



Direct Effects of Rock Lobster Pots on Temperate Shallow Rocky Reefs in South Australia

**A study report to the South Australian Rock Lobster
Industry**

Daniel Casement & Ib Svane

October 1999

South Australian Research & Development Institute



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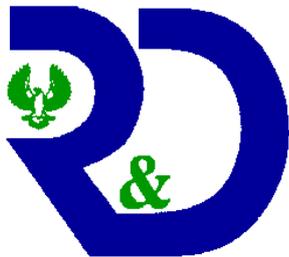
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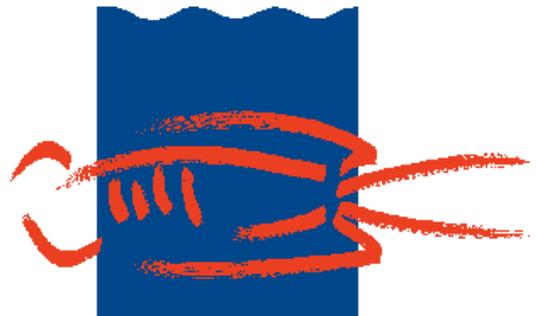
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**SA ROCK
LOBSTER
INDUSTRY**

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SUMMARY

The South Australian rock lobster fishery, wishing to be proactive in assuring the fishery is sustainable commissioned this study into the effects of pots on rock lobster habitat to allow an estimate of potential impacts.

This study assessed the impacts on shallow subtidal reef biota caused by deployment and retrieval of rock lobster pots. The study incorporated field trials, testing the effects of lobster fishing, and a survey of fishers across the two fishing zones of the South Australian rock lobster fishery to assess the number of pots snagged daily and the number of pots lost each season.

Experimental sites were chosen where fishing for rock lobster, *Jasus edwardsii*, is common. Other factors taken into account when choosing experimental sites were the accessibility for researchers and whether the areas were representative of the respective zones.

Field trials were conducted as qualitative and quantitative assessments. The qualitative trials involved video assessment of pots being deployed and hauled in typical rock lobster habitats on Yorke Peninsula. The habitats appeared to be physically unaffected by the fishing activity. Another field experiment quantified the effects of three variables: soak time, pot type and fishing location. This assessment was conducted in Rivoli Bay, near Beachport.

Results of the quantitative study showed that soak time had a significant effect on the amount of algae present on the pot when it was hauled. However, it is apparent that the significance of this effect may be a result of the pot being exposed to a greater mass of free drifting algae during longer soak times, and was not the result of the pot actually removing more attached algae from the benthos. No significant difference between pot types (light beehive design, heavy beehive design and a square pot) was found. Likewise, the effect of fishing location was not significantly different between the two locations tested in Rivoli Bay.

Previous studies in North America have shown that the number of pots lost each season is a substantial economic problem. Pot loss has not been quantified in Australia; thus this study assessed the number of pots that are snagged daily and the number of pots lost each season. A survey of a sample of vessels across the two zones has shown that on average, between 1.25 and 7.3% of the pots deployed are snagged when hauling. By simply changing the direction from which they haul the pot, fishers successfully retrieve the majority of snagged pots. The number of pots lost annually across the two fishing zones is approximately 3429, equating to 0.15% of the pots deployed each season.

The results for this study showed that lobster fishing in South Australia, using the investigated traps and methods, had little physical effect on shallow water rocky reefs.

INTRODUCTION

BACKGROUND

South Australia has an extensive coastline and a wide range of coastal and marine environments. The nearshore marine environment is composed of habitats such as rocky shores, sandy beaches, algal-covered reefs and kelp forests, estuaries, seagrass beds and mangroves (Lewis *et al.* 1998). The majority of South Australia's population lives on or near the coast, and places heavy demands on the coastal environment (Kailola *et al.* 1993). Lewis *et al.* (1998) states that most of South Australia's population of 1.4 million is situated on the coast with major towns and cities concentrated on the Fleurieu peninsula (including Adelaide) and northern Spencer Gulf. Other major regional centres include Port Lincoln and the towns of Mount Gambier, Robe and Kingston in the south east of the state. With most of our fisheries concentrated in the coastal fringe the challenge is to ensure conservation and sustainability of the coastal ecosystems and fisheries.

The South Australian rock lobster fishery for *Jasus edwardsii* is the states most valuable inshore fishery, first established in South Australia in the early 1900s (Zacharin 1997b). Lobster are taken commercially with pots and recreationally using pots and diving. The commercial fishery lands around 2700 tonnes, and the recreational fishery around 100 tonnes. The commercial fishery has an export value of around \$100 million¹. The fishery has a long history of active resource management aimed at sustainability. The development of management arrangements has given rise to a modern fishery that is divided into two management zones, the southern and the northern zones.

The southern zone is a limited entry fishery (with 183 licensees), managed under output controls in the form of a quota system, in addition to all of the historical input controls such as closed seasons, pot limits and size restrictions. The majority of boats operate from the seven principle ports between Port MacDonnell and Kingston in the south-east of South Australia (see Zacharin 1997a,b). The mean annual number of pot lifts for the southern zone is about 1,630,000².

The northern zone fishery is a limited entry fishery of 71 licensees managed with input controls such as pot limits, restrictions on the number of days fished, boat size and engine horsepower. Boats operate from ports between Victor Harbour and the Far West coast of South Australia. The zone has progressively reduced fishing time by introducing a flexible system of time closures in order to maintain effective fishing effort at levels equal to that during the early 1990s. The mean seasonal effort in the northern zone is about 717,000 pot lifts³.

The fishery has been routinely assessed for biological sustainability by a number of scientific authorities. It has been recognised as sustainable and is considered to be excellent by world standards of fishery management.

¹ - these three fishery figures taken from personal communication with the South Australian Lobster Industry

² - based upon the average no. of potlifts in the southern zone since the 1994/95 season

³ - based upon the average no. of potlifts in the northern zone since the 1994/95 season

Lobster pots, typically of a traditional beehive design, are used to capture the southern rock lobster in both zones. However, there are many variations on the beehive design such as weight, size and netting material used to cover the pot, and some fishers use square pots. By regulation, all pots are set individually.

The use of lobster pots may cause physical damage to the sea bottom and thereby change habitats. However, the natural habitat for the southern rock lobster is shallow rocky reefs highly pertubated and disturbed by natural events such as tide, storms and large swells. Disturbance is an important element in maintaining species diversity in such environments and a prerequisite for providing free space for colonisation. Frequent pertubations, such as storms and large swells, therefore develop a mosaic pattern of patches of organisms, primarily algae of various types and species, forming dynamically the habitat of the southern rock lobster.

THE PRESENT STUDY

The southern rock lobster fishery is important to South Australia and is effectively managed by government and industry in partnership, management being guided by principles of sustainability. The question of pot damage has emerged as a potential issue. Accordingly, the industry has commissioned this study to assess the significance of the problem.

The objectives of the study were :

1. To assess the physical effects of the deployment and subsequent retrieval of lobster pots on subtidal reef biota.
2. Estimate the number of lobster pots snagged daily and the number of lobster pots lost annually.

ASSESSMENTS CONDUCTED

A number of assessments were performed in order to fulfil the project objectives. Objective one, assessing the physical effects of deploying and retrieving lobster pots involved the following studies;

1. Qualitative assessment of the physical impacts of lobster pots using underwater video footage.
2. Quantitative assessment of the physical impacts of lobster pots.
3. Assessment of the potential area affected by lobster pots.

Objective two was attained using a;

1. Survey to assess the amount of lobster pots snagged daily and the number of lobster pots lost annually across the two fishing zones.

PHYSICAL EFFECTS OF LOBSTER POTTING

In order to assess the physical effects of lobster potting, field trials were conducted. A qualitative assessment involved the video monitoring of pots being deployed and hauled in typical rock lobster habitats followed by describing the events observed. The quantitative study was an experiment to test the effects of three variables; soak time, pot type, and fishing location on the removal of algae (and any other biota) by pots. Both field trials were conducted using commercial rock lobster vessels and commercial gear. This allowed realistic fishing practices to be applied during the trials. Calm weather and good underwater visibility were required for the underwater monitoring.

The division of the fishery into the two fishing zones and the location of the sampling areas are shown in Figure 1.

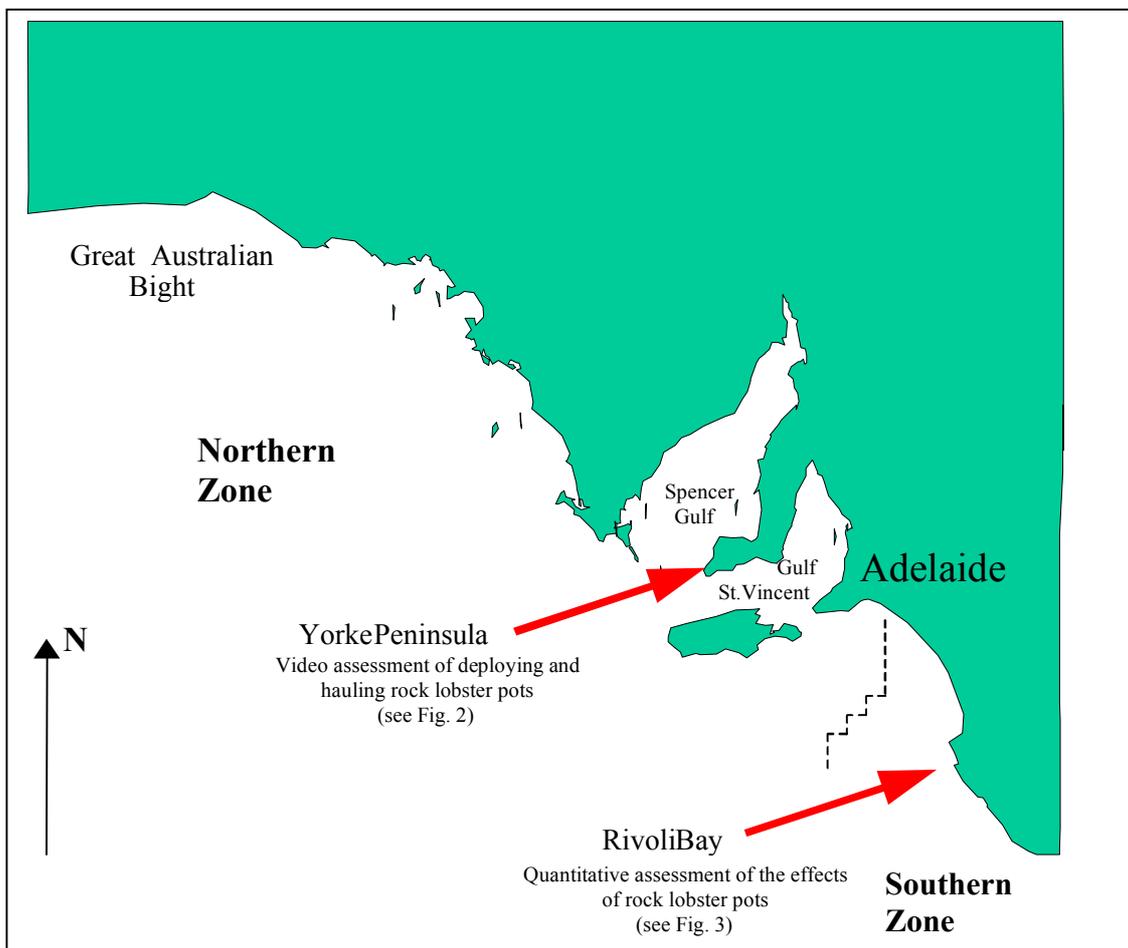


Figure 1: The location of the study areas (indicated by arrows), and the two rock lobster fishing zones within South Australia.

Site selection

The field trials were conducted on Yorke Peninsula, part of the northern zone, and in Rivoli Bay in the southern zone. These experimental sites were chosen for the following reasons:

- Potting (fishing) is common in each of the areas.
- Algae species and habitats representative of each zone were present.
- The site was accessible for experimental study; ie vessels and skippers were readily available, the site was accessible to researchers and water depths were within the diver's range.

Qualitative study on impacts of lobster pots

Using a lobster fishing vessel, commercially used beehive design pots were deployed 21 times on shallow rock lobster habitats around the southern tip of Yorke Peninsula over three days during December 1998.

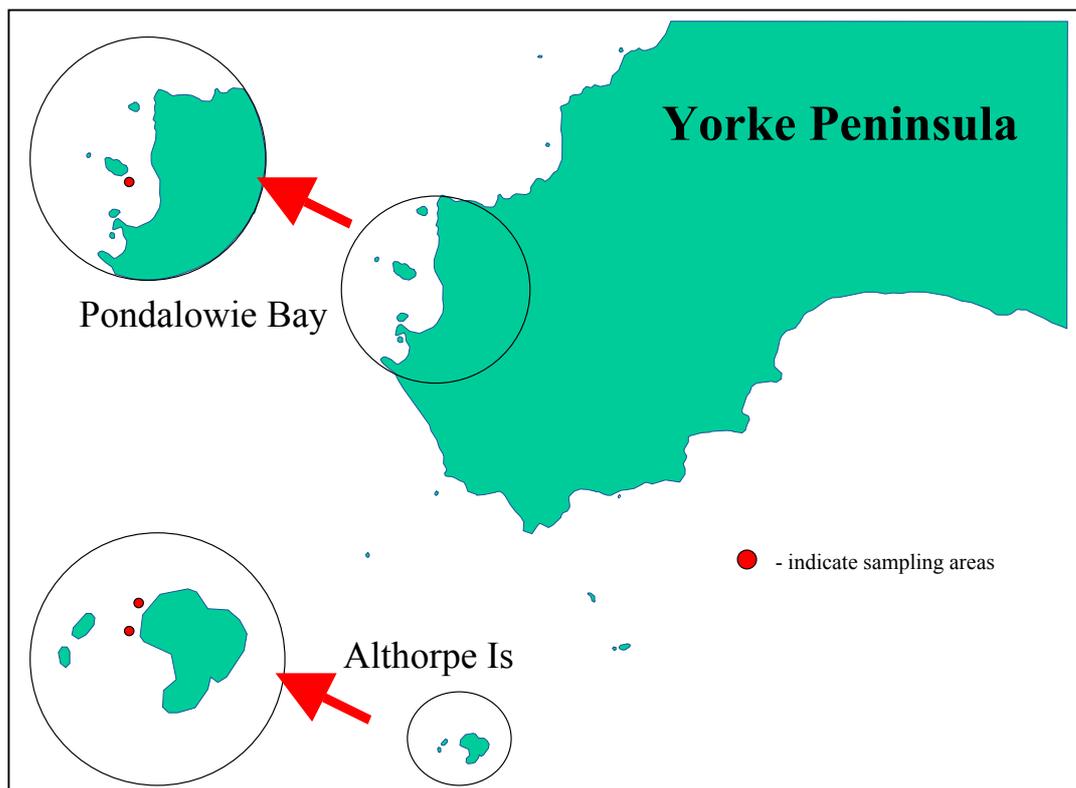


Figure 2: The location of the study areas on Yorke Peninsula in the northern zone to assess the impacts of lobster pots on benthos.

Materials and Methods

The two locations chosen for this assessment were around Althorpe Is and Pondalowie Bay, the sites shown in Figure 2. The pots were deployed and hauled using the same methods as a commercial fishing operation. During these trials we

utilised underwater video in three different fishing areas to estimate the effects of deploying and hauling lobster pots. These trials visually assessed the amount of algae removed and in how many instances other sessile species were affected, as well as any other physical habitat damage. The habitats examined ranged from exposed granite boulders and rocky substrata interspersed with coarse sediment, to large limestone ledges, all with common algae present. These habitats ranged in depth between 10 metres and 13 metres.

Results

Our observations showed that only small amounts of algae were removed. There was some evidence of sponges and small quantities of limestone also being damaged.

The sinking rate of a commercial lobster pot was calculated to be 1ms^{-1} . This was calculated from the video where the time to sink was taken in areas of known depth. Observations showed that the pots hit the seabed base first with a flat orientation. Video footage revealed that the pots generated a pressure wave, which tended to flatten the algae beneath it as it settled, thus reducing any impact. However, in very high relief the pots often hit the seabed at an angle after striking large boulders or limestone ledges.

Quantitative study on impacts of lobster pots

During March and April 1999 pots were set using commercial practice (color video echo-sounder) to place the pot on or near suitable habitat in Rivoli Bay in south-eastern South Australia, Figure 3. This phase of the project was designed to test, experimentally, three factors: soak time, pot type and fishing location, and their effects on the impact of lobster pots. It is anticipated that there is a difference in effect of pot type and for how long they are kept submerged and that the overall effect may be different among fishing locations. Accordingly, our experiment incorporates all three factors in one single experiment based on independent observations. The design used was a general linear ANOVA.

Materials and methods

To assess the impacts of the pots in each trial, all of the algae damaged and torn off by the pots during hauling were collected. Before a lobster pot was retrieved, divers inspected the pot. When the pot was hauled SCUBA divers collected anything that was torn off and not retained on the pot whilst any algae remaining on the pot was collected on board the vessel. The collected algae were identified to family and the weights recorded. The results are shown in Tables 5 to 7.

The pots were set in various habitats - limestone slabs with low ledges dominating the Lipson Reef site. The Penguin Island site was dominated by rubbly limestone boulders and ledges but of a generally higher relief than at Lipson Reef. These habitats ranged from 7 metres to 15 metres in depth.

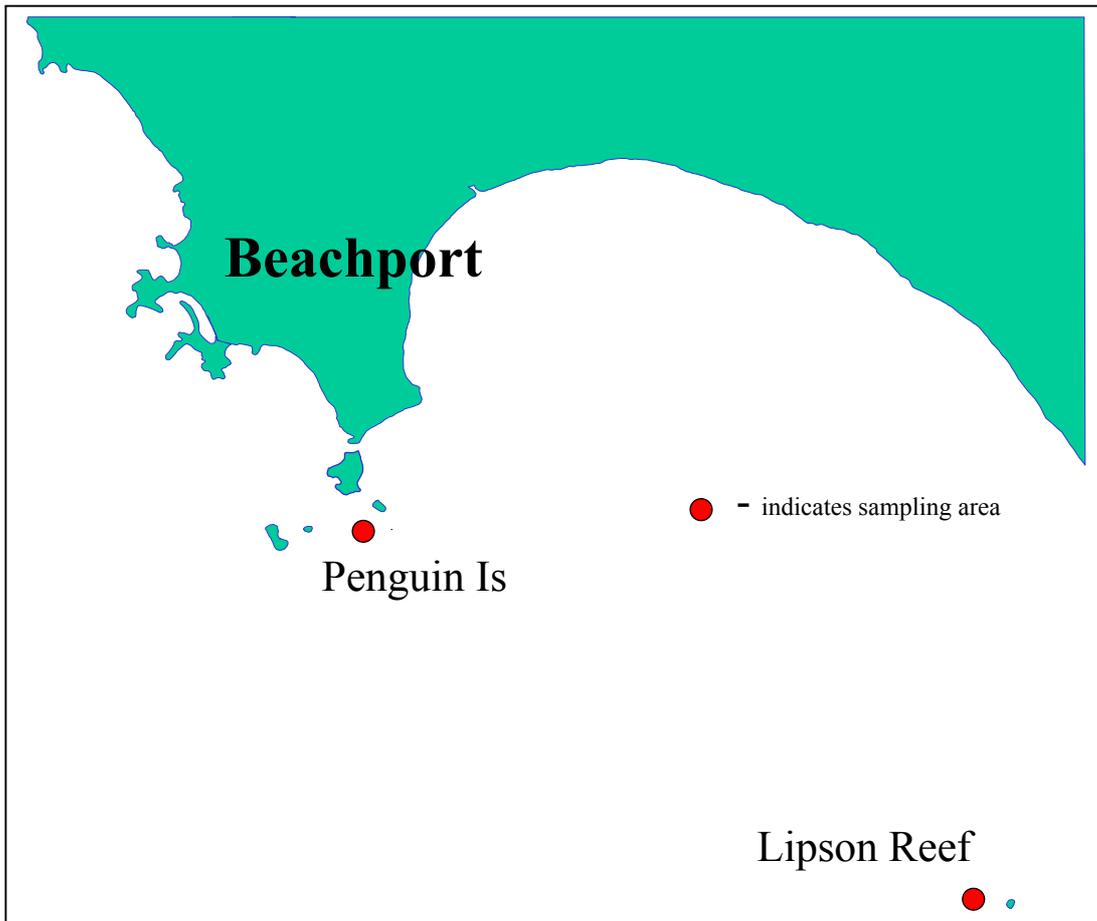


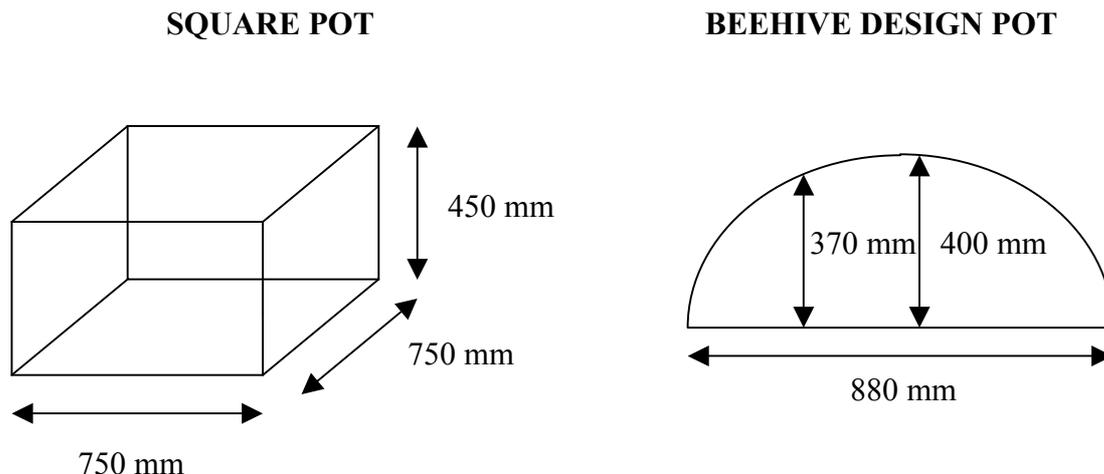
Figure 3: The location of the study areas within Rivoli Bay near Beachport in the southern zone to assess the impacts of lobster pots on benthos.

Lobster pots used in the study

There are many variations on standard lobster pot design used in the South Australian fishery. Three variations of lobster pot design were used in the study: a heavy and a light beehive design pot and a square pot. Pot dimensions are shown in Figure 4.

The weights of the study pots were as follows:

1. Light round beehive design = 21.6 kg
2. Heavy round beehive design = 34.9 kg
3. Square pot = 24.9 kg



	Square Pot	Beehive Design
Bar Spacings	38 mm gap (base)	15 mm gap (base)
Construction material	12 mm round steel rod 8 mm steel rod on base	21 mm round steel hoops 8 mm steel rod for round framework
Stainless steel netting used to cover the pots	50 mm x 1.2 mm stainless steel mesh	50 mm x 1.2 mm stainless steel mesh

NB: The heavy beehive design was simply the same as the light design with a weight added to the base

Figure 4: Diagram of the two pot designs used in the survey.

Experiments

The experimental design involved six replicates of each pot type being set and hauled randomly with respect to the pot type. One hour and twenty-four hour soak times were tested in two locations. A summary of the experimental design and the selected number of replicates are given in Table 1.

All calculations were performed using the statistical package SPSS 8.0 for Windows™.

Table 1: Variables and number of replicates in the experimental test of effects of lobster pot deployment.

Pot Type	Soak Time	Sites and Number of Replicates	
		Lipson Reef	Penguin Island
Light Round	1 hour	6 replicates	6 replicates
	24 hours	6 replicates	6 replicates
Heavy Round	1 hour	6 replicates	6 replicates
	24 hours	6 replicates	6 replicates
Square	1 hour	6 replicates	6 replicates
	24 hours	6 replicates	6 replicates

Results

The algal weight data were first tested for homogeneity of variances using Levenes test for equality of error variances.

The algae weight data did not conform to the assumption of homogeneity of variances ($P=0.003$) and were accordingly transformed using the log transformation ($\log(x+1)$). After transformation the assumption of homogeneity of variances was subsequently met ($P=0.154$), which is a precondition for using an ANOVA. To separate significance between the three tested factors; soak time, pot type and fishing location, a student Newman-Keuls test was chosen. The result of the ANOVA and further separation of factors using the student Newman-Keuls test showed that there was a significant effect of soak time (Figure 5) but not of pot type (Figure 6) or fishing location (Figure 7). See Table 2 and Table 3 for statistical results.

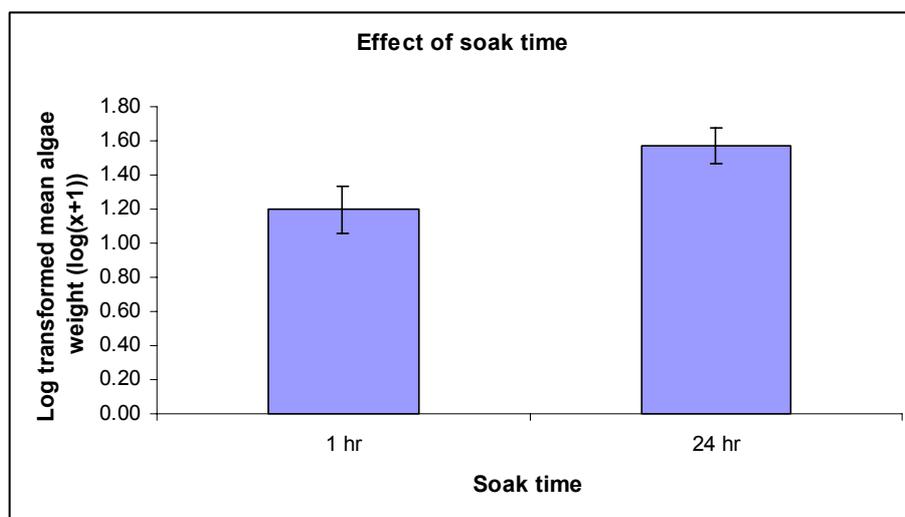


Figure 5: The effect of soak time on the transformed mean weight of algae dislodged or collected by lobster pots. (The vertical bars are standard errors).

More algae were dislodged or collected by lobster pots after 24 hours than 1 hour soak times. Some of the algae recorded as collected by the lobster pot appeared to be drift algae with no association to deployment and retrieval of the lobster pots. These algae were probably dislodged by natural causes and were only caught and accumulated by the netting of the lobster pots. Drift algae thus contribute to the significant effect of submergence or soak time.

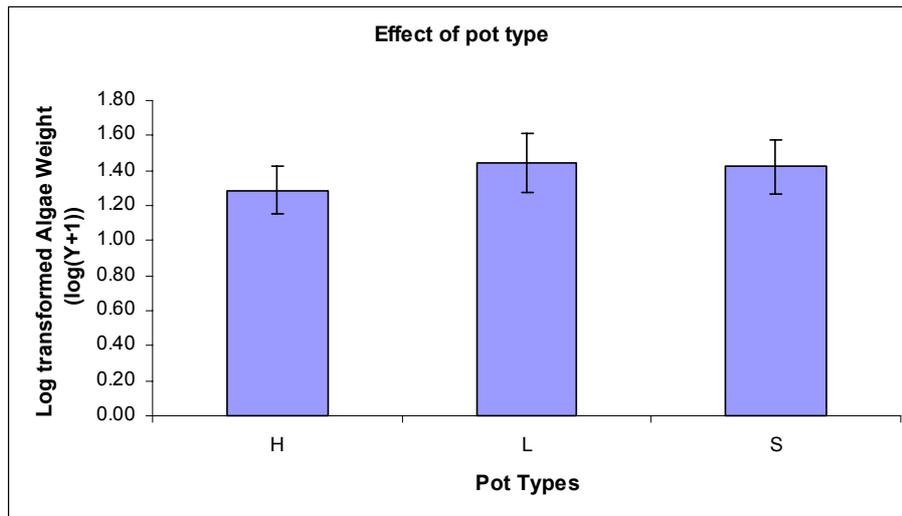


Figure 6: The effect of pot type on the transformed mean weight of algae dislodged or collected by lobster pots. (The vertical bars are standard errors).

Further analysis using the student Newman-Keuls test showed that the mean weights of algae collected at both locations and from the different pot types were relatively low (Figures 6, 7 and Table 3). However, the light pots collected the highest recorded weight. The variation between all three pot types was too large to show statistical difference (Figure 6).

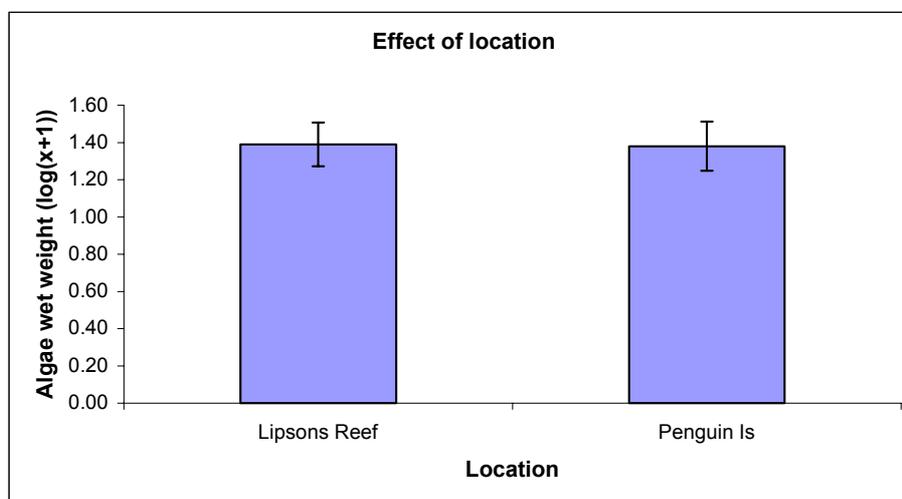


Figure 7: The effect of location on the transformed mean weight of algae dislodged or collected. (The vertical bars are standard errors).

The ANOVA showed that there was no significant effect between the two fishing locations used for the study. (Figure 7). A student Newman-Keuls test confirmed this (Table 3). Similar amounts of algae were collected or dislodged by lobster pots at the two sites in question.

Table 2: Results of the ANOVA test.

Tested factor	Degrees of freedom (df)	Significance (P) _a	Observed power _b
Soak time	1	0.033	0.572
Pot type	2	0.735	0.097
Fishing location	1	0.956	0.050
Soak time x Pot type	2	0.828	0.078
Soak time x Fishing location	1	0.345	0.155
Pot type x Fishing location	2	0.439	0.187
Soak time x Pot type x Fishing location	2	0.116	0.438

a. If $P < 0.05$ then the factor has a significant effect.

b. Power calculated using $\alpha = 0.05$

Table 3: Results of the student Newman-Keuls test

Tested factors	Difference _a	Critical difference
1 hr soak time Vs. 24 hr soak time	0.871	0.800
Heavy beehive Vs. square pot	0.309	0.980
Heavy beehive Vs. light beehive	0.355	1.177
Square pot Vs. light beehive	0.046	0.980
Penguin Is Vs. Lipson Reef	0.022	0.800

a. The value for the difference must be higher than that of the critical difference to indicate a significant effect.

The results indicate that soak time is the only factor determining the amount of algae collected by pots. There were no significant interactions found between the three factors and the results are accordingly consistent. However, the power of the test was, for all three factors, lower than the desirable level (0.8) due to the large variation between factors. The statistical powers for each of the factors and for any relationships between factors are presented in Table 2. The conclusions should therefore be treated cautiously.

Species affected in the trials

The algal species found in greatest abundance on the pots were less robust species including dominant red algae such as *Plocamium spp.* and brown algae such as *Cystophora spp.* However, it is also these species that were commonly observed drifting in the water column. Other, more robust algae such as *Ecklonia radiata* exist in the sampled areas but these were less affected by pot contact.

Although in most instances only the blades of the algae were dislodged or collected by the lobster pot, the holdfasts, which attach the algae to the substrata, were sometimes removed. Provided the holdfasts were not removed the species documented in this study would regenerate quickly. Table 4 presents a summary of how often this occurred. The species observed to be impacted by the pots are given in the following Tables 5, 6 and 7.

Table 4: Percentage of trials in which holdfasts were removed as well as algae.

Pot Types	% of trials where holdfast removed	
	Lipson Reef (n = 36)	Penguin Island (n = 36)
Light Round	8.3%	0
Heavy Round	25%	8.3%
Square	8.3%	0

Table 5: Percent total weight and sum of total weight of algae collected or dislodged during two periods of submergence time.

Species	% of total algae weight		Total algae weight (g)	
	1 hr	24 hr	1 hr	24 hr
Caulerpa spp.	4.7	0.2	110.5	4.5
Codium spp.	0.0	0.1	0.0	2.0
Acrocarpia spp.	0.9	4.6	21.0	132.5
Cystophora spp.	15.2	3.2	356.5	94.0
Ecklonia radiata	36.2	19.8	849.5	572.0
Perithallia spp.	0.6	0.8	14.0	24.5
Sargassum spp.	0.2	0.0	4.0	0.0
Seirococcus spp.	0.0	2.3	0.0	66.0
Ectocarpus	0.0	4.0	0.0	116.0
Callophyllis spp.	0.0	1.0	0.0	30.0
Gracillaria spp.	0.9	0.3	22.0	9.0
Plocamium spp.	33.3	45.3	782.8	1311.5
Phacelocarpus spp.	0.2	0.1	5.0	2.0
Polysiphonia spp.	0.0	1.5	0.0	44.0
Sarcomenia spp. (delesserioides)	2.2	0.0	52.0	0.0
Foliose red algae	5.4	3.9	128.0	112.0
Haloplegma preissii	0.0	0.8	0.0	24.0
Bryozoan - Orthoscuticella spp.	0.2	11.2	4.0	324.0
Sponge	0.0	0.9	0.0	26.0
	100.0	100.0	2349.3	2894.0

The two most common algae dislodged or collected by lobster pots were *Plocamium spp.* and *Ecklonia radiata*. However, the *Ecklonia radiata* that were collected may have been drift algae as this was observed frequently by divers in this area. These two algae did appear to be the most dominant algae in the area. The algae described as foliose red algae include *Crassilingua spp.* and *Rhodoglossum gigartinoides*.

The pots only collected sponges in one instance and diver observations showed little other substratum effects in the Rivoli Bay experimental trials. The video trials on Yorke Peninsula did, however, show some effects on sponges, and in 38% of trials small amounts of limestone were chipped off. The average weight of algae removed by any pot at either location for the two different soak times was 65.3g after 1 hour and 80.4g after 24 hours.

Table 6: Percent of total weight and sum of total weight of algae collected or dislodged by three types of lobster pots.

Species	% of total weight			Sum of total algae weight (g)		
	Heavy	Light	Square	Heavy	Light	Square
Caulerpa spp.	10.0	0.6	0.0	98.5	16.5	0.0
Codium spp.	0.0	0.0	0.1	0.0	0.0	2.0
Acrocarpia spp.	0.2	0.6	8.4	1.5	16.0	136.0
Cystophora spp.	8.5	2.6	18.3	84.5	69.0	297.0
Ecklonia radiata	0.5	47.1	11.0	4.5	1239.0	178.0
Perithallia spp.	1.5	0.9	0.0	14.5	24.0	0.0
Sargassum spp.	0.0	0.0	0.2	0.0	0.0	4.0
Seirococcus spp.	0.0	2.5	0.0	0.0	66.0	0.0
Ectocarpus	11.7	0.0	0.0	116.0	0.0	0.0
Callophyllis spp.	0.0	0.0	1.8	0.0	0.0	30.0
Gracillaria spp.	2.2	0.0	0.6	22.0	0.0	9.0
Plocamium spp.	50.1	37.5	37.7	495.8	986.0	612.5
Phacelocarpus spp.	0.0	0.2	0.1	0.0	5.0	2.0
Polysiphonia spp.	0.0	1.4	0.5	0.0	36.0	8.0
Sarcomenia spp. (delesserioides)	0.0	1.8	0.4	0.0	46.0	6.0
Foliose red algae	10.1	4.3	1.7	100.0	112.0	28.0
Haloplegma preissii	0.0	0.0	1.5	0.0	0.0	24.0
Bryozoan - Orthoscuticella spp.	2.6	0.5	17.8	26.0	13.0	289.0
Sponge	2.6	0.0	0.0	26.0	0.0	0.0
	100.0	100.0	100.0	989.3	2628.5	1625.5

The average weights of algae removed by each pot type were 41.2g for the heavy pots, 109.5g for the light pots, and 67.7g for the square pots. Divers noted that they were unable to move the pots easily in the horizontal plane, indicating that the pots may not move freely on the substrate.

Table 7: Percent of total weight and sum of total weight of algae collected or dislodged by three types of lobster pots at two locations.

Species	% of total algae weight		Total algae weight (g)	
	Lipson Reef	Penguin Is	Lipson Reef	Penguin Is
Caulerpa spp.	0.4	3.7	10.0	105.0
Codium spp.	0.1	0.0	2.0	0.0
Acrocarpia spp.	0.2	5.3	4.0	149.5
Cystophora spp.	16.6	1.8	400.5	50.0
Ecklonia radiata	28.5	25.9	688.0	733.5
Perithallia spp.	0.7	0.8	16.5	22.0
Sargassum spp.	0.2	0.0	4.0	0.0
Seirococcus spp.	0.0	2.3	0.0	66.0
Ectocarpus	4.8	0.0	116.0	0.0
Callophyllis spp.	1.2	0.0	30.0	0.0
Gracillaria spp.	0.9	0.4	21.0	10.0
Plocanium spp.	42.2	38.0	1019.5	1074.8
Phacelocarpus spp.	0.1	0.2	2.0	5.0
Polysiphonia spp.	1.5	0.3	36.0	8.0
Sarcomenia spp. (delesserioides)	0.0	1.8	0.0	52.0
Foliose red algae	1.5	7.2	36.0	204.0
Haloplegma preissii	1.0	0.0	24.0	0.0
Bryozoan - Orthoscuticella spp.	0.2	11.4	6.0	322.0
Sponge	0.0	0.9	0.0	26.0
	100.0	100.0	2415.5	2827.8

The average weight of algae removed by any pot type at each location was 67.1g at Lipson Reef and 78.55g at Penguin Is.

Conclusions of the quantitative studies

A significant difference was found between the amount of algae dislodged or collected after 24 hours and that after 1 hour of soak time. It is apparent, that the significance of this effect may be increased by pot collection of drifting algae rather than dislodgment. It was not possible to assess how much of the collected algae are due to drift algae. One possible estimate of the amount of algae that may be attributed to drift algae is to make the assumption that all algae collected by the diver is dislodged by the pot whilst all algae collected on board the boat is due to drift algae. This gives an approximate value of 60 - 70% of the algae collected being due to drift algae.

No significant effect was found between the three pot types. It was observed that the light beehive design pot removed the most algae, although this was not statistically significant. The larger amount of algae dislodged or collected by the light pots may have been due to some movement of the lighter pots with the swell, although diver observations showed that the pots were often hard to drag. Therefore this movement would only be small.

No significant effect of lobster pot fishing was found between two locations tested in Rivoli Bay. Difference in habitats between these two sites was observed. That no significant effect was detected indicated that locations in a similar area, despite habitat type, incur no difference with respect to the amount of algae that is dislodged or collected by lobster pots.

The conclusion is that submergence time determines the amount of algae dislodged or collected by a pot but pot type and locality of deployment has little or no effect at all.

Quantitative assessment of potential area affected by pots

Each year lobster pots are set and settle on a small percentage of the fishable rock lobster habitat and total continental shelf area. An assessment of this is included to give an indication of how small this affected area is.

Materials and Methods

Information about the area of lobster habitat present in each of the state's statistical catch reporting areas was collected from 25 fishers independent of this study for fishery modelling purposes. These estimates were then used to determine the total area (km²) of lobster habitat in the state.

Results

The average number of pot lifts across the two zones is 2,347,000 (based upon earlier estimates). The combined area upon which the bases of these pots settle is calculated using the following equation:

1. Pot lifts x ($\pi \times R^2$)

R = radius of base of pot = 44cm

Pot lifts = mean pot lifts each season = 2,347,000

Equation one provides an estimate of 1.427km² as the total area upon which the pots settle each season. The area of the total Marine Fishing Areas is 228,439km² whilst the estimated area of the fishable habitat in this area is 26,795km². Thus the percentage of the total area and the fishable area may be estimated using the following equation.

2. (Area of pots/Substrate area) x 100

Area of pots = 1.427km²

Substrate area = MFA area or Fishable habitat area

Results from equation two show that the pots deployed each season will settle on 0.0053% of the fishable habitat and 0.00062% of the total Marine Fishing Area. This figure disregards the scenario of some pots settling on the same spot more than once, thus the affected area may be even less.

Conclusions of the area assessment

Although relatively high numbers of rock lobster pots (2,347,000) are deployed during each fishing season, they only settle on a small percentage of the fishable rock lobster habitat and continental shelf area. Estimates found that pots settle on only 1.427km², which is equivalent to 0.0053% of the fishable rock lobster habitat and 0.00062% of the total Marine Fishing Area or continental shelf area.

ANALYSIS OF SNAGGED AND LOST LOBSTER POTS

The second objective of this study was to assess the frequency with which pots were snagged on a daily basis and the total number of pots lost annually. This was done by asking fishers to keep a log of snagged and lost pots.

Lobster pots may be lost at sea for various reasons. Storms may tangle the buoy lines or displace the pots. Marker floats, or the buoy lines may become detached from the lobster pot, or the pot may be snagged and the buoy line is broken whilst retrieving the pot. Other vessels including fishing boats, pleasure craft or merchant ships may cut the float lines.

Previous studies on the effect of lost lobster pots have been carried out in North America (Kruer pers. comm.⁴). These studies estimate that approximately 20-30% of pots fishing inshore and offshore along the Atlantic coast of America were lost. In the Florida Keys, up to 20% of traps are lost per year for the lobster fishery and this may increase in years with bad storms (Kruer pers. comm).

Materials and Methods

A sample of fishers (n = 6) across the two zones were requested to keep a record of how many lobster pots they snagged each day over a period of time (6 fishers logged the number of pots snagged out of 4320 pots over a total of 76 days). The mean number of snagged pots in the sample population was used to estimate, using extrapolation, the total number snagged. A second survey was carried out across a number of ports to determine how many lobster pots are lost each season, using the same method of extrapolation.

Results

Fishers from the West Coast, Yorke Peninsula, Kangaroo Island and Cape Jaffa responded to the request for information on the number of pots snagged. Table 8 presents the results of the average number of pots snagged daily in the given areas.

⁴ - Personal communication with Curtis Kruer via email

Table 8: Average number of pots snagged in any given day across the two zones of the South Australian Rock Lobster fishery.

Zone	Area	Sample size	Average no. pots snagged/day	% pots set each day snagged (mean)
N	West coast	2	0.75	1.25
N	Yorke Peninsula	2	0.89	1.75
N	Kangaroo Island	1	1.67	2.8
S	Cape Jaffa	1	4.00	7.3

Fishers in the southern zone, assuming that Cape Jaffa is representative of the zone, will snag (and retrieve) approximately 7.3% of their pots each day, whilst in the northern zone the number snagged will range from 1.25% to 2.8%. Therefore, the estimated number of pots snagged annually by fishers in the southern zone is approximately 118,990 pots and between 8,960 and 20,080 pots snagged annually in the northern zone.

Table 9 shows the results of a survey to estimate the number of lobster pots lost annually in the South Australian rock lobster fishery.

Table 9: Average number of pots lost annually by fishers across the two zones of the South Australian rock lobster fishery.

Zone	Area	Sample size	Average no. pots lost/yr
N	West coast	6	10.33
N	Yorke Peninsula	1	20.00
N	Kangaroo Island	4	6.00
S	Beachport	15	15
S	Port MacDonnell	30	15
S	Southend	15	15
S	Robe	15	15

The results of the survey showed that on average a fisher in the northern zone would lose approximately 9.64 pots in a season. This equates to approximately 18%⁵ of their gear being lost in any season. Results of the survey show that the average fisher in the southern zone would lose approximately 15 pots annually. This will equate to approximately 684 pots lost in the northern zone and 2745 pots⁶ in the southern zone.

Conclusions of the snagged and lost pot analysis

Only a small number of pots were snagged. One fisher snagged and lost 10 pots in any one given day, this was however a rare occurrence which took place in deep water

⁵ - Based upon the zone having 71 licensees, each with an average of 56 pots

⁶ - Based upon the zone having 183 licensees

with extreme tides (Pers. comm). These pots may have been dragged into deeper water where the buoy line was insufficient in length.

A sample of vessels across the two zones has shown that on average, between 1.25% and 7.3% of the pots deployed are snagged when hauling. Generally, these snagged pots are retrieved again.

The low number of snagged pots, compared to 1,630,000 pots hauled annually in the southern zone and 717,000 pots hauled annually in the northern zone, may be considered to be a relatively benign impact.

The results of the survey showed that on average a fisher in the northern zone would lose approximately 9.64 pots in a season, and a fisher in the southern zone would lose approximately 15 pots annually. Thus, across the two fishing zones, there are approximately 3429 pots lost each season which is around 0.15% of the pots deployed annually.

DISCUSSION

The study presented here provided an opportunity to assess the impacts of lobster pots on shallow rock lobster habitats in South Australia and thus in a modest way evaluate the wider ecological implications lobster fishing may have for the shallow temperate reef systems where lobsters are typically fished.

Our results have to be viewed in the context of the environment where lobster fishing occurs, which is a marine coastal environment exposed to a high degree of natural disturbance. The organisms that occur in such an environment are adapted to frequent disturbance by possessing the ability to rapidly re-grow and re-colonise. A high degree of disturbance is a prerequisite for high diversity and persistence and patch dynamics. Storms may be a principal element in structuring algal assemblages on South Australian rocky shallow reefs. Shepherd (1979) showed that total algal biomass declined shortly after storms and increased during calm weather. Shepherd (1979) observed extensive kelp forests (*Macrocystis angustifolia*) at Cape Northumberland. These kelp forests were found both in the lee of near-shore and further offshore reefs at depths between 13 and 25 metres. These kelp forests disappeared during storms, probably in late 1974, and at the time of Shepherds report they had not regained the previous cover. Shepherd (1979) found that *Plocamium spp.* grows vegetatively into fortuitous storm-caused gaps. Their stolons persist on the substratum and despite a seasonal growth and decline of fronds, a colony may persist for several seasons. After disturbance whether it is storms or lobster pots, this species is likely to recover rapidly by regeneration if the holdfasts persist. Similar observations were made of *Ecklonia radiata* where erosion of the blade occurs distally⁷ and is higher for larger blades than for smaller. In our investigation, pots only affected this species in a few instances and in the recorded cases only single blades were observed.

⁷ - Distally; away from the point of origin

Natural disturbance events may occur frequently, such as large swells and strong wave-action or infrequently, such as cyclones (Kailola *et al.* 1993). Natural disturbances are to a large extent stochastic with 90% of the impact perhaps taking place in 1% of the time (Anon 1991).

Kaiser (1998)⁸ presented a simplistic model to illustrate the relative importance of a constant level of fishing disturbance in different habitats that are subjected to different levels of natural disturbance (Figure 8). The model predicts that when levels of natural disturbance decline, fishing disturbance accounts for a relatively greater proportion of the total disturbance. For the South Australian rock lobster fishery, the value for fishing disturbance (d_f) is probably at a level considerably lower than the value for natural disturbance (d_n). We can accordingly conclude that lobster fishing causes little physical disturbance on shallow rocky reefs in South Australia.

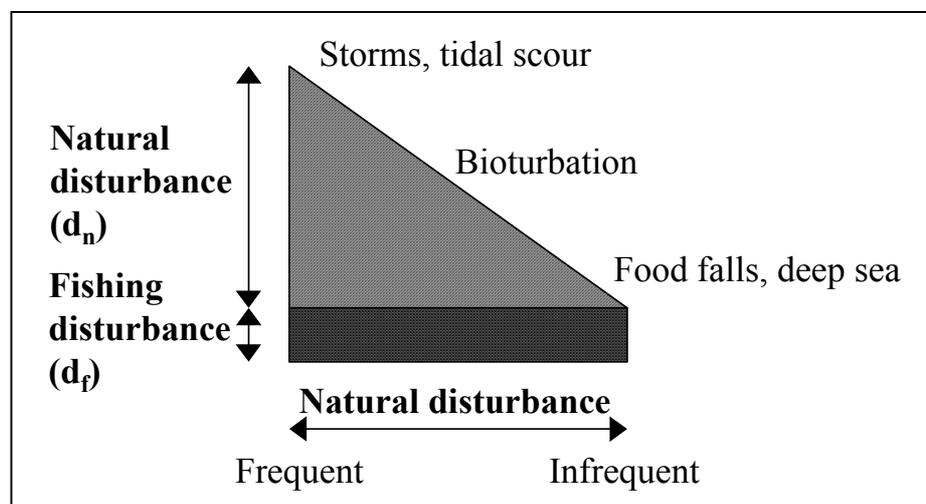


Figure 8: A simple model illustrating the relative importance of a constant level of fishing disturbance in different habitats that are subjected to different levels of natural disturbance (Adapted from Kaiser 1998).

The relatively large sample variances and the low statistical power of the tests, lead us to treat the statistical results with caution. A greater number of replicates would be needed to overcome these problems and increase the power of the tests. Nevertheless, direct diver observations and video recordings support the statistical results and we find it unlikely that the obtained experimental results will be any different when using more replicates.

One shortfall of our study is the inability to discriminate and quantify that algae which is dislodged and collected on pots and that which is fully drifting. The results we present are therefore worst case results and the pots may have considerably less effect on dislodging algae than indicated. The mass of algae removed in pots probably has no ecological significance.

⁸ - in Conservation Biology, No. 12, 1998

A pressure wave observed beneath a pot before reaching the bottom is believed to reduce impacts. This has also been observed in a study on the effects of creels⁹ in a soft sediment environment in Scotland. During this Scottish study, slow growing, long lived species, previously considered being fairly susceptible to damage were undamaged by the action of the creel landing, due to this pressure wave (Eno *et al* 1996).

The direct impact of pots on temperate reef systems may best be demonstrated by comparing the area of substratum that pots contact with the total reef area. We demonstrated that pots only contact 0.0053 % of the estimated reef area.

Effects of lobster fishing on ecosystems have received little attention relative to studies on effects of trawling. Bjørdal (1988) studied the “conservation value” that can be attributed to fishing gears. Conservation value in this classification may simply be defined as efficiency. Bjørdal evaluated two types of fishing gear: longlines and trawls (Table 10). Using an adaptation of Bjørdal’s classification method we added lobster pots to this evaluation. It was found that lobster pots, along with longlines were the most non-destructive and efficient fishing methods.

Table 10: Conservation oriented aspects of longline gear, trawl gear and craypots. H = high degree of conservation, M = medium degree of conservation, L = low degree of conservation.

	Longline	Trawl	Craypots
Species selectivity (eg. Bycatch)	H	L	H
Size selectivity	H	L	H*
Survival after escapement	M	M	H
Fish quality	H	M	H
Ghost fishing potential	L	L	L
Environmental impacts (eg. Habitat impacts)	H	L	H
Energy conservation (eg. Fuel usage)	H	L	H

* This may only apply when escape gaps are fitted.

‘Active’ commercial trawls and dredges are the main fishing gear that may cause habitat destruction and subsequent environmental degradation. This occurs not only through the gear being actively in contact with and being hauled over the seabed, but also through the bycatch of non-target species including juveniles. This problem is frequently debated and highly controversial (Conservation Biology Vol. 12, No. 68, Dec 1988; Kaiser *et al.* 1998, Ramsay *et al.* 1998, Thrush *et al.* 1998, Tuck *et al.* 1998).

Lobster pot fishing was previously thought to cause impacts comparable to anchor damage. However, it is not feasible to compare these impacts due to the difference in physical structure and action between the two objects. Anchors are steel structures, usually attached to steel chains with vessels swinging around due to wind, tide and swell action. This action often causing scours in the substratum. Lobster pots, in

⁹ - Creels are used to capture the Norway lobster and consist of mesh covered steel frames, similar to the square pots used in this study.

comparison, are attached to floating ropes with light marker buoys attached on the surface, the pots not usually causing scours on the substrata. Edinger (1998) found that in Indonesia dynamite fished or anchor damaged reefs are 50% less diverse in shallow water (3 metre depth) than undamaged reefs in the same region. At 10 metres depth the relative diversity decrease only 10%. By comparison, Edinger (1998), found that a reef damaged by storms had 30% reduced diversity at 3 metres depth, and 15% reduced diversity at 10 metres depth. Backhurst and Cole (unpubl. manus.) found during their study in New Zealand, that large brown macroalgae were more abundant where anchoring was less intense, but they did not occur in the habitat that boats anchored. The same authors also found that experimental anchoring of different intensities damaged some species, which were then attacked by whelks and starfish. It was also found that anchoring scars persisted for up to four months. This observation wouldn't apply to any pot impact, as pots were not observed to leave scars. This may be due to the cushioning effect of the pressure wave beneath the pot as it lands and deliberate attempts by fishers to be directly above the pots when they retrieve them.

Results on the number of pots lost are in concordance with data from the Florida Keys where 20% or greater of the pots were lost each year (Kruer, pers. comm.). However, if the results are considered in the context of how many pots are lost compared to how many pots are set each season, the probability of a pot being lost is low. Discussions with fishers in the southern zone suggest that up to 50% of the pots lost may be cut off by merchant ships. The dissimilar metals used in lobster pot construction ensures that lost pots are rapidly consumed by corrosion and electrolysis once their anodic protection is lost.

Impacts due to anchoring are not believed to be important in the South Australian Rock Lobster fishery as 70% of the fleet make only day trips. The northern zone fleet generally anchors in sheltered waters. The selection of sheltered areas is significant in that the fishers avoid anchoring on reef and utilise sand holes to aid retrieval of their anchors.

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