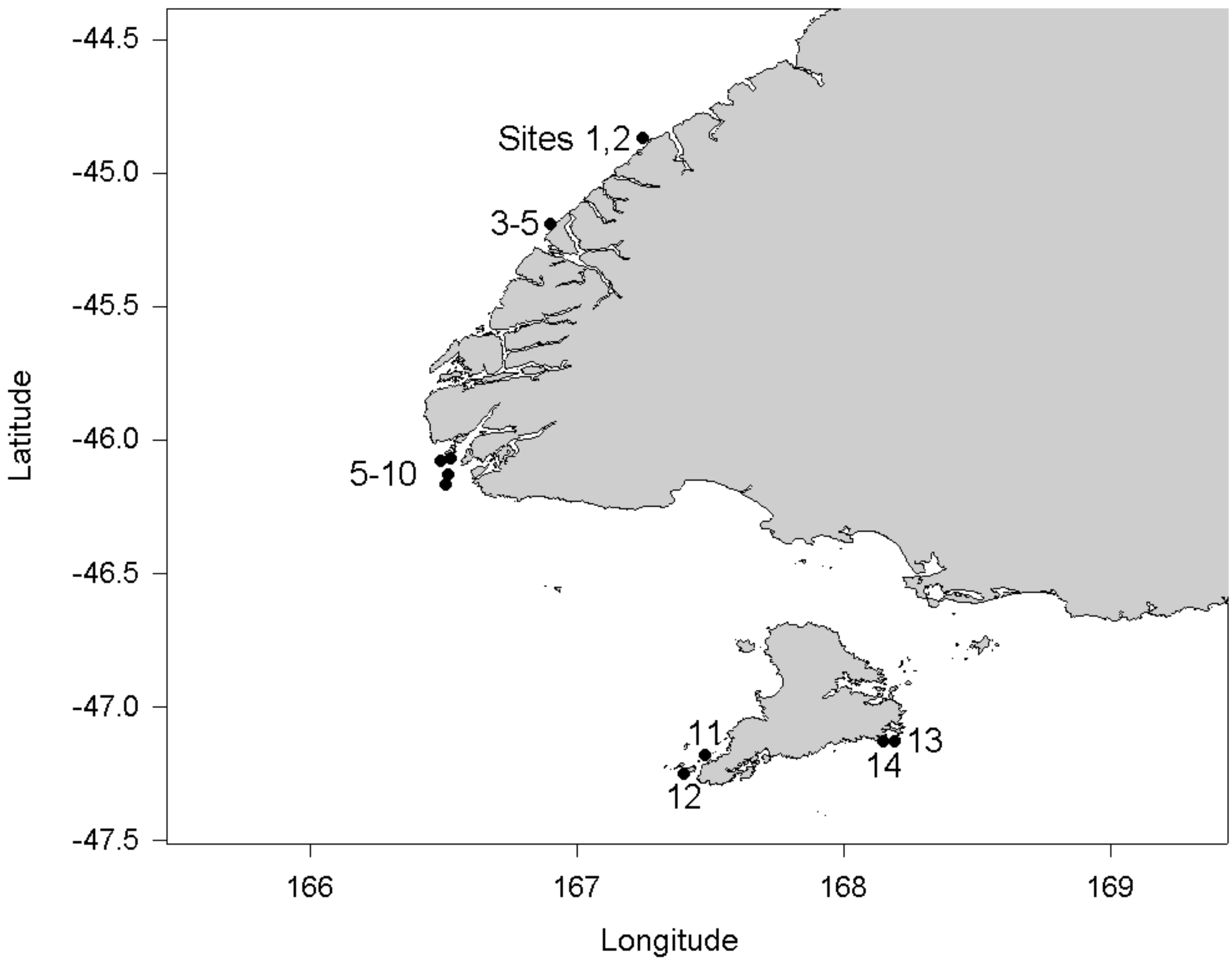

Figure 1: Map of Fiordland and Stewart Island showing approximate locations of study sites.

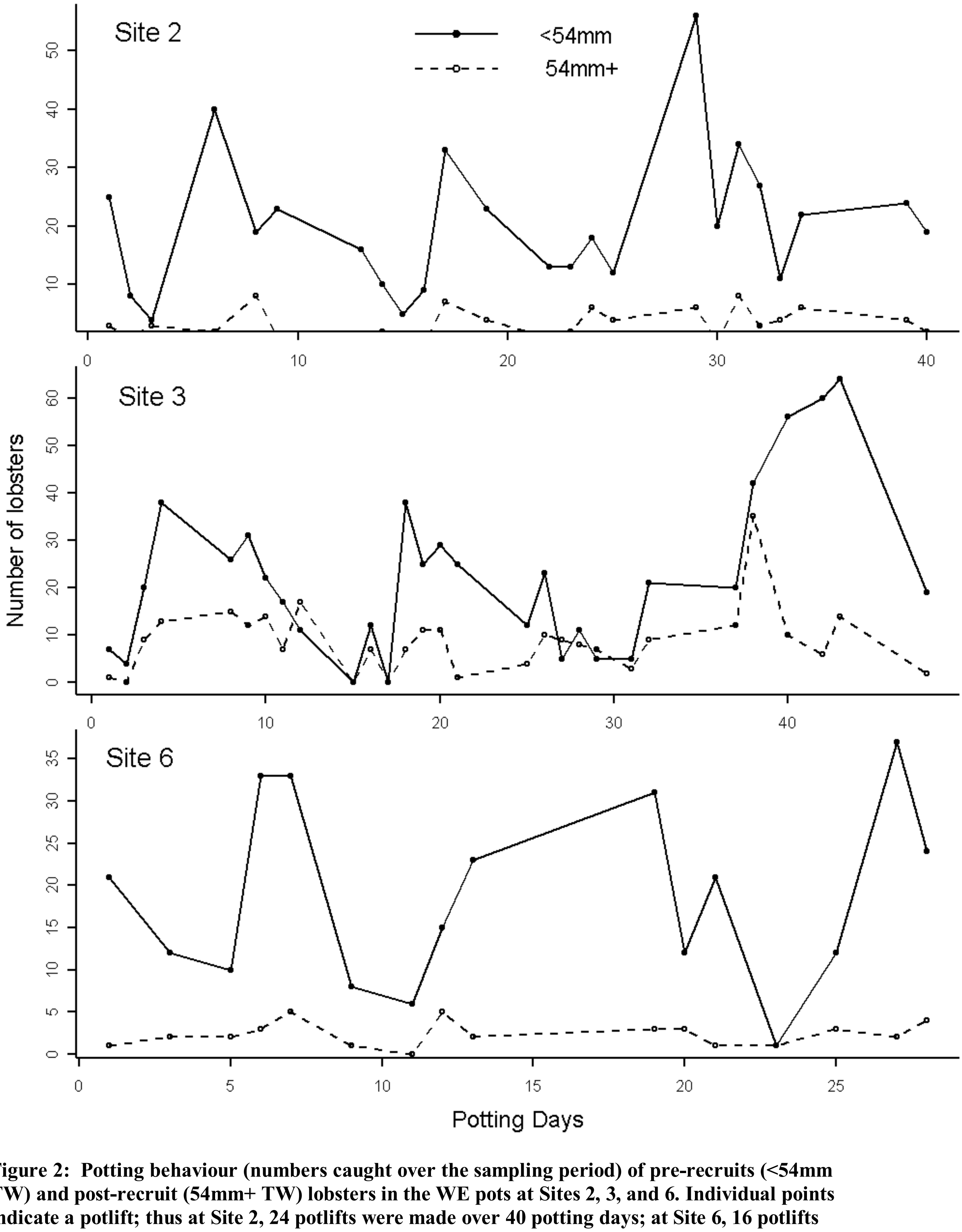

Figure 2: Potting behaviour (numbers caught over the sampling period) of pre-recruits (<54mm TW) and post-recruit (54mm+ TW) lobsters in the WE pots at Sites 2, 3, and 6. Individual points indicate a potlift; thus at Site 2, 24 potlifts were made over 40 potting days; at Site 6, 16 potlifts were made over 28 potting days.

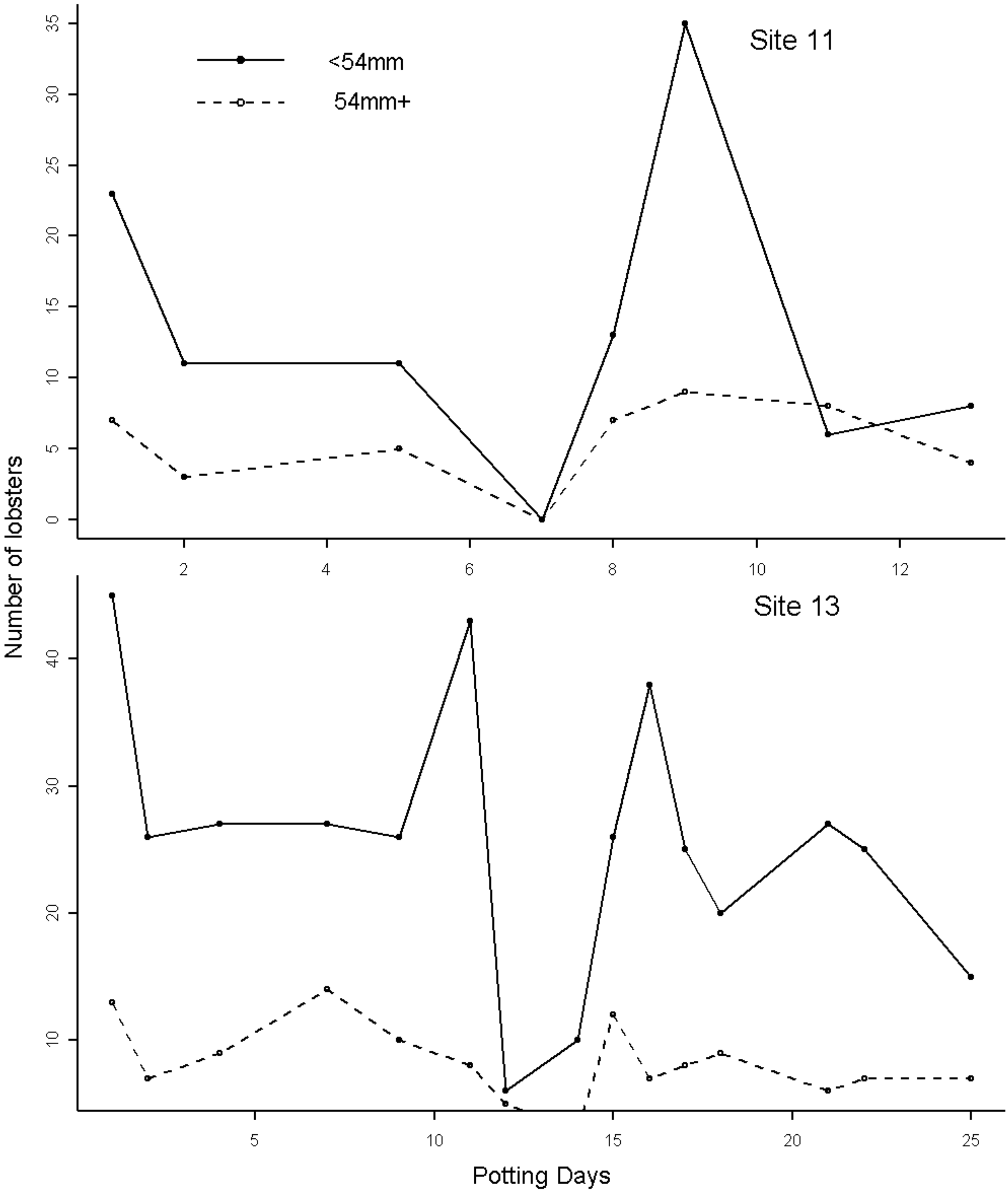

Figure 3: Potting behaviour (numbers caught over the setting period) of pre-recruit (<54mm TW) and post-recruit (54mm+ TW) lobsters in the WE pots at Sites 11 and 13

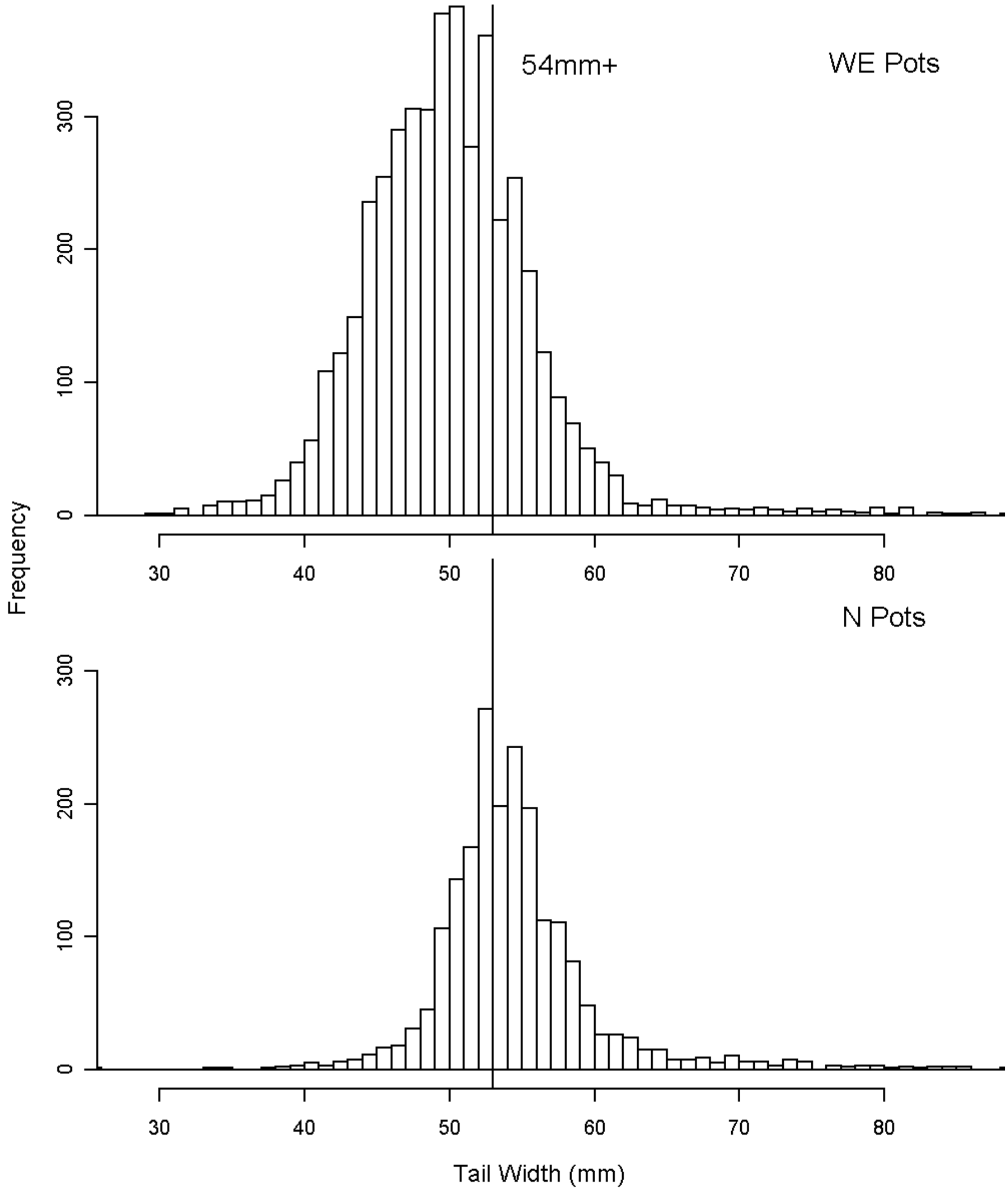

Figure 4: Size-frequency of all *Jasus edwardsi* caught during the pilot study in the two pot types. The vertical line indicates minimum size which escape gaps are designed to retain.

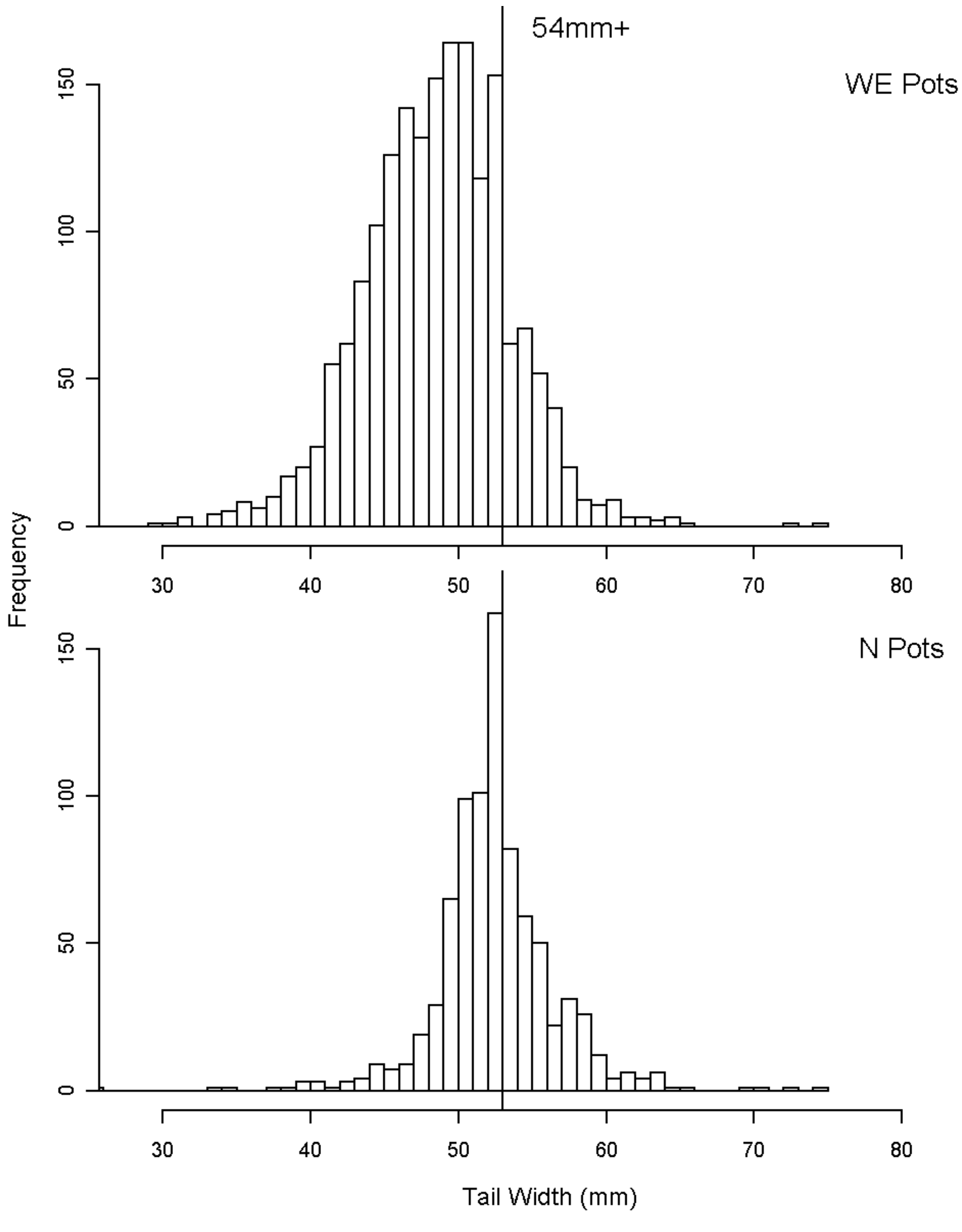

Figure 5: Size-frequency of male *Jasus edwardsii* caught during the pilot study in the two pot types. The line at 54mm+ indicates the minimum legal size for males

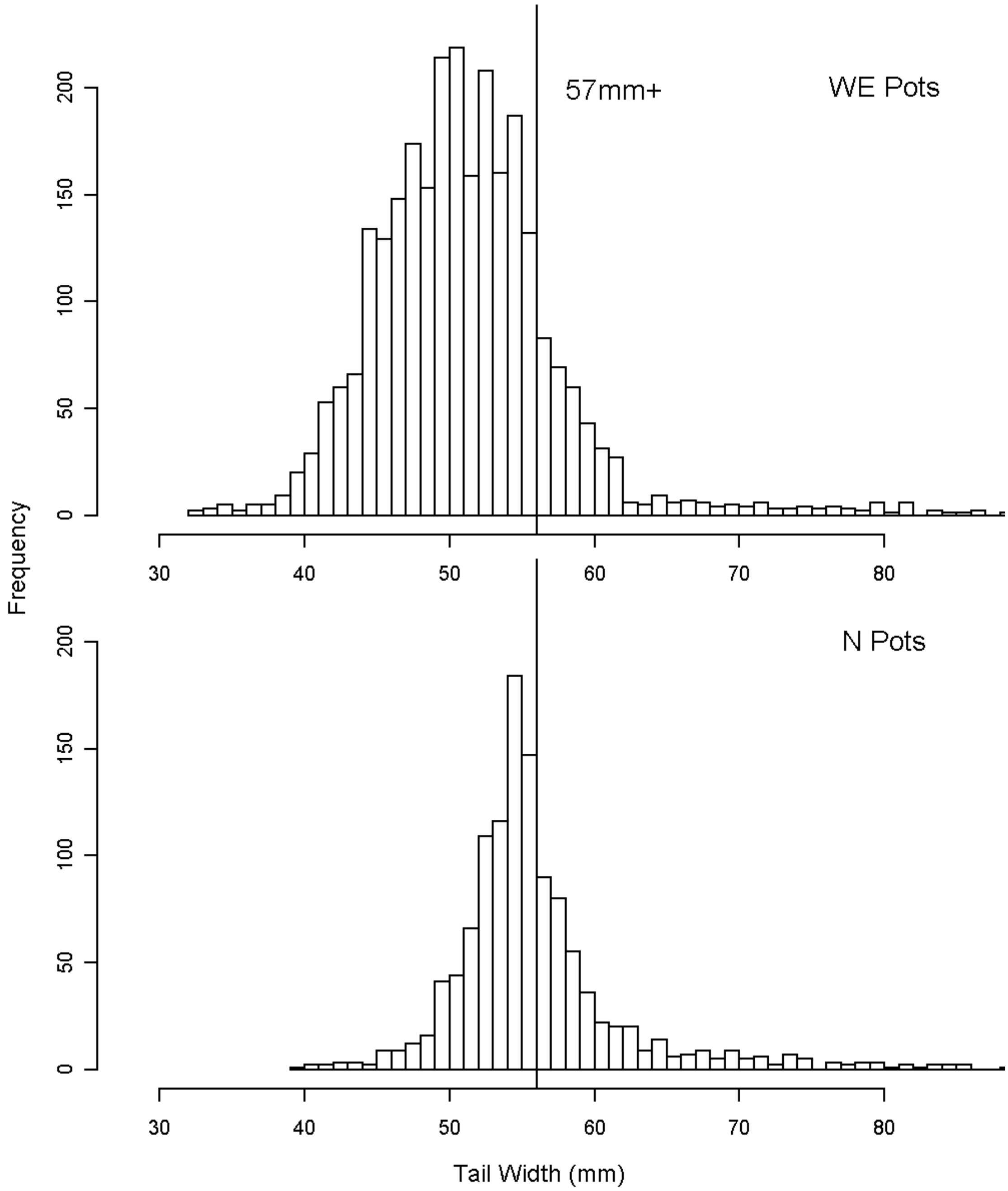

Figure 6: Size-frequency of female *Jasus edwardsii* caught during the pilot study in the two pot types. The line at 57mm+ is the minimum legal size for females

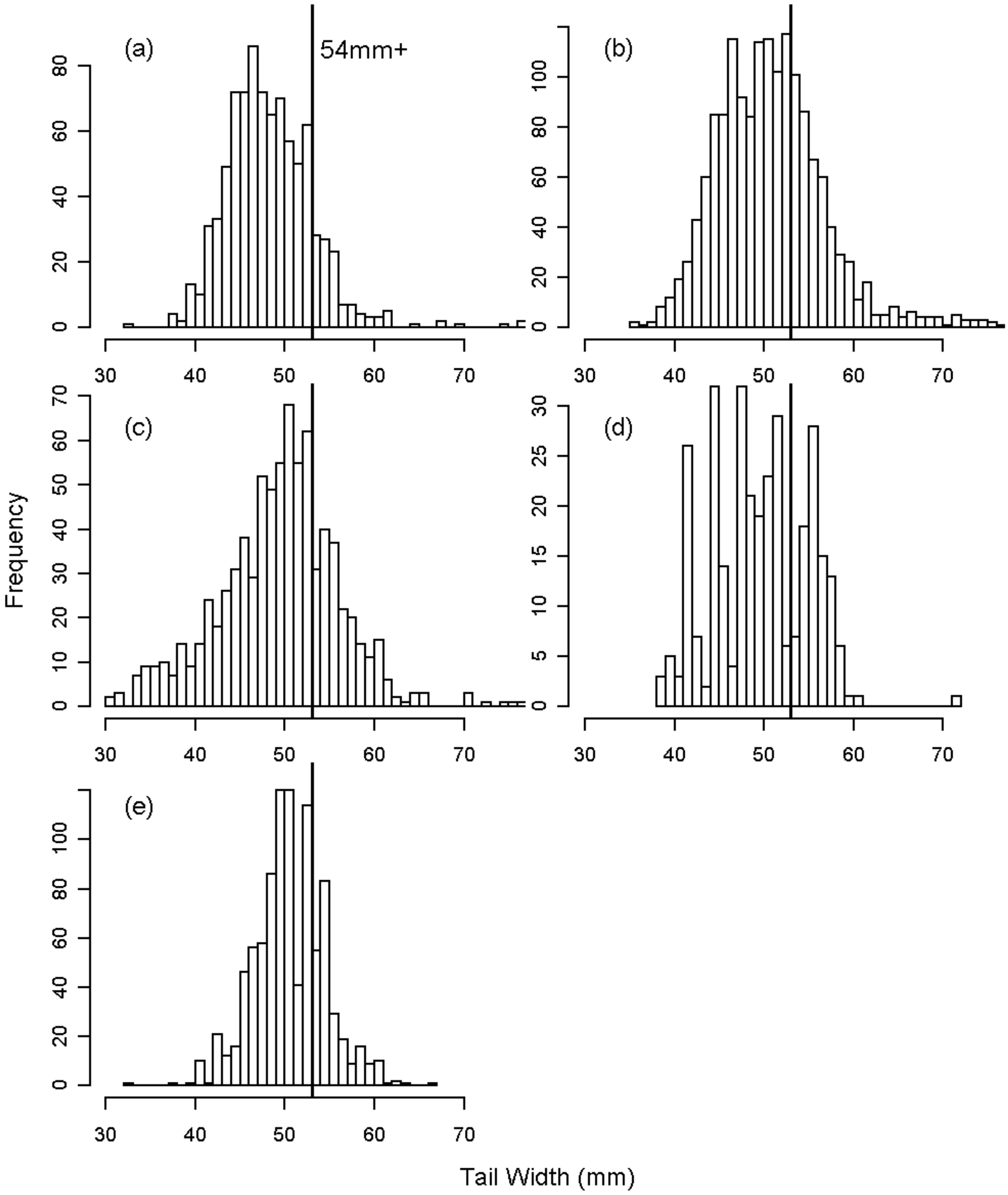

Figure 7: Size-frequency of *Jasus edwardsii* caught in WE pots at each of the main locations within CRA 8. (a) - Mid-Fiordland (Sites 1-2), (b) South-Fiordland (Sites 3 – 5), (c) South Shore/ Foveaux Strait (Sites 5-10), (d) West Stewart Island (Sites 11 - 12); (e) East Stewart Island (Sites 13 - 14).