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REPORT FOR THE SEA LION SCIENTIFIC REFERENCE GROUP

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INTERIM REPORT FOR THE MEMBERS OF THE WESTERN ROCK LOBSTER FISHERY / SEA LION INTERACTION SCIENTIFIC REFERENCE GROUP (SLSRG).

This interim report has been prepared for the Rock Lobster Industry Advisory Committee and the SLSRG. The research reported has been undertaken to address issues of sea lion-rock lobster fishing interaction as identified in the Ecologically Risk Assessment (ERA) process for the western rock lobster fishery (WRLF). This assessment process was undertake as part of the accreditation of the WRLF by the Marine Stewardship Council and to satisfy the Commonwealth Government regulations for sustainable development of fisheries under the *EPBC Act* (1999) (DoFWA in press). The relevant points of this document are based on the resolutions agreed upon by the members of the Scientific Reference Group at the meeting on the 28th July. This report is appended (Appendix A) for reference to the specific resolutions. The sea lion species referred to in this document is the Australian sea lion (ASL), *Neophoca cinerea*.

STRATEGIES TO ADDRESS INTERACTION WITH SEA LIONS

Study site

The site for the study of sea lion behaviour and trial of the proposed sea lion exclusion devices (SLEDs) were conducted at North Fisherman Island (Fig. 1).

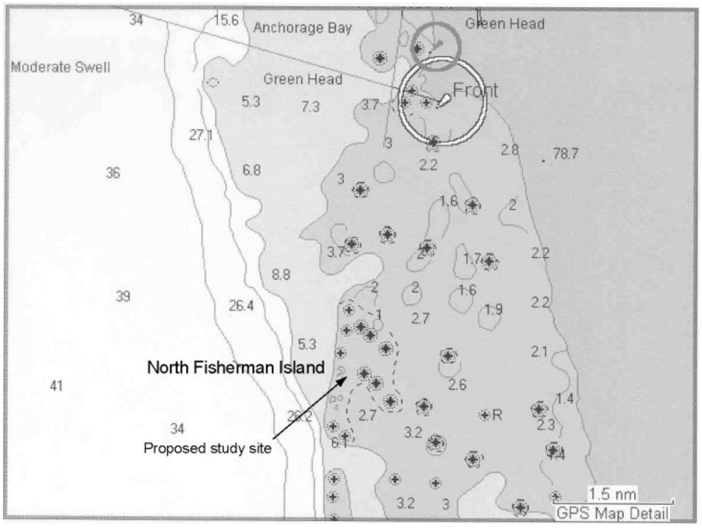


Figure 1. Location of the study site for trials of the SLED near the breeding colony of North Fisherman Island on the mid-west coast of the west coast of Western Australia.

Sea Lion Exclusion Device (SLED) design and video trial

Design of the preliminary SLED was based on the pre-existing device used in Victoria by commercial rock lobster fishermen communicated to the Department of Fisheries (DoF) by Mick Parsons. This consisted of a metal bar placed through the neck of the pot and secured in position (Fig. 2). Consultation with commercial fishermen raised concerns about the oxidation of the steel bar and the associated bubbles of oxygen released which may act as a deterrent to rock lobsters entering the pot. Stainless steel was proposed as a suitable material, however concerns were raised over the "shinyness" of this material deterring lobsters from entering the pot. It was decided to use painted stainless steel for the commercial trials thus removing the potential adverse impacts on catch rate.

Subsequent to this decision by the SLSRG, discussions with rock lobster fishery managers at SARDI and with officers of the Seanet organisation in South Australia revealed that individual fishermen use SLEDs to prevent sea lions from entering their pots and stealing bait and/or product (A. Linnane & C. van Der Geest pers. comm.). The two devices used were a steel bar placed through the neck and a spike attached to the bottom of the pot and protruding into the neck. There was no quantified evidence available of the impact of these devices on catch rate.

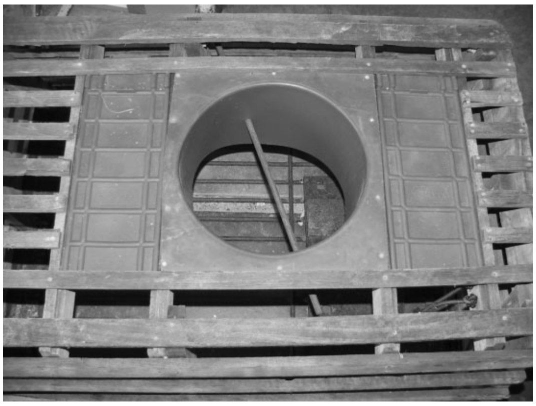


Figure 2: Initial sea lion exclusion device consisting of a steel bar (6mm diameter) placed through the neck of the pot and secured around the post with shock cord and clip.

Video trials at North Fisherman Island consisted of two commercial redneck pots with approximately 20-30 rock lobsters in each being set in shallow water near the beach of the breeding colony at North Fisherman Island. The pots were standard commercial pots with the escape gaps covered to encourage predation by ASL through the neck. One pot was modified with a SLED 1 (bar through the neck) and the other was a normal commercial pot used as a control. The experiment showed that the bar through the neck was effective in stopping sea lions from entering the pot (Figs. 3a&b).

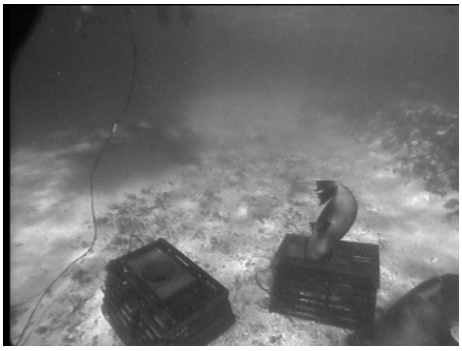
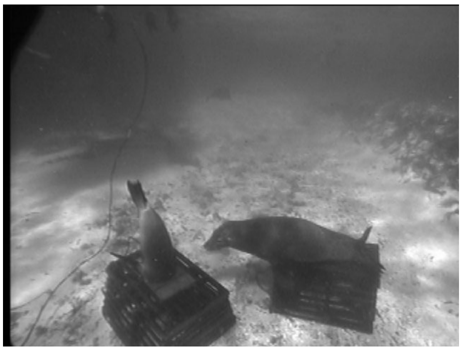


Figure 3a: A juvenile Australian sea lion attempts to enter the modified pot on the right which has a SLED in place (bar through the neck).



3b: Moments later the same animal gains entry into the unmodified pot and is able to access lobsters at the end of the pot.

A summary of Australian sea lion behaviour from this trial is presented in Table 1. An entry into the pot was defined as animal getting its head below the bottom of the redneck. All other attempts were defined as unsuccessful. The total number of rock lobsters taken from the pot by ASL was recorded as well as the number taken directly out through the neck of the pot. All other predation occurred through the battens of the pot.

Alternative SLED designs

Further SLEDs were designed in consultation with pot manufacturers and commercial fishermen, and video trials were again conducted to assess their efficacy in excluding sea lions from all types of commercial pots. Two additional devices were trialed, the first suitable only for the plastic redneck (Fig. 4a), and the other being suitable for all types of pots (Fig. 4b).

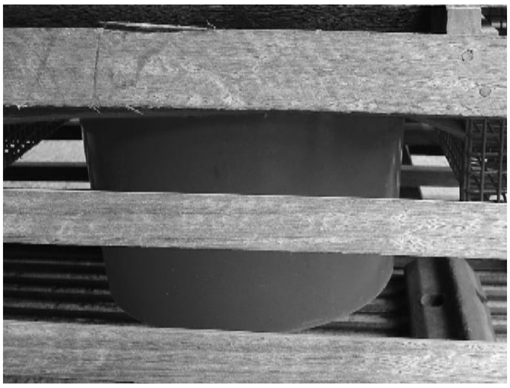


Figure 4a: Double neck pot consisting of a second redneck being attached to existing neck creating a deeper opening.

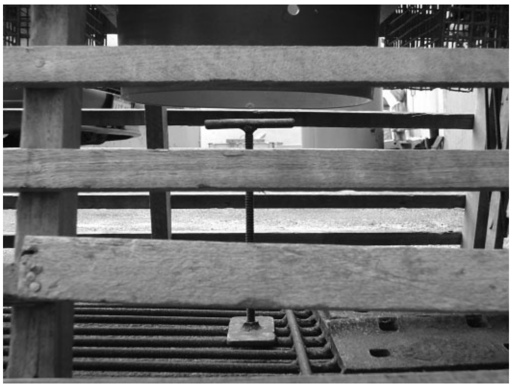


Figure 4b: T-bar exclusion device (220mm high X 100mm wide) and the welded female fitting on the base of the pot.

The double neck consisted of a second neck being attached to the pre-existing neck to create a deeper entry to the pot that finished approximately 150mm from the bottom of the pot. This was proposed to prevent sea lions from gaining access to the body of the pot and drowning. The t-bar device can be modified in terms of the height of the shaft and the width of the cross piece to suit the different types of necks and dimensions of commercial pots. This device consisted of a female fitting welded to the base of the pot and a threaded t-bar being screwed into the fitting and secured with a locking nut.

Trials were conducted in January 2004 to examine the effectiveness of the alternative SLEDs in excluding sea lions from rock lobster pots of all types. A summary of results is shown in Table 1. The t-bar designs were not as effective as SLED 1 (steel bar) in keeping sea lions from entering their head into the redneck pot. A significant number of successful attempts were observed, and predation rate of lobsters was reduced but not eliminated (Table 1). Whilst this indicated that some level of entry was possible, videographic evidence suggested that even a young juvenile animal could not get fully inside the body of the pot with a pot modified with the t-bar (220x100mm). Representation of this is shown in Fig. 5. The final design implemented in commercial field trials for redneck pots is displayed in Fig. 4b. Specifically, the t-bar should reach to the bottom of the neck structure (± 20mm). For other types of pots including stickpots (beehive) and fingerneck style pots it was determined that a cup head bolt, which was positioned similarly to the t-bar device, was sufficient in keeping sea lions from entering the pot. In all cases the SLED is designed to finish at the level of the bottom of the neck structure (± 20mm), though there may be further modification of this criterion. The double neck device (Fig. 4a) was less effective in keeping animals out of the pot and it was decided that this device was probably unsuitable for the purposes of an exclusion device. It was noted that the flexibility of the plastic redneck contributed greatly to the ease of entry of sea lions into the pot. The more rigid fingerneck (wood and plastic) and stick pot styles in combination with a simple cup-head bolt (instead of a t-bar) prevented sea lions from entering the pot. Further trials of these devices will be conducted in November 2004 to examine the behaviour of young pups (approx. 5-6 months of age).

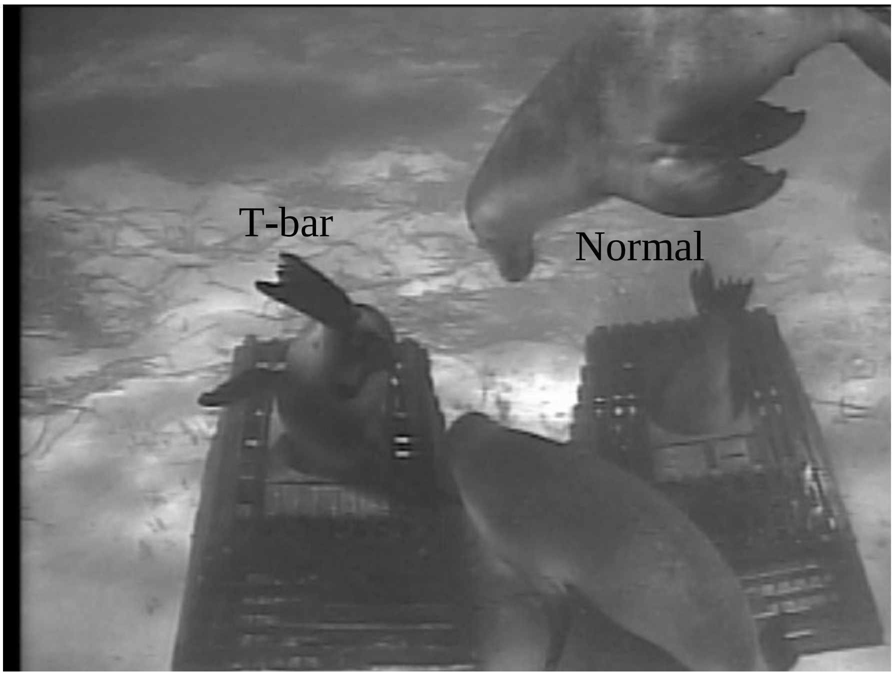


Figure 5. Videographic presentation of the performance of the t-bar device in excluding sea lions from entering commercial lobster pots. A juvenile ASL is shown nearly fully in the normal pot on the right , whereas the modified pot on the left prohibits the sea lion entering the pot.

The t-bar or cup head bolt devices can be made from existing materials used in pot construction. The base plate with the female fitting is comprised of a length (50mm) of escape gap iron with a nut welded to it. This is fixed in position on the base of the pot with a weld. Standard mild steel rod (diameter 10mm or greater) can be used to construct the t-bar. It is anticipated that this structure would last for at least for a single season and greater longevity could be achieved by using galvanised or stainless steel materials.

There were safety concerns raised by industry members during the trial of the t-bar device. The potential incidence of a pot rope becoming caught around the device and result in a pot being flung around the deck would endanger workers. To alleviate this concern, it was agreed that a blunt single upright (e.g. cup-head bolt, Fig. 6) would be trialed as a SLED in all types of pots in the forthcoming commercial season (2004/05). Further video investigation to determine the efficacy of this device would also be undertaken in November 2004. In addition, a variety of pots used by the recreational fishing industry will be trialed to investigate the potential of incidental bycatch in this equipment.

Figure 6. The modified SLED to be trialed in the 2004/05 WRL season. This device consists of a galvanised cup-head bolt that screws into a fitting welded to the bottom of the pot.

***Commercial trials of SLED* 1.**

Following the video trials of this device, commercial field trials were run to assess the impact of the device on the catch rate of rock lobsters. Nine commercial fishermen who operate in the mid-west coast area volunteered to use ten modified pots each among their gear. Fishermen were provided with data logbooks to record daily catch details in individual pots of the ten modified SLED pots and ten normal or control pots. The normal pot was defined as the next pot pulled after the SLED pot. In most cases pots area set 20–50 metres apart. This ensures that comparisons are made between pots on similar habitat that have equal opportunity to catch lobsters. As the trial was run voluntarily, individual fishermen were under no obligation to continue if they considered that there was an adverse impact on the catch rate. For this reason, the length of the trial varied between individuals.

A summary of the data shows that there was a significant impact of the bar on the catch rate of rock lobsters (Fig. 7). The daily catch rate of both sized and undersized lobsters was compared between the modified pots and the control pots using a paired t-test for all fishermen combined. There was a significant difference in the catch rate of both sized and undersized lobsters and this represented an 18% reduction in catch.

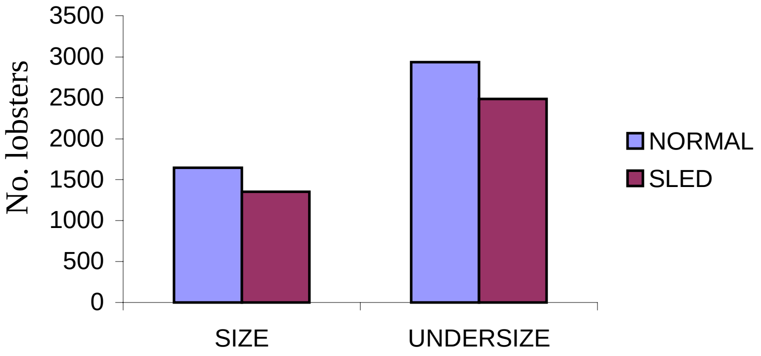


Figure 7: Total numbers of size and undersize lobsters caught in the SLED pots and control pots for all fishermen combined. This represents 733 pot pulls for each type of pot.

Assessment of the catch rates by individual fishermen revealed that eight out of nine experienced a decline in catch rates of sized and undersized lobsters (Figs. 8 & 9). One individual reported an increase in catch in the modified pots and further investigation revealed that there was no difference in the modification of the pot. It was suggested that fishing style may have resulted in the different trend evident between this fisher and the other participants in the trial. It should be noted that large variance in catch rate is evident for all fishermen, and that there was a low number of replicates for some participants.

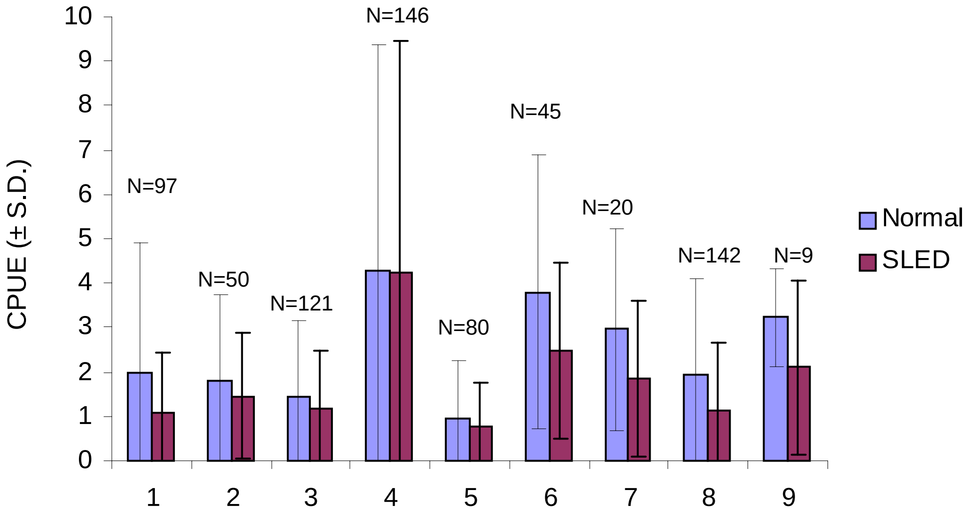


Figure 8. Mean catch of size lobsters per pot in control and modified pots for individual fishermen. The numbers of pot pulls for each type of pot is indicated on the graph.

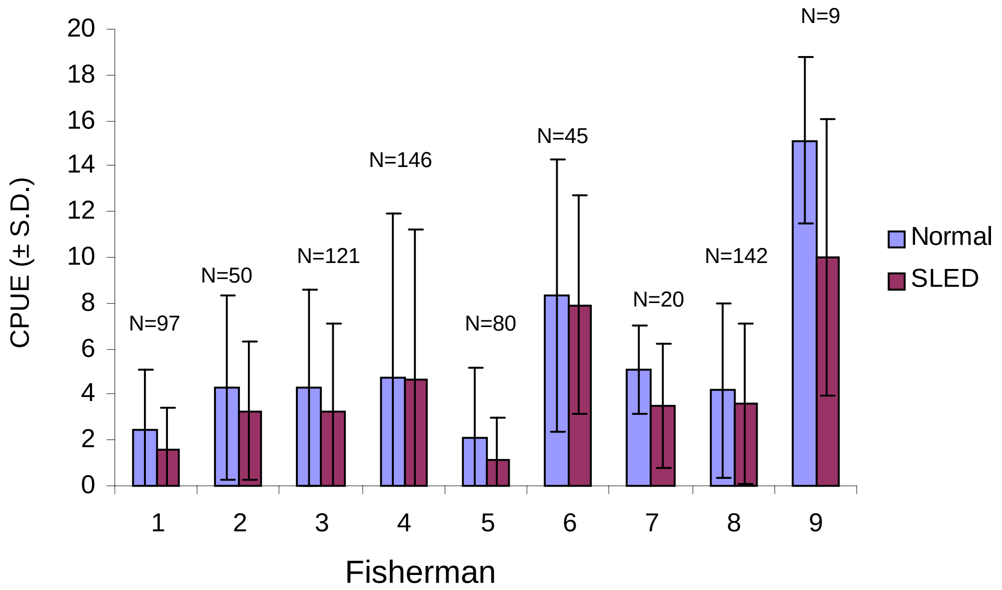


Figure 9. Mean catch of under-size lobsters per pot in control and modified pots for individual fishermen.

Commercial trials (Part II)

After the field trials of the alternative SLEDs, commercial trials were conducted to examine their impact on catch rate of lobsters. Field trials of the t-bar devices (220 x 100mm) were conducted in the mid-west coast region and at the Abrolhos Islands.

Mid-west coast

Eleven fishermen volunteered to trial the new SLEDs from February 2004 onwards. Due to a number of factors including low catch rates in shallow areas, only seven fishermen participated in the trial. Catch rates of legal sized lobsters from all depths were greater in the normal pots than in the 't-bar' pots (Fig. 10). This was supported by statistical analysis of catch rate between normal and t-bar pots ($F_{1,221}$ =5.61 p<0.05).

However, analysis of catch rate of sized lobsters for fishing effort in less than 20 metres showed that there was no significant difference ($F_{1,183}$ =1.05 p=0.31) and only a small difference in raw data (Fig. 11). This difference equates to a 2% difference in raw catch rates between normal and modified pots. One possible reason for the difference in catch rates for the two pot types in the two depths may be that the bigger lobsters in the deeper waters were not entering pots. There is no data currently on size frequency difference between normal and modified pots across depths. Significant variation in catch rate was evident among fishermen and within individual fishermen's daily catch totals (Figs. 13 & 14). Some individuals recorded greater catch rates for the normal pots and some for the modified pots for both sized (Fig. 14) and undersized lobsters (data not shown).

Abrolhos Islands

Four fishermen volunteered to trial the t-bar devices in a number of pots each for the 2004 fishing season, two fishermen in both the Easter and Pelsaert Groups. Limited data are available at present from only one fisherman and suggest that there is no difference in the catch rate between modified and normal pots (Fig. 15).

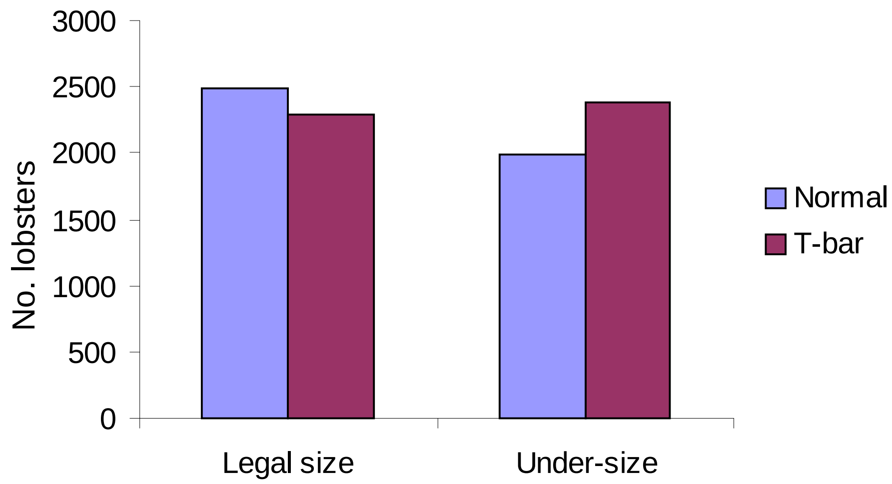


Figure 11. Total catch of size and under-size lobsters in normal and modified pots for all fishermen combined in the trials. These data represent 1425 pot pulls for each pot type.

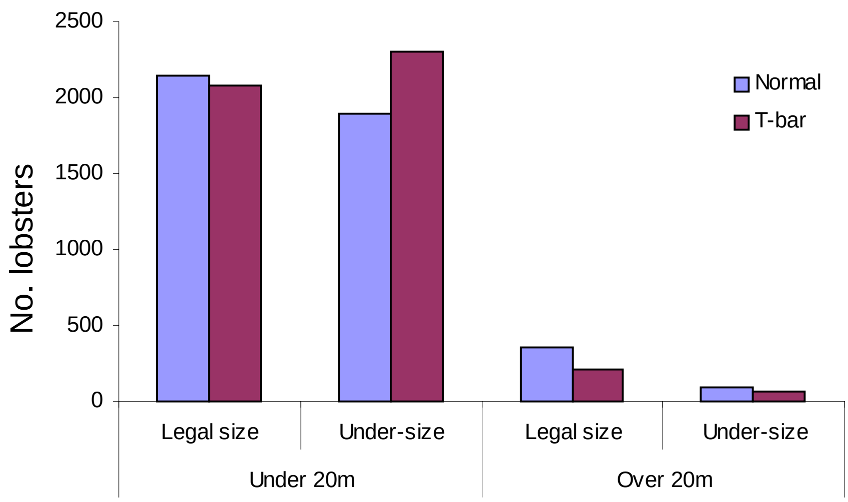


Figure 12. Total catch of size and under-size lobsters in normal and modified pots for fishing effort in shallow and deep waters in the mid-west coastal region.

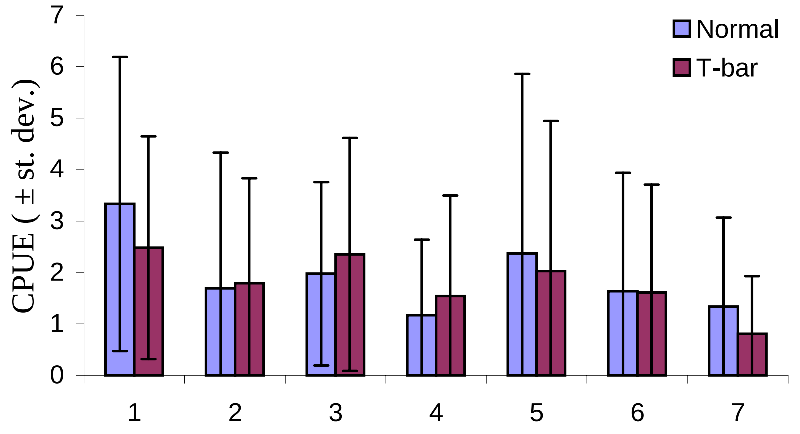


Figure 13. Mean catch rate of legal size lobsters per pot in control and modified pots for seven individual fishermen.

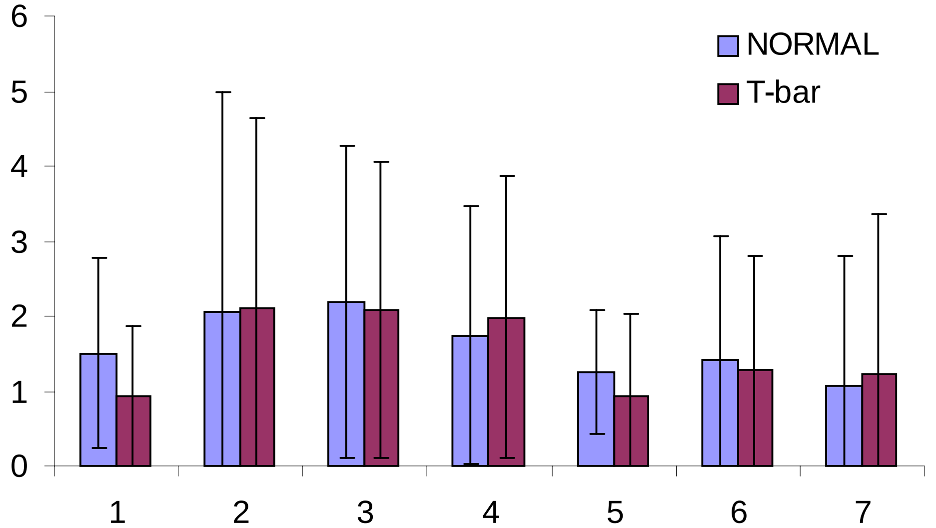


Figure 14. Mean catch rate of legal lobsters per pot in control and modified pots for individual fishermen in shallow waters (<20m).

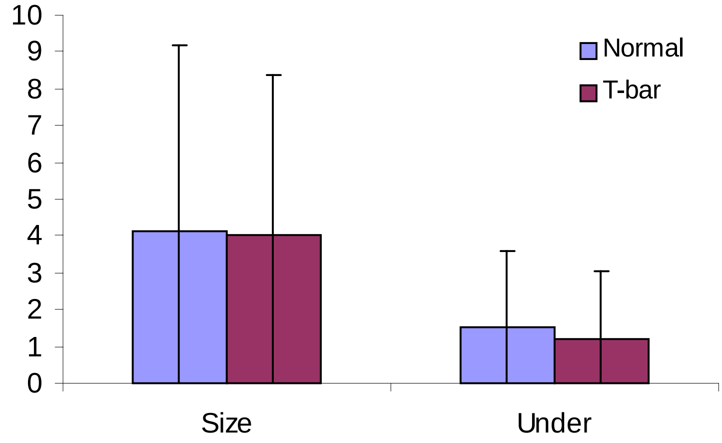


Figure 15 Mean catch rate of legal-size and under-size lobsters in the Abrolhos Islands.

Figure 15. Mean catch rate of legal lobsters per pot in control and modified pots for individual fishermen at the Abrolhos Islands.

Incidental catch data: Spatial and temporal patterns

A compilation of all volunteered bycatch data and the results of random and targeted telephone interviews with commercial fishermen is presented below.

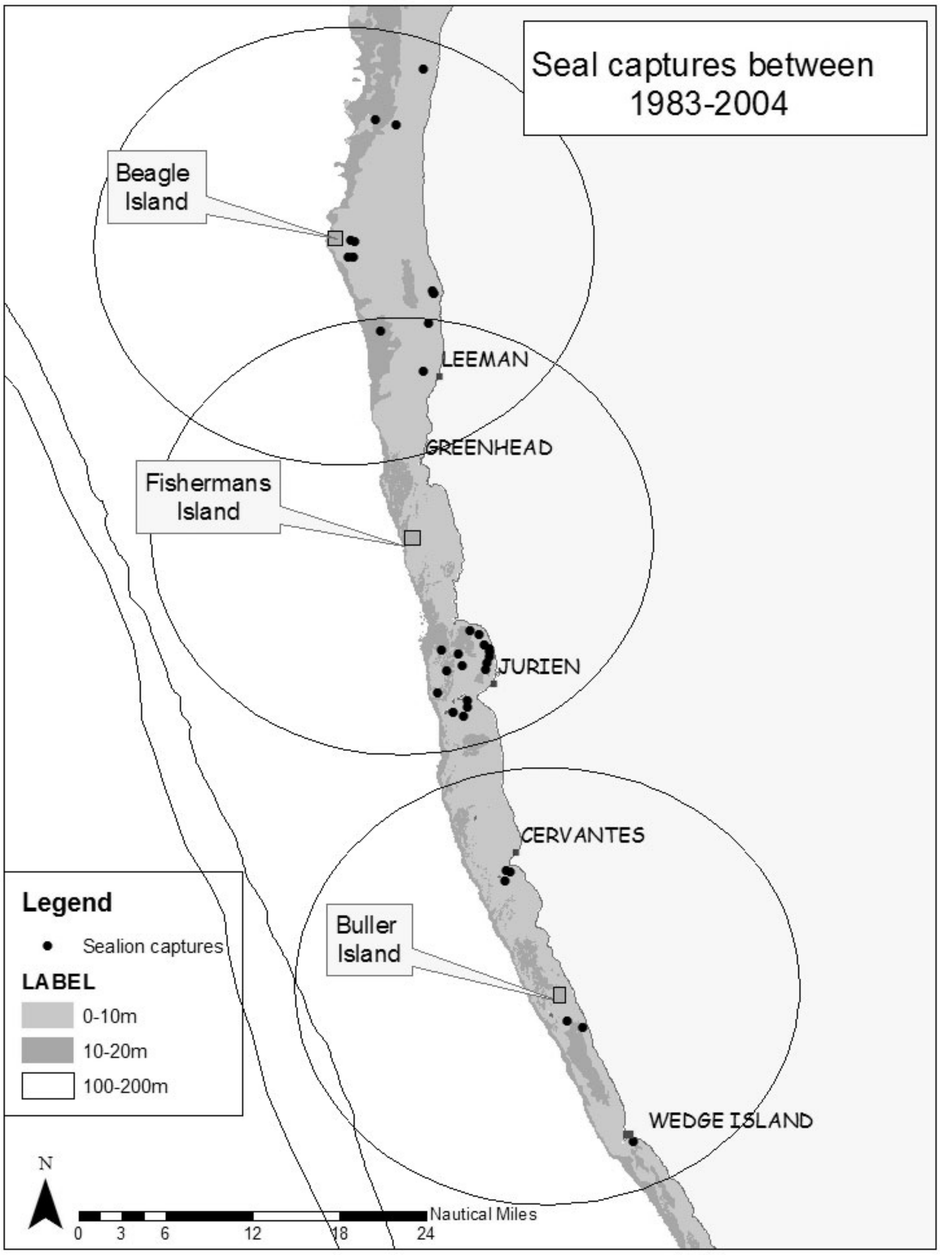


Figure 16. Location of all recorded incidental mortalities of Australian sea lions associated with the WRLF. Areas within 25km of breeding colonies are indicated by the black circles. All captures fall within this zone and are in waters less than 20 metres.

There are some patterns evident in the spatial analysis of the bycatch events. All captures occur within shallow water (<20 metres), and the majority of these in waters less than 10 metres (Fig. 16). This suggests that young animals target pots that are most accessible in relation to their diving ability. Captures are also localised around breeding colonies and known haulouts (e.g. Jurien Bay, Beagle Is). A significant number of the bycatch events occurred in the Jurien Bay region, and this may be due to the relatively calm waters and haulouts available.

Calculation of the overall rate of capture of Australian sea lion in the WRLF was based on four methods (Table 2). The recorded number of captures from all survey methods combined provides a minimum estimate of the level of incidental capture (Table 2). Extrapolation of the numbers recorded from the survey and the participation rate of the relevant survey resulted in an annual estimate for each method. The annual survey provided the highest estimate of 12 in 1999/2000, which was well above the minimum observed rate of 6. Estimates from the phone survey were the lowest recorded, and were lower than the minimum observed estimate. The number of pot lifts in the 0-10fm (approx. 0-20m) depth range is also included as a measure of fishing effort and shows some variability between seasons. The number of pot lifts per mortality is also expressed based on the maximum measure of estimated mortality from all methods. This resulted in an average value of 195 337 pot lifts for every estimated incidental mortality of an Australian sea lion (Table 2).

Table 2. Estimates of the total mortality of Australian sea lions in the WRLF for the past five fishing seasons. Estimates are rounded to whole numbers. Number of potlifts is from the area of interaction between Australian sea lions and the WRLF.

Method	**Estimate for fishing season**					
	1999/2000	2000/'01	2001/'02	2002/'03	2003/'04	Mean (± CV)
Annual survey	12	8	4	0	3	5.4 ± 0.86
Volunteer logbook	N/A	N/A	5	5	3	3.25 ± 0.72
Phone survey	1	1	1	1	1	1 ± 0
Reported mortalities	6	5	2	2	4	3.8 ± 0.47
No. potlifts in 0-10fm	1162484	1143538	1495530	1212134	?	1253422 ± 0.13
No. potlifts / mortality**	96874	142942	299106	242427	?	195337 ± 0.47

Spatial and temporal extent of SLED implementation

The mid-west coastal area and Abrolhos Islands will be addressed separately in light of the differing levels of incidental mortality recorded by the industry.

<u>*Mid-west coast*</u>

The proposed area of the SLED use zone is suggested to cover all waters less than 20 metres up to a distance of 25 kilometres from the known breeding colonies (Fig. 17). The proposed zone was to include all waters up to 60 metres depth as mentioned in the SLSRG report (Appendix A, p. 26). This was based on the evidence of young ASL off Kangaroo Island in South Australia being recorded diving to 60 metres (S. Fowler, pers. comm.). However, as this behaviour refers to animals in a different habitat, and is not representative of the common diving pattern of young ASL, the zone may be refined to a shallower depth. In light of the spatial extent of captures limited to waters less than 20m, the recommended zone may include all waters up to 20-25 metres. Bathymetric profiles show that there is steady drop-off from 20 30 metres and that extending the SLED zone from 20 to 25 metres would not include a large amount of fishing ground (Fig. 17b). However, fishing effort is sometimes concentrated around the ten fathom bathymetry line (~18m), and further consultation with the commercial industry will be undertaken to minimise the concerns over fishing on the edge of the defined zone.

It is proposed that research on the diving and foraging behaviour of the ASL along the west coast of Western Australia would greatly benefit the definition of the proposed zone, and provide confidence in defining the boundaries. In particular, knowledge concerning the range of dispersal of the vulnerable cohorts of pups and juveniles would greatly benefit the programme.

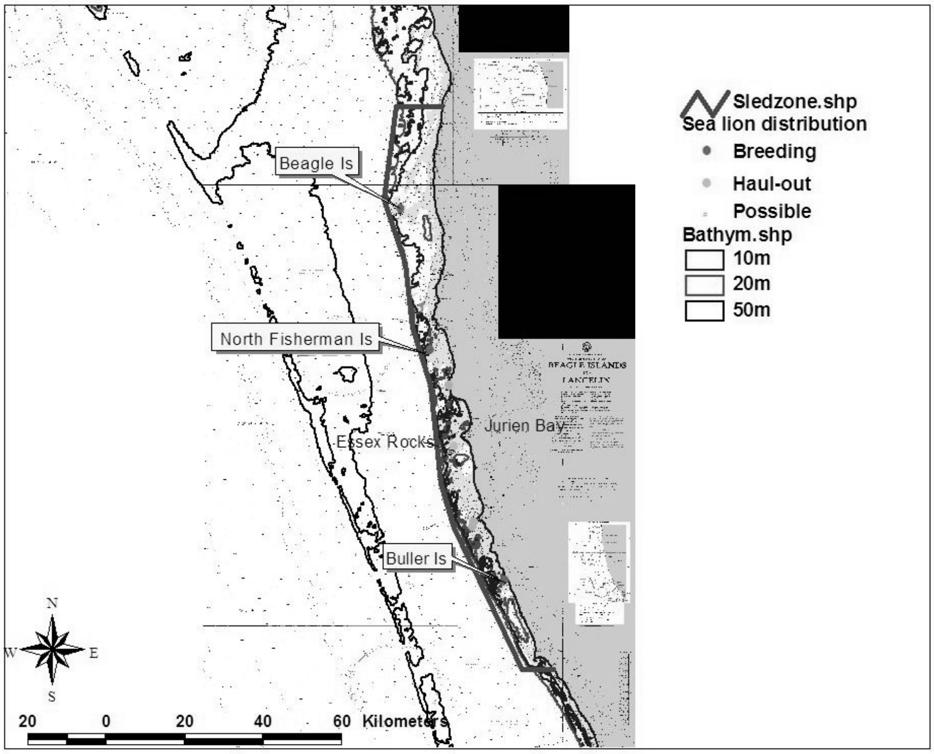


Figure 17a. Suggested boundaries for the zone of mandatory use of exclusion device in WRLF. This includes all waters less than 20metres and within 25 kilometres of breeding colonies.

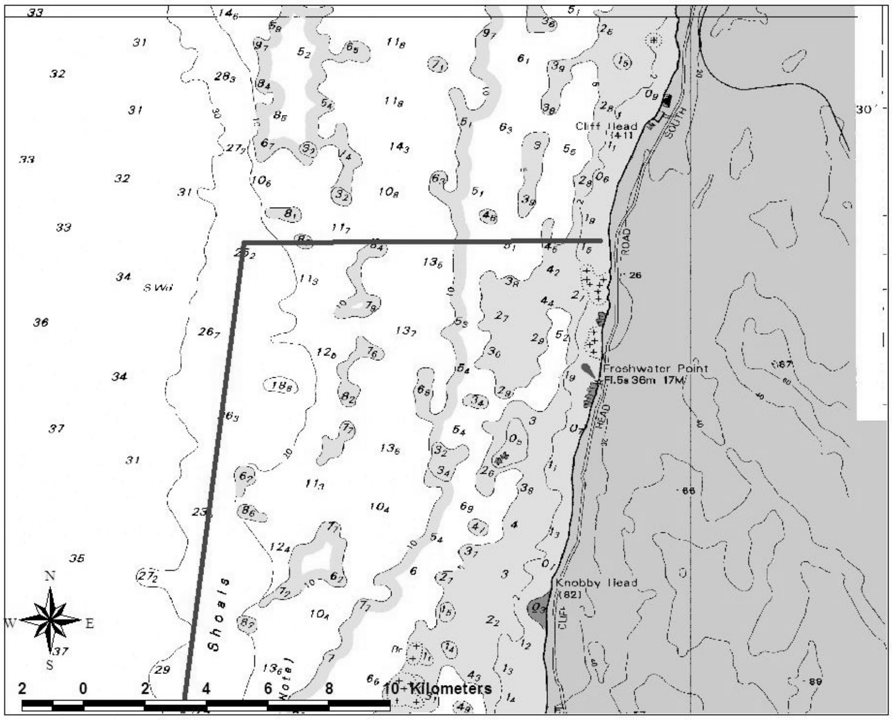


Figure 17b. Northern boundary of proposed SLED zone. Map shows the relatively rapid drop-off from 20 (red line) to 30 metres (black line).

The proposed area for the Abrolhos Islands SLED zone may be significantly smaller due to the limited amount of shallow water habitat. There may be significant behavioural differences of ASL in this area due to the lower density of animals and habitat differences. Surveys of the three island groups of the chain have revealed that breeding occurs only in the Pelsaert and Easter groups, and that predominantly sub-adult and adult males have been recorded as present in the Wallabi group and at North Island. The distribution of breeding colonies and known haulout areas against the bathymetry profiles of the islands and a representation of fishing effort for the 2001 season shows that there is limited fishing pressure on the shallow waters around breeding areas (Fig. 18). This may have some impact on the definition of the zone in the Houtman Abrolhos Island chain. There are anecdotal reports that sea lions do not interact with pots at the Abrolhos Islands as they do on the mainland coast, and there have been no reported incidental mortalities from this area. Video observation work will be conducted here to investigate the behaviour of the Abrolhos Island ASL population around lobster pots. It is also possible that behavioural changes may occur among ASLs after the mandatory implementation of the SLEDs. Animals may forage from pots in slightly deeper waters if they find they cannot get access to pots in shallow waters.

Monitoring of efficacy of programme and ongoing testing

Due to the low level of interaction, it was decided that independent monitoring of the rate of interaction was logistically and financially difficult (p. v, Appendix A). It is proposed that the experiments defined in this report of video observation of modified pots and Australian sea lions be repeated on an annual basis to provide certainty that the devices continue to provide effective mitigation. This will be performed in addition to the annual monitoring of bycatch through voluntary logbook forms as well as instigating a section on protected species interactions in the CAES returns system which will target all commercial fishers from 2005/06 onwards. In addition, the DoF compliance operations, which monitors all aspects of commercial fishing operations including pot legislative requirements, will enforce the mandatory use of SLEDs in the relevant areas as part of their ongoing programme.

Potential Biological Removal

The impact of the incidental catch rate of *N. cinerea* on the population was investigated using a Potential Biological Removal (PBR) model. This is a non-age structured model designed to calculate a maximum allowable bycatch rate, which will allow a population to maintain or reach an optimum population size (Barlow et al. 1995). This model has been used extensively in the United States in calculating an allowable level of human induced mortality in marine mammal species as required under the Marine Mammal Protection Act (Barlow et al. 1995). It is a generic model that requires no age-specific demographic data and can be applied across species. The formula is the product of three variables, N_{min} - the minimum population size, $0.5R_{max}$ - one half the maximum net reproductive rate for a population and F_r- a recovery factor based on the status of the stock, where;

$$PBR=N_{min}*0.5R_{max}*F_r$$

The calculation of these variables is based on a number of assumptions and default values. For further details readers should review Barlow et al. (1995), Wade & Angliss (1997) and Wade (1998). N_{min} is calculated as the lower 60th percentile of a log-normal distribution of a stock, and is designed to provide ".. an estimate of the

numbers of animals in a stock that: (a) is based on the best available scientific information on abundance, incorporating the precision and variability associated with such information; and (b) provides a reasonable assurance that the stock size is equal to or greater than the estimate." (p. 8, Barlow et al. 1995). For the purposes of this study, N_{min} was calculated using equation 1 (Wade & Angliss 1997) as the lower 60^{th} percentile of a log-normal distribution with a default value CV=0.2 where; $N_{min}=N/\exp(0.842x[\ln(1+([CV(N)]^2)]^{1/2})$.

The maximum net reproductive rate is defined as the maximum annual per capita growth rate of increase in a stock resulting from additions due to reproduction, less losses due to natural mortality. There is limited data in the literature regarding population growth rates for Australian sea lions. A default value for pinnipeds of 0.12 is recommended in cases where no real data are available, and is based on information from Northern fur seal populations (Barlow et al.1985). However, a lower default value of 0.08 was applied to the New Zealand sea lion, an annual breeding species, based on expected lower growth rates for southern hemisphere otariids (Wilkinson et al. 2003). A value of 0.08 was used for this study, which may be an over-estimate due to the extended breeding cycle of this species. The recovery factor, a value between 0.1 and 1, is determined by the status of the stock and is an interpretation of the ability of the stock to recover from perturbations, but also allows to correct for uncertainty in the calculation of the other variables. It has been suggested that endangered species be assigned a value of 0.1, and that for depleted and threatened stocks a default value of 0.5 be used. The current status of the Australian sea lion would suggest a value of 0.5, though it could be argued that the sub-division of the west coast stock in combination with the high level of female natal site fidelity would warrant a value of 0.1 for all colonies. Pup surveys over the last 16 years show that the west coast population is relatively stable (Fig. 19). Surveys at the Abrolhos Islands show pup production at approximately 20 per breeding season (Gales et al. 1994, Campbell 2003). Estimating population size of pinnipeds is difficult as there is always an unknown percentage of the population at sea. Population size is estimated by multiplying pup production numbers (P) by a correction factor based on estimated life history parameters (Berkson & DeMaster 1985). For the ASL, population size is estimated by 4.3P (CV=0.5P, Gales et al. 1994). This results in a population size of approximately 740 ± 65 animals for the west coast of Western Australia based on the average pup production over the past 16 years. Population size for individual colonies is calculated in the same manner. This species is currently under review for addition to the Commonwealth register of vulnerable species under the EPBC Act (1999). For the purposes of this study a range of PBR values for a continuum of minimum population sizes was calculated for two values of F_r (0.1 and 0.5).

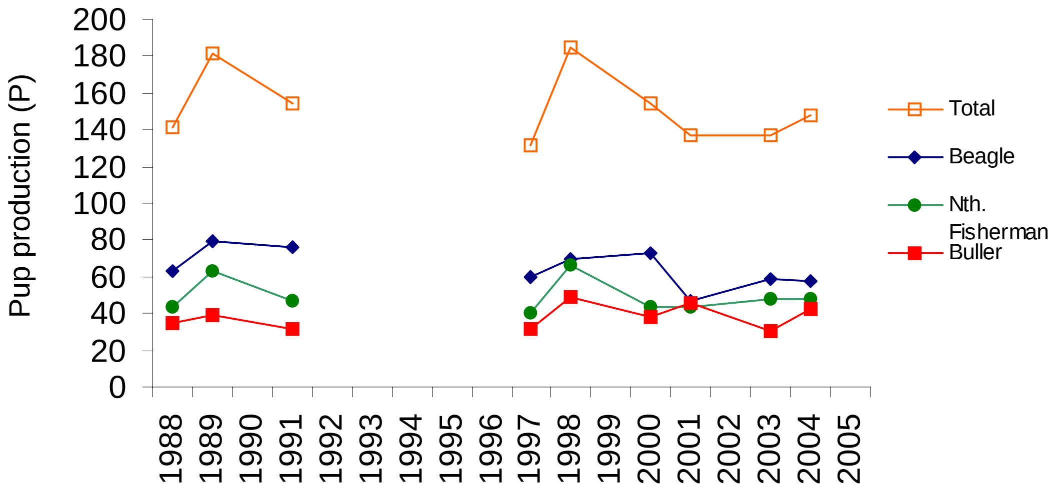


Figure 19. Pup production estimated from surveys for the three main breeding colonies on the west coast and a total for the three colonies.

One fundamental concept for the calculation of a PBR is the definition of a stock. In general a stock, as defined by the United States Marine Mammal Protection Act is a group of animals in common spatial arrangement that interbreeds. However in the face of specific biological information such as population genetic structure, management units can be significantly smaller populations or demes that experience little or no gene flow between them (Wade & Angliss 1997). Recent genetic investigations of the Australian sea lion reveal that the west coast population experiences very little gene flow with the rest of the population. Additionally, there is very fine scale subdivision of populations, such that females show an almost exclusive natal site fidelity to the breeding colony (Campbell 2003). On this basis it is suggested that individual breeding colonies represent management units, and accordingly the PBR analysis should be calculated for each individual stock or breeding colony.

Estimates of PBR for the west coast population are shown in Fig. 20. The estimated values of N_{min} for the individual colonies are indicated along the x-axis. PBR analysis suggests that the level of allowable catch for the west coast population of *N. cinerea* would be low even if the entire west coast population was considered a single management unit for both values of F_r (Fig. 20). Under a more restrictive regime of F_r =0.1 and single colony management units, the recommended rate of capture would be less than 1 animal per colony, and a total of two animals for the entire west coast population (Fig. 20). This figure is equal to or below the minimum observed estimate of bycatch recorded in recent seasons (Table 2). Whilst this level of capture is low, especially in comparison to other reported interactions (e.g. New Zealand fur seals in the hoki trawl fishery, see Woodley & Lavigne 1991), this rate may be enough to adversely impact the growth rate of the west coast population. Survey data on the west coast population suggests that the population is stable with no discernible trend in pup production rate over the last 15 years (Campbell 2003). In addition, there is a positive density-dependent effect on pup mortality, which may be indicative of a population close to its carrying capacity. However as the PBR analysis suggests, even a low level of bycatch may prevent this population from reaching or maintaining an optimum size.

Some caution must be used in interpreting the PBR analysis as it is a non-age structured model that does not allow for variations in fertility and mortality rates. It is not expected that exceeding the recommended PBR level will result in a population decline. Populations rarely attain a stable age structure and fluctuations in this can have a profound effect on the growth rate of a population. This leads to differences between theoretical and observed population growth rates and may overestimate the rate of recovery of a population. A more complex age-structured model including reproductive output and status of animals caught, and allowing for seasonal variation in demographic traits would require much greater knowledge than is presently available for this species. The collection of these data would be both logistically and financially prohibitive and would result in considerable disturbance to the breeding populations. It is not immediately obvious whether these disturbances would be justified for the value of the data collected. The use of data from other species and the limited data from other populations of *N. cinerea* to estimate demographic parameters for this population would be of limited value given the unusual breeding biology of this species and the very high levels of population subdivision seen in *N. cinerea*. Further investigation into assessing the impacts of incidental bycatch are the subject of a current application to the Fisheries Research and Development Corporation (FRDC).

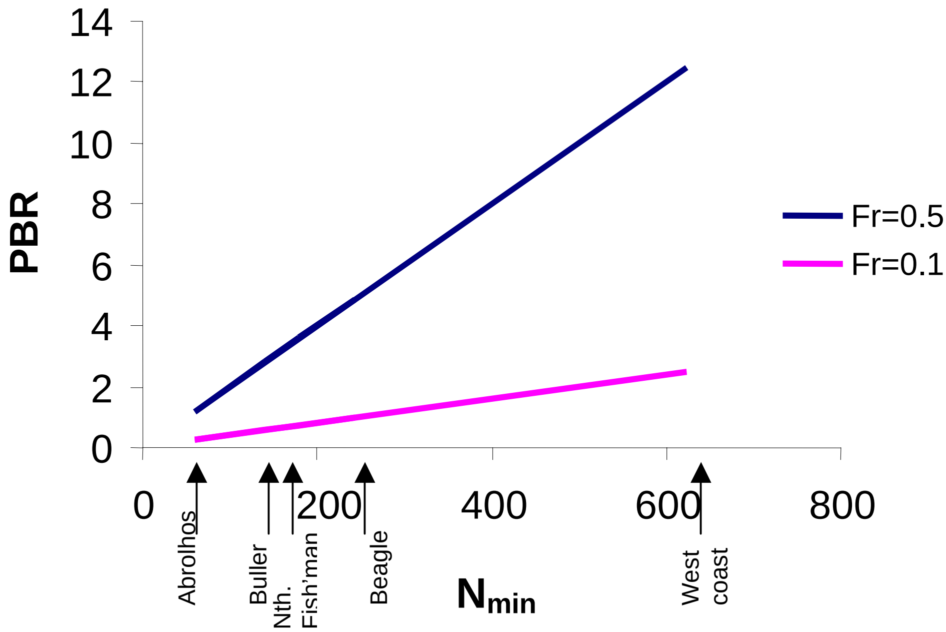


Figure 19. Estimated PBR values for the west coast of Western Australia population of Australian sea lions with values of N_{min} indicated. Models were calculated for two values of recovery factor (F_r=0.5 & 0.1), and two stock definition concepts (All west coast & individual colony).

Table 1. Entry rate and predation rate of Australian sea lions into rock lobster pots using experimental sea lion excluder devices.

Experiment type (pot type-SLED)	No attempts		% of raids where head was below neck		No. lobsters taken		Rate of success (no. successful/total no. raids)		Predation rate per hour
	SLED	OPEN	SLED	OPEN	SLED	OPEN	SLED	OPEN	
Redneck-steel bar sled	67	113	0	93	0	27	0	0.24	9
Redneck-220X150 tbar	21	16	5	81	0	0	0	0	0
Redneck-180x100 tbar	33	29	70	79	3	1	0.09	0.03	4
Redneck-220x100 tbar	59	45	66	91	7	9	0.12	0.20	21
RN-Doubleneck	30	34*	80	0	6	1	0.20	0	13
SL_F/N_180x150 tbar	15	21	0	86	0	5	0	0.24	8
SL_F/N_180 x 100mm tbar	10	11	0	73	0	0	0	0	0
SL_F/N_180mm bolt*	7	4*	0	0	0	0	0	0	0
St_F/N_180x100 tbar	15	19	0	100	0	4	0	0.21	5
St_F/N_180mm bolt*	36	9*	28	0	0	0	0	0	0
Stpot_180X100 Tbar	34	47	0	87	0	10	0	0.21	13
Stpot_180mm bolt	35	16	3	50	0	0	0	0	0
Total combined	362	362	0.27	0.77	16	57	0.05	0.18	8

* indicates where the open pot has been effectively closed to encourage attempts at the SLED pot.
RN-redneck, SL_F/N-sloped fingerneck, St_F/N-straight fingerneck, Stpot-stickpot or beehive pot
Note that measurements of SLEDS are in millimetres.

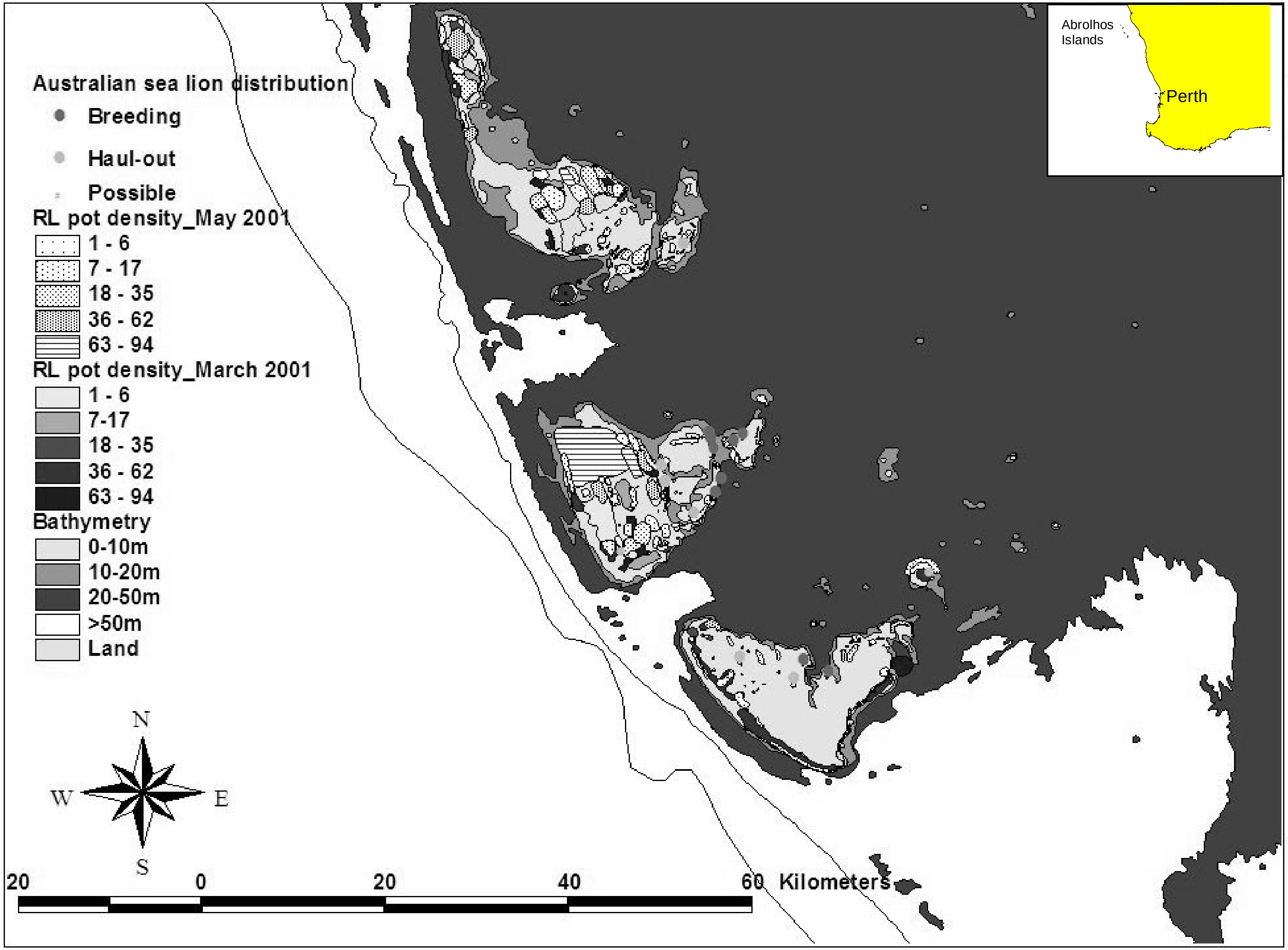


Figure 18. Estimates of fishing effort relative to water depth and distribution of Australian sea lions in the Abrolhos Islands.

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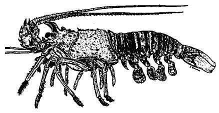
APPENDIX A



Report of the Western Rock Lobster Fishery / Sea lion Interaction Scientific Reference Group to:

Peter Rogers, Executive Director Department of Fisheries
&
Ian Finlay, Chairman WA Fishing Industry Council

The Western Rock Lobster Fishery / Sea Lion Interaction Scientific Reference Group (the SRG) has been convened jointly by the Department of Fisheries and the WA Fishing Industry Council (WAFIC). The SRG (with all members present) met for the first time on Monday 28 July in Perth, and this document is the official report from that meeting.

The composition (also those who were in attendance) of the SRG is:

- Ron Edwards — Independent Chair
- Nick Gales — Australian Antarctic Division
- Peter Mawson — Department of Conservation and Land Management
- Richard Campbell — University of Western Australia
- Jim Penn — Department of Fisheries Research Division
- Tim Bray — Executive Officer (non-member)

In addition to members of the SRG a number of advisors / observers were also present to observe the process and assist the SRG where required. These people were:

- Guy Leyland — WAFIC
- Nick Caputi — Department of Fisheries
- Chris Chubb — Department of Fisheries
- Katie Weir — Department of Fisheries

Prior to meeting the SRG was provided with the following documents:

- Meeting program for 28 July (Attachment 1)
- Establishment of the “Western Rock Lobster Fishery / Sea Lion Interaction Scientific Reference Groups” (Attachment 2)
- The Environmental Management Strategy of 28 February 2003 (see MSC website)
- Scientific Certification System’s Addendum 1 Surveillance Report No. 5 (see MSC website).

All SRG members were advised that should they require any further reference material that it would be provided on request.

SUMMARY OF PROCEEDINGS

Marine Stewardship Council Certification Overview

Following opening remarks by the Chairman the program for the day was adopted and Mr Tim Bray was asked to provide an overview of the MSC certification process and how the SRG fitted within it. Mr Bray emphasised that the SRG is an independent body provided with the task of developing the best strategies to address the bycatch of Australian sea lions in western rock lobster pots and that these strategies should be based entirely on scientific merit. It was pointed out that the resolutions of the SRG would be contained within a report to the Department of Fisheries and WAFIC and that this would be a public document to ensure the process is transparent.

Sea lion population structure and history of human induced mortality

Richard Campbell presented to the SRG his PhD research on sea lion population structure in Australia with a particular focus on Western Australian populations. He also provided a summary of the work he has been undertaking for the Department of Fisheries Research Division and on the history of known human induced mortality in Western Australia dating back to survivors of shipwrecks in the 17th century. This presentation allowed for a high degree of interaction discussion with many questions and clarifications throughout with and input from all reference group members.

SRG key points agreed under this item:

1. Australian sea lions breed in a range from Abrolhos Is. in WA to the Pages Islands in South Australia.
2. Australian sea lions are non-selective benthic predators with a comparatively good diving capability that is also present in pups.
3. Given the high abundance of undersize rock lobsters in shallow waters in the mid-west and Abrolhos region there is a very low chance of any effect of lobster removal on the sea lion population.
4. At Kangaroo Island in South Australia, adult female sea lions dive to depths of up to 150m, but mostly dive in the 60-100m range. In Western Australia adult female sea lions have been recorded diving in 10-120m depths, and it is assumed that their foraging range includes continental shelf waters adjacent to where they live.
5. Recent research on the development of diving in sea lion pups has shown that pups of 6-18months of age (the study ages) can dive extensively, and in South Australia dive to depths of at least 60m.
6. The Australian sea lion's reproductive strategy is quite different from other pinnipeds.
7. The breeding cycle is about 17.5 months, but the timing of breeding differs significantly (by months) from one colony to the next, with an asynchronous pattern of breeding across their range.
8. Genetic analyses (female haplotype) indicated females display a strong breeding site fidelity ("house bound cow" phenomenon).
9. Males move relatively freely amongst regional colonies but probably do not migrate large distances, i.e. movements between WA and SA colonies would be very rare if at all.
10. There is a history of localised extinction in Australia, e.g. Bass Strait, Islands around Albany, Carnac Is, Garden Is.

11. The ability to repopulate areas where sea lions used to inhabit appears to be negligible because of female breeding site fidelity.
12. Four main breeding colonies on the west coast of WA described as being Abrolhos Is (several islands), Beagle Islands, North Fishermen Is and Buller Is.
13. Pup production at these sites is estimated to be a total of about 150 at the 3 mid-west islands and about 20 at the Abrolhos..
14. There is a documented history of a substantially more abundant population of sea lions at the Abrolhos Is. The reduction to today's very low levels appears to be linked to culling / harvesting events by early explorers and whalers, and a likely low level of take until recent times.
15. There is no evidence to suggest colonies in the Jurien area were subject to as high a level of culling / harvesting as occurred at the Abrolhos and it is therefore likely that the Jurien colonies are closer in size to population sizes along the coast prior to human induced mortality.

Resolution 1

The SRG summarised the status of Australian sea lions off the west coast as representing isolated and small populations with low genetic variability that is segmented with little or no scope for migration from other populations. The SRG assessed that the impacts of what appear to be low levels of mortality from the fishery can in fact be critical for west coast sea lion populations. The SRG also concluded that given the generalist feeding behaviour of the sea lion, that there was a very low probability of any effect of lobster removal on the sea lion population.

Current data collection

A description of the relevant data currently being gathered by the Department of Fisheries was provided and is summarised as follows:

1. Commercial monitoring data (collected by fisheries research observers aboard commercial vessels)
2. Voluntary logbook data (detailed catch and fishing effort data with increased spatial and temporal resolution provided voluntarily by almost 40% of commercial rock lobster fishers)
3. Annual Gear and Equipment Survey forms (recently upgraded to allow for bycatch of specially protected species data to be included)
4. Random telephone surveys.
5. Targeted telephone surveys of commercial fishers known to have caught sea lion pups.
6. Relevant data from CALM data bases.

From these data sets and the collective knowledge of the SRG the following points were agreed by the SRG members:

1. Pups are vulnerable to capture in rock lobster pots from the age they enter the water and start diving (approximately five months) to a point when they are too large to enter into a pot and drown (possibly about 24 months of age).
2. Most accounts refer to pups caught being in the size range of 2.5 to 3 feet long, which is consistent with the estimated vulnerable age class.
3. All known catches are close to shore, but recent tracking studies of pups in South Australia demonstrate that these catches could occur further offshore.
4. The impact of recreational rock lobster pot fishing is unknown, but is likely to contribute to some extent to pup mortality.
5. It is not possible to extrapolate from existing data to provide a useful or accurate estimate of total mortality from the commercial rock lobster fishery, however, the current estimate is regarded as being a minimum estimate.
6. As there are no data on age/sex specific survival data, and minimal data on production for Australian sea lions, any attempt to model the impact of fisheries take on sea lions population would yield highly uncertain results that would be of little use to management.
7. Efforts to collect the necessary survival and production data that could be used for such models requires intensive research within the sea lion communities, and activity that would cause significant disturbance to the sea lions themselves, and would take a great deal of time.
8. Given the statistically low reported incidence of sea lion interaction with rock lobster gear, it is not feasible or cost effective to adopt a sufficiently independent observer program to collect data that could reliably estimate the level of interaction.

Points 6 and 7 were the subject of considerable discussion. In particular the SRG identified that there is no data for this species upon which estimations of age / sex specific survival could be made and there is only a very small amount of data on reproductive output.

This being the case, any modelling exercise would have to be based on information from other species. The SRG believes this would be inappropriate because of the significant differences in life history patterns between the Australian sea lion and other pinniped species, i.e. 17.5 month breeding cycle as opposed to regular 12-month cycles displayed in other species.

The SRG also discussed in detail the advantages and disadvantages of programs to collect data from sea lion populations off the west coast designed to address the knowledge gaps. Collection of relevant data would be dependent upon the ability to permanently mark pups for subsequent re-sighting and identification. Methods of doing this include flipper tags, microchip tags, paint branding and hot or cold iron branding.

Flipper tags are notoriously unreliable for this species because they will invariably lose them, paint branding is not effective due to moulting and hot / cold iron branding is regarded as being unethical and has been outlawed in Australia. Microchip tags would be a more reliable technique. However, the process of tagging and subsequent animal identification would be dangerous to researchers and cause great disturbance to what are understood to be vulnerable populations.

To elaborate further on the disturbance issue, the SRG understands that the type of data collection envisaged would require a regular and frequent human presence on colonies for a period of 10-20 years. Data collection would require physical handling of animals. Due to the aggressive behaviour of sea lions (particularly when pups are present) such data collection has an unacceptably high risk of causing stress to adults and exposing pups or juveniles to increased rates of mortality from larger adult seals.

The aggressive and elusive behaviour of sea lions would also confound the efforts of researchers to locate all (or at least the majority) of tagged animals; this would introduce a significant error into any modelled results.

Finally, any model of impacts would require accurate and precise estimates of fishery take. Experience in other fisheries has shown that this can only be achieved through the use of independent observers, a program that is logistically entirely impractical in this fishery.

Resolution 2

The SRG do not believe there is sufficient, or appropriate, data available to conduct a modelling exercise designed to better understand the dynamics of Australian sea lion populations off the west coast, and the impact of fisheries on them. Furthermore, based on the SRG's understanding of sea lion behaviour, in particular their susceptibility to disturbance, the SRG recommends against collecting data that could potentially be used to model sea lion populations and the effect of fishing induced mortality because there is an unacceptably high risk of increasing pup mortality, or reducing sea lion production.

Strategies to address interaction with sea lions

Eliminate capture of sea lions

The SRG believes that the development of an effective sea lion exclusion device (SED) is a critical and essential component of any strategy to address the mortality of sea lions in rock lobster pots. Furthermore, with reference to the SRG's assessment of sea lions populations in Western Australia, the objective of any process to develop a SED should be the elimination of sea lion bycatch and mortality from rock lobster fishing.

Resolution 3

The SRG advises that a trial of rock lobster pot sea lion exclusion devices, developed with the assistance of gear technologists from, but not limited to, existing designs, be undertaken as a matter of priority to determine the most effective means of eliminating sea lion mortality in rock lobster pots.

The SRG gave consideration to how, when and where such a trial should be conducted. Key elements of the trial should be based on the following:

- Conducting a pilot project to assess the use of video equipment to observe the interaction of sea lion pups/juveniles with rock lobster pots. This should occur as soon as possible (August 2003) and it is recommended that the colony at North Fishermen’s Is. be the study site.

- The design of SEDs should be undertaken by fishing gear technologists, and can be based on, but not limited to, existing designs. The SRG considered that a successful design will be inexpensive to produce, easily fitted and removed from existing pot designs, completely exclude sea lions from entering and drowning in pots, and should not affect the rock lobster catching characteristics of the pot.

- If the pilot project is successful this approach should be expanded and used to examine the interaction of sea lion pups with pots with and without SEDs to enable a preliminary assessment of the likely success of using the SEDs. This study should occur in October 2003 and July 2004 to enable the assessment of the interactions with large and small sea lion pups.

- It is important the pots used in the SEDs video trial are modified so as to allow for the quick release of any sea lion that may be captured during the trial.

- To assist in the uptake of SEDs by the rock lobster industry a study to examine the impact of the pot modifications on rock lobster catches should occur. Such a study should be conducted from willing commercial vessels. 50% of the gear would be modified to include a SED the other 50% unchanged. The study area should include waters 20nm north and south of known sea lion colonies to a depth of 40m. Researchers / observers should be onboard participating vessels to record relevant data including any interaction with sea lions.

- The duration of this at sea trial should be for the entire 2003/04 season.

The SRG expects to be provided with a detailed description of the trial study to review and comment on.

Without wanting to pre-empt the outcome of a SEDs trial, the SRG contemplated the mandatory use of SEDs for the 2004/05 season.

The spatial and temporal extent of where the SEDs should be used can be finally determined at the end of the research proposed by the SRG.

Resolution 4

Assuming the SEDs trial demonstrates that sea lions can be excluded from rock lobster pots the SRG recommends that it become compulsory from the commencement of the 2004/05 season to have a SED fitted to every rock lobster pot when fishing in waters from Lancelin to Dongara to a depth of 60m and for all waters of Zone A.

Measuring the effectiveness and review of a bycatch elimination strategy

To assess the effectiveness of using SEDs it is important to ensure that reports of any captures are received and that an index of abundance for the respective sea lions colonies is available.

With the data on sea lion bycatch it is difficult to say more than current fishing operations do result in some level of sea lion mortality. The SRG would like to be informed in 12 months time as to the success, or otherwise, of initiatives by the Department of Fisheries to educate industry through public meetings, the coastal tour process, information brochures, posters and other mediums of the importance of reporting any interactions. At that point the SRG should be given the opportunity to examine if there are under-reporting or misreporting issues that would undermine the bycatch elimination strategy.

Resolution 5

Given that it is not feasible to have sufficient independent observer data to reliably estimate the level of interaction, the Department of Fisheries should continue with education process designed to improve industry's reporting of whether or not they have interacted with sea lions (and other specially protected species).

To give credibility to the target of eliminating mortality it is important that if there were a mortality event from gear with an approved SED that such an event would trigger a review of the effectiveness of the SED in use. Such a review may or may not result in further modifications to approved pot design depending upon the circu mstances surrounding the mortality event or events.

Resolution 6

The SRG recommends that the Environmental Management Strategy by revised to include a management trigger requiring a review of SED management rules should there be a sea lion mortality when the use of SEDs becomes mandatory.

With respect to the need for an index of abundance, the SRG advises that regular pups counts timed to coincide with each breeding event is the best approach. The SRG acknowledges that this method still has issues with respect to the potential injury of researchers and disturbance to the colonies. However, these risks are much less and therefore far more acceptable then approaches required to collect data for modelling purposes. There is already a time series of data, and as this time series is extended the SRG expects that the value of pup count data as an indicator of abundance will improve.

Resolution 7

The SRG recommends that pup count data be collected for every breeding event to act as an indicator of abundance.

In addition to pup counts, the SRG would like to see the results of a Potential Biomass Removal (PBR) analysis conducted on available information. The SRG expects that a number of significant assumptions will have to be made for this to occur and therefore does not want to overstate the value of such an analysis. However, the SRG believes it is appropriate to conduct the exercise. In this light conducting a PBR analysis is a suggestion rather than a recommendation.

Other Research Initiatives

Clearly the SRG has recommended an approach that focuses on eliminating mortality caused by the rock lobster fishery and chooses a measure of abundance, pup count data, that is reliable and minimises the risk of disturbance. However, the SRG believes that there is scope for further advancement of our understanding of sea lions.

In particular the SRG identified the following as relevant options for further consideration:

1. A non-archival satellite telemetry tagging program of animals 6 – 18 months old designed to gather data on the foraging range and behaviour of juvenile sea lions at a time they are vulnerable to fishery interaction. This would improve the knowledge base with regard to this species while assisting in the longer-term refinement of measures to eliminate mortality, and inform spatial and temporal limits of where SEDs should be used.

2. A SCAT analysis, or studies of sea lion faeces, to better understand the diets of sea lions. Benefits could include knowledge on what attracts sea lions to rock lobster pots and whether food supply is a factor limiting the recovery of sea lion populations. The SRG noted that these generalist feeders were unlikely to be food-limited as a result of rock lobster fishing.

3. Further genetic studies using existing tissue samples to better understand the population sub-structure on the west coast.

4. Investigate the potential to provide hides for pups on known colonies to reduce mortality from large adults.

Other threats to sea lion populations

In addition to mortality from the commercial rock lobster fishery the SRG identified additional unquantified threats to sea lion populations in Western Australia. In particular:

- Recreational rock lobster fishing
- Net fishing – both commercial and recreational
- Tourism – private and tourist operators

Summary

On behalf of the SRG members I would like to thank both the Department of Fisheries and WAFIC for coordinating this process. All SRG members agree that the process was well designed and provided the opportunity for meaningful and constructive engagement on the issue at hand.

As provided in the terms of reference the SRG looks forward to monitoring progress on this issue and having further constructive input.

It is with pleasure that I present this inaugural report of the Western Rock Lobster / Sea Lion Interaction Scientific Reference Group to both the Department of Fisheries and WAFIC for your consideration in the broader context of the Environmental Management Strategy.

Should you require further advice or clarification please do not hesitate to contact me.

Yours sincerely

Ron Edwards
Chairman
Western Rock Lobster / Sea Lion Interaction Scientific Reference Group

12 August 2003