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A Report of the Effects of Fishing Advisory Group (EFAG) Meeting (2 – 3 November 2010) and The Western Rock Lobster Ecological Effects of Fishing Research Plan Revised and Updated by the Effects of Fishing Advisory Group (2 – 3 November 2010)

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Section 1.

A Report of the Effects of Fishing Advisory Group (EFAG) Meeting 2-3 November 2010

Attendees:

Effects of Fishing Advisor Group (EFAG) members

- Professor Gary Kendrick, Director, Oceans Institute, University of Western Australia (UWA)
- Dr Pippa Moore, proxy for Associate Professor Glen Hydnes, Senior Lecturer, Edith Cowan University (ECU)
- Professor Colin Buxton, Director, Tasmanian Aquaculture and Fisheries Institute Marine Laboratories, Hobart, Tasmania
- Dr Russ Babcock, Marine Ecologist, CSIRO, Cleveland, Queensland
- Dr Rick Fletcher, Director, Research Division, Department of Fisheries (DoF)

Apologies

- Professor Neil Loneragan, Chair in Fisheries Science, Biological Sciences, Murdoch University

Observers

- Mr Nic Solfoulis, Executive Officer, Western Rock Lobster Council (WRLC)
- Dr Lynda Bellchambers, Senior Research Scientist, Biodiversity and Biosecurity, DoF
- Dr Matthew Pember, Research Scientist, Biodiversity and Biosecurity, DoF
- Mr Rhys Brown, Principal Management Officer, DoF
- Dr Simon de Lestang, Senior Research Scientist, Rocklobster, DoF
- Dr Nick Caputi, Supervising Scientist, Invertebrates, DoF
- Mr Jason How, Research Scientist, Rocklobster, DoF
- Mr Peter Stephenson, Senior Research Scientist, Rocklobster, DoF
- Dr Arani Chandrapavan, Research Scientist, Invertebrates, DoF

Meeting Objectives

- Provide an overview of rock lobster research in shallow and deep water.
- Review DoF's *Western Rock Lobster Ecology –The State of Knowledge* document.
- Review habitat mapping (now referred to as Understanding the habitat of the Western rock lobster).
- Review rock lobster catchability using pots and how it may affect interpretation of abundance, size frequencies, etc from the closed area.
- Review work on trophodynamics.
- Review DoF's current effects of fishing project (FRDC 2008/13).
- Review and update the Effects of Fishing Research Plan.
- Examine EFAG's terms of reference.

Deep-water research overview – Dr Matthew Pember
The overview outlined the steps that were taken to negotiate and select the deep-water research area that will be closed. The process included the following:

- establishment of a industry and scientific closed area reference group,
- securing funding sources for closed area research (FRDC 2008/13 and WAMSI 4.3),
- selection of potential closed areas based on the criteria established by the former Eco SRG in 2007,
- short-listing of potential areas and field validation of their suitability, and
- final selection and agreement on a closed area on 30° south line.

The Eco SRG's 2007 criteria that were used to select the closed area were that it must be:

- representative of Western rock lobster (WRL) demographics,
- central to and generally representative of the fishery,
- accessible,
- representative of deepwater lobster habitat based on information obtained from previous habitat mapping work,
- an optimum location for enforcing compliance of the closure, and
- an appropriate size to assess the impacts of lobster biomass removal.

(See full details of the Eco SRG's 2007 Effects of Fishing Research Plan at: http://www.fish.wa.gov.au/docs/op/op039/index.php?0706)

Other information presented included; maps of the closed and open areas (Attachment 1), results – catch rates, length frequencies, sex ratios, distribution, etc, from the Independent Breeding Stock Surveys (IBSS – the open area control site) and the area to be closed (Attachment 1) and results from the habitat mapping and ground-truthing (Attachment 2)

The potential risks of having only one closed area, as representative of the deep-water fishing grounds, was discussed by the EFAG. It concluded that, although one closed area was not ideal, based on the resources available for the project and the fact that the area chosen appeared to be reasonably representative of deep water habitat along the central west coast, it was adequate for a "pilot" study. If results from the closed area showed that the large scale removal of legal size lobsters was having an ecological impact, then the number and location of research sites may need to be expanded.

EFAG also commented on the need to clearly state the hypotheses that were being tested in the closed/open area experiments.
For example:

- Was it expected that an increase would occur in some or all of the size classes of lobsters within the closed area for both sexes?
- How is movement within the closed area, especially on the boundaries, going to be assessed?
- Would the results from the closed area research be able to distinguish between the impact of the closure compared to management measures that had significantly reduced fishing effort by over 50% (and hence exploitation) across the entire fishery?

Shallow-water research overview – Dr Pippa Moore

For the component of the research that focused on the relationship between lobster density and community structure, the results indicated high spatial and temporal variability among benthic assemblages that potentially masked density driven effects due to differences in lobster abundance. There was some indication that lobsters can influence the abundance of trochids, suggesting potential for some flow-on effects on epiflora abundance/biomass, although there was no evidence of this from the study.

The study showed high benthic diversity and small-scale spatial variations possibly due to larval supply and physical parameters that may have a stronger structuring influence than top-down pressures due to lobster predation. This meant it was very difficult to pick up any patterns in the abundance for a number of lobster prey items such as crustaceans. Stable isotope analysis revealed no difference in lobster diet between areas with high and low lobster densities, in either macroalgal or seagrass habitats, or between large and small lobsters. High densities of lobsters suggested the potential for 'halo' effects at small spatial scales, ~30m away from their reef shelters, however, they are unlikely to have any significant impact on the benthic assemblages at distances greater than 30m.

Based on these results, the main conclusion drawn was that removal of legal size lobster (>77 mm carapace) by the WRL fishery is unlikely to have a significant impact on benthic algal and faunal assemblages of shallow limestone reefs and seagrass meadows.

Discussion points, issues and research gaps identified by this research;

- Historic comparison. Prior to heavy commercial fishing on inshore populations (pre 1960s), there would have been higher numbers of large lobsters that may have had a greater role in structuring benthic assemblages. The current study areas, with the possible exception of Kingston Reef, are unlikely to have had the pre-commercial fishing size structure.
- There was significant background noise in the data due to large spatial and temporal variability in benthic assemblages that were probably due to natural fluctuations in recruitment and physical habitat, rather than lobster predation pressure.
- Over 30 years of shallow water research data available throughout the range of WRL shows similar patterns. It would appear that there are only relatively small-scale differences in lobster behavior and diet across latitudinal gradients and that the impact on their ecology is not great.
- The large-scale removal of lobster by the WRL fishery has not been found to have a measurable effect on benthic assemblages in shallow water seagrass meadows and limestone reefs of the study areas. However, this may need to be tested at lower/warmer latitudes (higher metabolic rates), higher densities and in other habitats (e.g. coral). There appears to be value in undertaking some larger-scale latitudinal (whole range) study in shallow waters.
- The impact of RL density on the ecology in shallow water appears to be minimal as all the research results point to them being ecosystem trackers rather than either ecosystem engineers or a keystone ecological species.

Western Rock Lobster Ecology – State of Knowledge document
EFAG provided positive feedback on the *Western Rock Lobster Ecology – State of Knowledge* document that DoF had prepared that summarised the ecological research associated with WRL. EFAG felt it would be useful in providing an understanding of the ecological effects of WRL fishing. The document is also referred to as the *P2 document*, as it relates to Principle 2 of the Marine Stewardship Council's certification criteria.[1] EFAG suggested that it would be useful to have a table at the end of each chapter to summarise the research projects from which the information was sourced.
A draft of the *Western Rock Lobster Ecology – State of Knowledge* document can be found at: http://www.fish.wa.gov.au/docs/op/op089/index.php?0706

Knowledge of habitat (formerly titled habitat mapping) – issues and gap analysis
EFAG suggested that the title of this section be changed to reflect the fact that it was broader than just mapping habitat.

The regions identified as needing greater attention were Big Bank and the majority of the deeper water (>20 – 30 m) lobster fishing grounds. A dedicated research project to survey the habitat of Big Bank was suggested.

EFAG suggested that it would be useful to have an overview map of the WA coastline showing the main regions of the inshore and offshore lobster fishing grounds that have had their habitats mapped in some form. The overview map would visually highlight the deficiencies in the habitat mapping. Although more deep-water sites may require habitat-maps, more extensive mapping may become available when the Commonwealth eventually implements proposed large spatial closures off the WA coastline.

For the habitat-mapping chapter in the *Western Rock Lobster Ecology – State of Knowledge* document, the following table column structure was suggested: year, study source, region (depth range and area covered), scale (broad, fine, medium), classification system, methodology, and confidence levels. EFAG also identified some additional habitat mapping related projects that did not appear in the document and suggested they be included:

- *Classifying shallow water benthic habitats in the Swan Marine Region* by Wildsmith et al. 2008. Murdoch University, and
- *Establishing benchmarks of seagrass communities and water quality in Geographe Bay, Western Australia* by Van Neil et al. 2007. University of Western Australia.

EFAG discussed what it felt was the ambiguity of the MSC condition relating to habitat mapping and concluded that it was up to DoF to present to the MSC the classification system used by most jurisdictions in Australia and the scale of the habitat mapping that could be produced from the available data. It was suggested that DoF provide layered habitat maps showing bathymetry and baseline geomorphology of the fishing grounds overlayed with available detailed habitat information and to use predictive modelling to fill gaps in the regions where habitat information was missing.

[1] Information on the MSC Principles and criteria can be found at www.msc.org

Existing fine-scale habitat information could be used to increase the confidence level of the predictive modelling that would be based on the geomorphology.

EFAG then discussed the various agencies, departments and companies that may hold existing data on the marine geomorphology and benthic habitats of WA. These included:

- Environmental Resources Information Network (ERIN)
- Western Australian Land and Information System (WALIS)
- Department of Sustainability, Environment, Water, Population and Communities
- CERF Marine Biodiversity Hub (national classification system) –Nic Bax
- Department of Mines and Petroleum (DMP)
- Department of Environment and Conservation (DEC)
- Light Detection And Ranging (LIDAR) dataset for WA
- Naval maps
- Geoscience Australia (Brenden Brook)
- BlueNet
- IVEC
- GIR (hydro-acoustic data)

EFAG suggested DoF consider expanding the habitat mapping into a stand alone project, under the direction of an appointed GIS specialist who would coordinate the collation of existing datasets relating to benthic biophysical characteristics, and through collaborations with the other agencies listed above produce a broad-scale benthic habitat map for all Western Australian waters. The output from this project would provide benthic habitat information for not only the rock lobster fishery, but for the greater scientific community and the public. To initiate this it was suggested a habitat mapping working group be established and funding be applied for.

EFAG discussed the issue of relating habitat type to lobster abundance and it reviewed the results of the DoF's effects of fishing project (FRDC 2004/49) and the Bellchambers et al (2010) publication and recommended that the current DoF project (FRDC 2008/13 – *Assessing the ecological impact of the Western Rock lobster fishery in fished and unfished areas*) be completed before any further research in this area was considered.

Issues and gap analysis of lobster catchability and movement

EFAG raised the need for additional information on the catchability of different sized lobsters by commercial and research pots and how this would differ by seasons, lunar cycle and reproductive cycle, as lobster potting will be one of the methods used to measure lobster abundance and size structure in the research areas. Questions raised were:

- Do large lobsters deter small lobsters from entering pots?
- How catchable are large lobsters, i.e. those greater than 120mm CL?
- Do longer soak times (e.g. two or more days) increase the catch rate of larger lobsters?

One study mentioned as potentially useful was a current PhD study – Natalie Toon (Murdoch University), *Catchability of Western Rock lobster (Panulirus cygnus); the influence of temperature, light intensity, habitat and commercial fishing apparatus*.

DoF plans to mount cameras on pots to obtain video footage of lobster behaviour around them (Pember and de Lestang FRDC project application – pending funding). There are also plans to compare lobster abundance from potting verses diving at Rottnest Island (ongoing research from Bellchambers et al. 2009) and to continue with the small mesh potting project, which samples the size distribution and abundance of 1+, 2+ and 3+ lobsters across the range of the fishery (including deepwater). The small mesh pots will also be used in the open and closed research areas.

EFAG also discussed the issue of movement and migration of lobsters that could impact on the abundance of lobsters in the closed and open research areas and how migration effects recruitment to the deep water breeding stock areas, such as the reefs on the edge of the continental shelf and Big Bank. Questions were also asked as to whether there was much movement in relation to reproductive and moult cycles. EFAG recommended that a tagging study be undertaken in the closed and open areas to determine lobsters site fidelity.

Issues and gap analysis of trophic dynamics

The results from the shallow-water study at Jurien Bay indicated that the shallow-water ecosystem functional groups were highly influenced by changes in the biomass of benthic communities, particularly algae such as *Ecklonia*. This suggested that bottom-up processes are the main drivers of shallow-water lobster ecosystems / habitats, as most of the shallow water habitat on the central west coast is similar to that found in Jurien Bay. The Abrolhos Islands, where there are coral reefs, as well as limestone reefs, could be somewhat of an exception.

The importance of lobster bait as a food supply in deep-water was discussed as evidence from pervious research showed it may play a role (Waddington et al. 2008). Qualitative modelling outcomes indicated that general fish e.g. wrasse and small crustaceans would be the most suitable indicators of overall change to the deep-water ecosystem that might be caused by changes in lobster abundance / size structure.

There is a lack of information relating to the predators of lobsters in the deep-water ecosystem, therefore it was unclear what role they would play in the overall ecology if lobster abundance / size structure increased significantly.

The deep-water conceptual modelling results were considered to be representative of the central coast even though it was based on one location (Jurien) as the reef systems (submerged ancient eroded limestone coastlines) running north/south and parallel to the coast, have similar geomorphology and hence algal and faunal assemblages. However, it is possible that these indicators may not be appropriate for some of the coral dominated lobster habitats found in some areas of the Abrolhos Islands.

Additional comments were made regarding sampling methodology and trophic modelling:

- The sensitivity of the system to predator-prey interactions needs to be tested using the model.
- Need to incorporate as much quantitative data as possible in the model and to generate tables as part of the model outputs. Key loop-analysis diagrams should in the model documentation.
- Need to include greater information regarding the boundary conditions of the model and to clearly document any assumptions that are made, such as those relating to lobster movement.
- The trophodynamic model that has been produced for shallow water (Loneragan et al. 2010) should be used to investigate what effect very low puerulus recruitments may have on the ecology, as the shallow water areas will be impacted the most, because the majority of settlement occurs there.
- It appears, from acoustic and other physical habitat survey data and the results of ecological and habitat research conducted on the central west coast in both shallow (0-20 m) and deep water (30-50 m) that the habitats of the two areas is much more similar than previously thought. They have a similar geomorphology (protruding limestone reefs and bedrock overlain with sand of varying thickness) that supports similar algal and faunal assemblages (Radford et al 2008)

Review of current FRDC effects of fishing deepwater project – Dr Matt Pember

Presentation and discussion

- The presentation began with a time series data (2008-2010) to highlight the temporal variation in lobster abundance/size structure within the proposed closed area. Changes in size/structure and abundance were indicative of annual recruitment trends and management measures. Comparisons of lobster stocks between the proposed closed and the open IBBS site both showed a skewed sex ratio where there were greater numbers of females than males. (Attachment 1).
- Comparisons of lobster sizes caught using normal commercial verses small mesh pots were also presented (Attachment 1).
- Intended methods for the lobster tag-recapture study to investigate movement of lobsters in and out of the closed area.
- Qualitative / conceptual modelling has been completed, which indicated general fish (e.g. wrasse) and small crustaceans (e.g. amphipods) as key indicators to monitor prior to and after the closure is implemented.
- BRUVs (Baited Remote Underwater Videos) will be used to monitor general fish species and abundance, while information on small crustaceans will be collected using scavenger traps.
- Since the interaction between lobsters and octopus inside pots is the only well documented interaction, the extent of their natural interaction in the absence of pot fishing will be investigated by analysing octopus gut/contents and lipid/fatty-acids.
- EFAG recommended the use of Remotely Operated Vehicles (ROVs) and / or Automated Underwater Vehicles (AUVs) to monitor benthic assemblages as they were the most effective and economic method and superior to drop cameras, which only capture limited footage at lower resolution.

Pot selectivity

Given that the catchability of different size lobsters by pots is not fully understood, smaller lobsters (1+, 2+ and 3+) will be sampled using pots covered with small mesh. A power analysis[2] will need to be undertaken to determine the number of meshed pots that will need to be used in the closed and open area sampling. Sampling using standard pots (i.e. normal commercial type batten pots, not covered with mesh, but with escape gaps closed) will continue to be conducted, as some sampling methods need to remain comparable to those used at the open IBBS site and by the commercial fishery. It was also suggested that longer soak times be tested to see if they would attract larger lobsters into pots (>120 mm carapace lobsters generally don't seem to be well sampled by pots). An additional advantage of using small mesh pots is the greater retention of by-catch species, which can be used to supplement the benthic assemblage data.

Information on habitat and the nocturnal activity of lobsters and their prey and predators around pots will be obtained by mounting video cameras on pots used for sampling. It is planned to expand this project to other areas of the fishery, e.g. Big Bank, and during the whites migration.

A review of the methods for monitoring lobster prompted an in-depth discussion on the working hypotheses of the project and the confidence level of each of the proposed monitoring techniques. The key discussions and questions that were asked were:

- What are the changes in the indicator species (e.g. fish and crustaceans) likely to be, e.g. dramatic or subtle?
- How much do we know about the behaviour of the indicator populations in relation to their interaction with lobsters and lobster potting and separate to them?
- Without an understanding of the trophic interactions in the deep-water ecosystem, how can the appropriateness of the monitoring methods be assessed? It was suggested that the trophodynamic model developed for shallow water could be used to give an indication of the interactions, as the ecosystems in shallow and deep water appeared to be similar (see shallow water overview and trophic dynamic section – last dot point, above).
- Without strong evidence that rock lobsters are driving either top-down or bottom-up ecological processes, is there any justification for monitoring lobster abundance, as it would not be critical to ecosystem processes?
- Given that the shallow-water research showed lack of a significant impact on the benthic assemblages from the large scale removal of legal size lobster, there needs to be the highest possible degree of confidence in the "sensitivity" of the indicators species that have been selected to represent the changes that may occur in the deep water ecosystem, as the abundance of lobsters increases due to the closure.
- EFAG felt there was no need to expand the monitoring of potential predators of lobsters, other than octopus, as it did not appear that any fish, shark, or ray predators were significantly dependent on lobsters. They are very mobile with

[2] Power analysis can be used to calculate the minimum sample size required to accept the outcome of a statistical test with a particular level of confidence.

generally large home ranges (much larger than the closed area), so they can quite easily switch prey.
- Further modelling needs to be done on the ecological impact of bait used in lobster pots.
- The issue of continued commercial and recreational fishing activities for demersal finfish in the closed area was raised as a possible factor that could confound data on lobster predators. With regard to recreational fishing, the closed area is 20nm offshore and is unlikely to attract a significant amount of activity. Commercial scale fish licensees may fish the area.

In addition to answering the effects of fishing related questions, the closed area will provide data on the lobster carrying capacity of deep-water reef habitats, movement of lobsters unaffected by fishing activity and could be used to assess / understand changes that are likely occur to lobster stock structure in other unfished deep-water regions of the fishery (e.g. Big Bank), or in areas where fishing effort is likely to decline significantly due to quota management (e.g. deep water reefs on the edge of the continental shelf).

The fundamental question the closure area will be used to answer is:

In the absence of lobster fishing (removal of legal size lobster biomass, 77 mm) what are the impacts on lobster stock structure, diet, behaviour and the ecosystem in broad terms?

The following changes that may occur in the closed area were discussed:
- increased abundance and change in size structure of lobsters due to the cessation of fishing activity,
- increased abundance and change in size structure of lobsters due to changes in the management of the fishery (i.e. the move to quota),
- impact of the removal of bait as a food source for lobsters and other macro-invertebrates, and
- possible reduced predation of lobsters by octopus due to lobsters not being confined in commercial pots. Lobsters in the closed area will only have access to pots during short sampling periods.

Given lobsters are not considered to be drivers or key-stone species in this ecosystem, the EFAG considered that the likelihood of significant changes occurring in the trophic levels immediately above or below them, due to an increase in their abundance and size structure, was likely to be low. Therefore before monitoring the suggested components of the ecosystem (indicator species), it is necessary to identify the trophic level(s) that is most likely to be impacted by an increase in lobster abundance / size structure in the closed area. This should be at the macro-level, therefore monitoring and quantifying primary producers (algae and seagrass) and easily identified larger invertebrates and possibly molluscs would be appropriate.

Discussion of appropriate investigative methods included:
- AUVs for monitoring macro-level indicators,
- the large natural temporal and spatial variations that can occur in the abundance of amphipods/isopods that could mask the effects of the closure (increase in lobster abundance / size structure),
- BRUV's as a useful tool to identify changes in the abundance of finfish species generally and potential lobster predators,

- a combination of fatty-acid and stable isotope analyses could be useful for identifying long-term change in lobster diet and nutritional condition, however, lobster foraging ranges that extend beyond the closed area (which could include consumption of bait) could make this data difficult to interpret.
- the cost of sampling equipment, available resources and the effectiveness of the methods in answering the objectives of the study.

EFAG suggested that the Client (Western Rock Lobster Council) and DoF communicate to the MSC auditors that a null result, i.e. the removal of legal size lobsters (>77 mm carapace) by the rock fishery does not significantly impact on the deep water ecology of the central west coast, is the most likely outcome of the project. It also recommended that DoF provide them with a single condense research framework in table from that would incorporate data already available on the shallow and deep-water habitats, ongoing projects and future research directions. The table to be included in the *Western Rock Lobster Ecology – State of Knowledge* document.

Review of Effects of Fishing Research Plan
In light of the research outcomes since the first research plan was developed (2007), the need to review / update the Effects of Fishing Research Plan was discussed. The reviewed / updated plan is presented in the section below titled "*Western Rock Lobster Ecological Effects of Fishing Research Plan – Revised and Updated by the Effects of Fishing Advisory Group, 2 – 3 November 2010*".

EFAG also developed new conceptual model for the effects of fishing research (see Attachment 3). A table listing the current and planned research projects on the effects of rock lobster fishing on the ecology that will underpin EFAG's conceptual model and research plan is provided in the section on the revised / updated Effects of Fishing Research Plan.

EFAG terms of reference
EFAG discussed the terms of reference and suggested some minor changes that have been included (see Attachment 4).

References

Bellchambers, L., Evans S., Meeuwig, J., 2010. Abundance and size of Western rock lobster (*Panulirus cygnus*) as a function of benthic habitat: implications for ecosystem-based fisheries management. *Marine and Freshwater Research*, 2010, **61**, 279–287.

Bellchambers, L., Bridgwood, S., How, J., Lewis, P., de Lestang, S., Mackie, M and Coutts, T., 2009. Development of a long-term program to monitor coastal communities within the Swan region. Fisheries Research Report No. 183. Department of Fisheries, Western Australia. 144p.

Loneragan, N.R., Babcock, R.C., Lozano-Montes, H., Dambacher, J. M. 2010. Evaluating how food webs and the fisheries they support are affected by fishing closures in Jurien Bay, temperate Western Australia. FRDC Final Report 06/038.

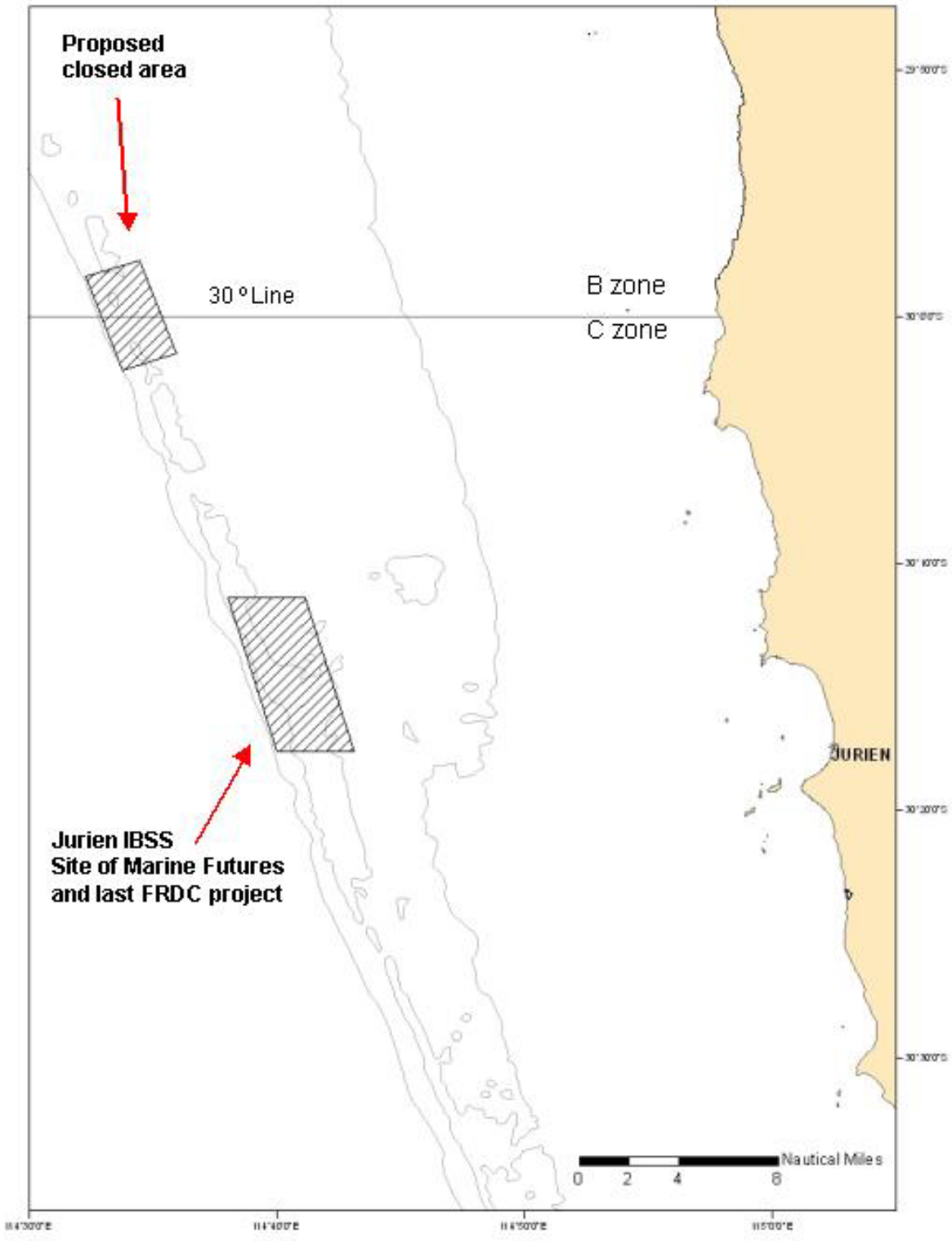
Radford, B., Van Neil, K. P., Holmes, K., 2008. WA Marine Futures: Benthic modeling and mapping final report. UWA.

Waddington, K. I., Bellchambers, L. M., Vanderklift, M. A. and Walker, D. I. 2008. Diet and trophic position of Western rock lobsters (*Panulirus cygnus* George.) in Western Australian deep-coastal ecosystems (35-60 m) indicates they are more carnivorous than their counterparts in shallow water ecosystems. *Estuarine, Coastal and Shelf Science*. 79: 114–179.

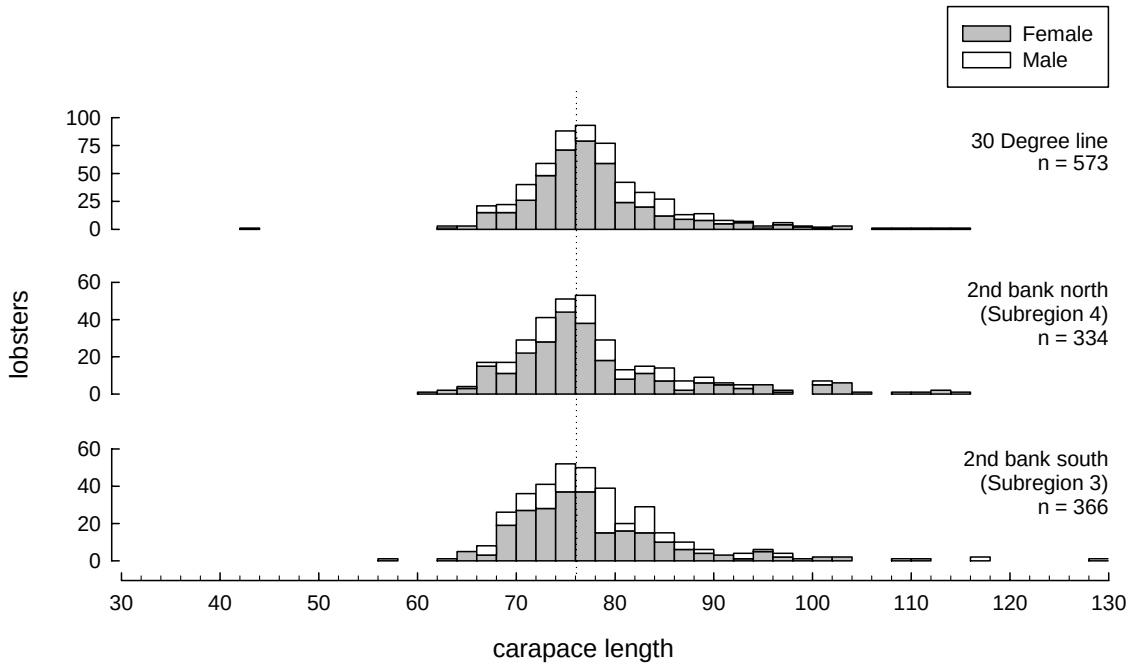
Western Rock Lobster Ecology – State of Knowledge. Marine Stewardship Council – Principle 2: Maintenance of Ecosystem (2010).
http://www.fish.wa.gov.au/docs/op/op089/index.php?0706

Attachment 1.

Map of study area

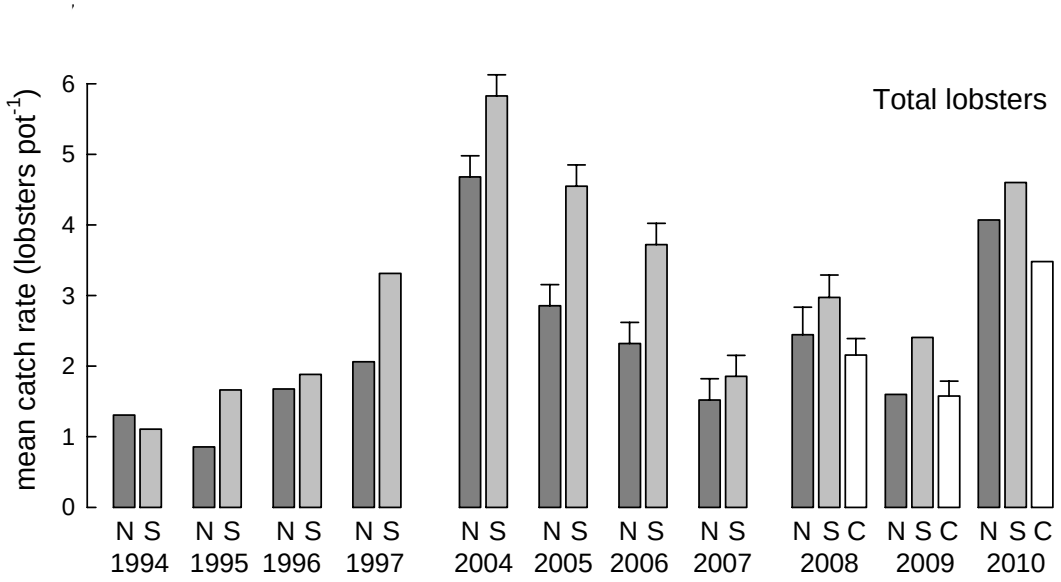


ORIGINAL 2008 COMPARISON OF SIZE STRUCTURE



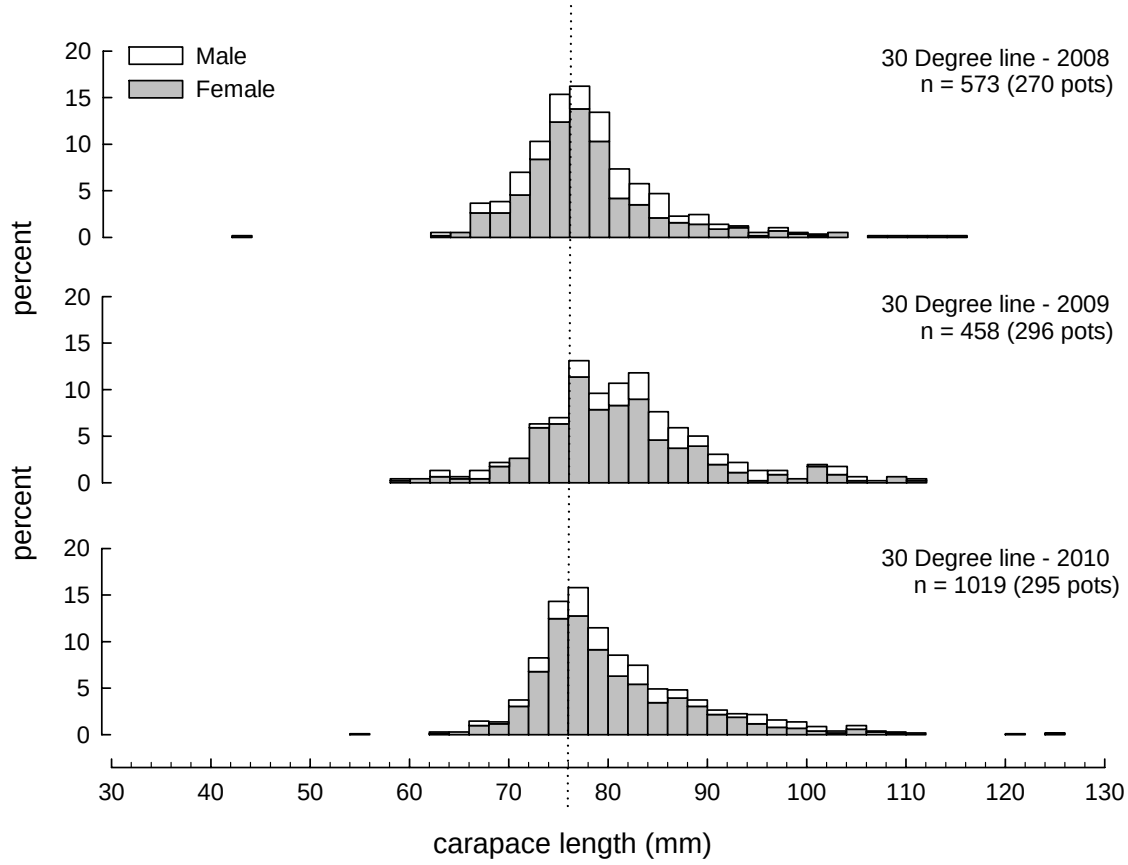
Size distribution of male and female Western rock lobsters caught using commercial lobster pots (escape gaps closed) during the independent breeding stock survey (October 2008) in and adjacent to the potential closed area (30 degree line) and the Jurien control areas (2nd bank north & 2nd bank south).

CATCH RATE COMPARISON – ALL YEARS



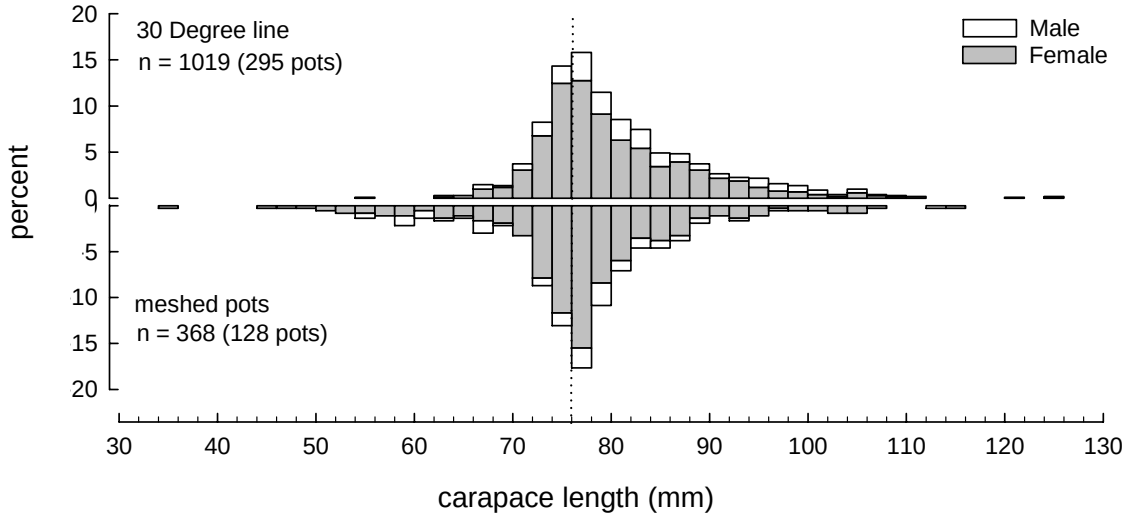
Catch rates (total lobsters pot^{-1}) of Western rock lobsters caught using commercial lobster pots (escape gaps closed) during the independent breeding stock surveys (October) 2008-2010 in and adjacent to the potential closed area © and the northern and southern Jurien control areas (N & S). Catch rates at the Jurien control sites are also given for the periods 1994-1997 and 2004-2007.

COMPARISON OF SIZE STRUCTURE – CLOSED AREA ONLY 2008-2010

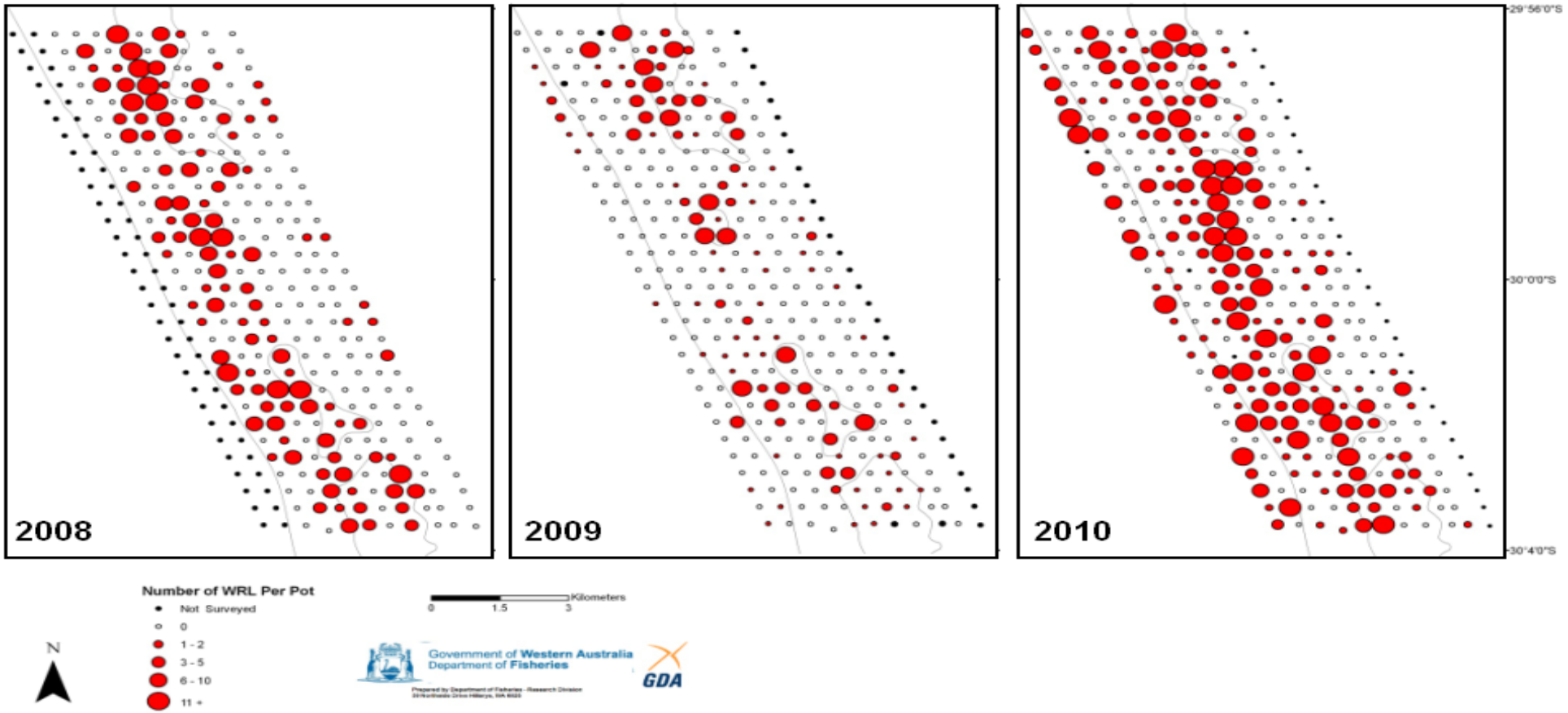


Size distribution of male and female Western rock lobsters caught in and adjacent to the 30 degree line closed area, using commercial lobster pots (escape gaps closed) during the independent breeding stock survey (October) 2008-2010.

COMPARISON OF SIZE STRUCTURE – MESHED POTS– CLOSED AREA ONLY 2010

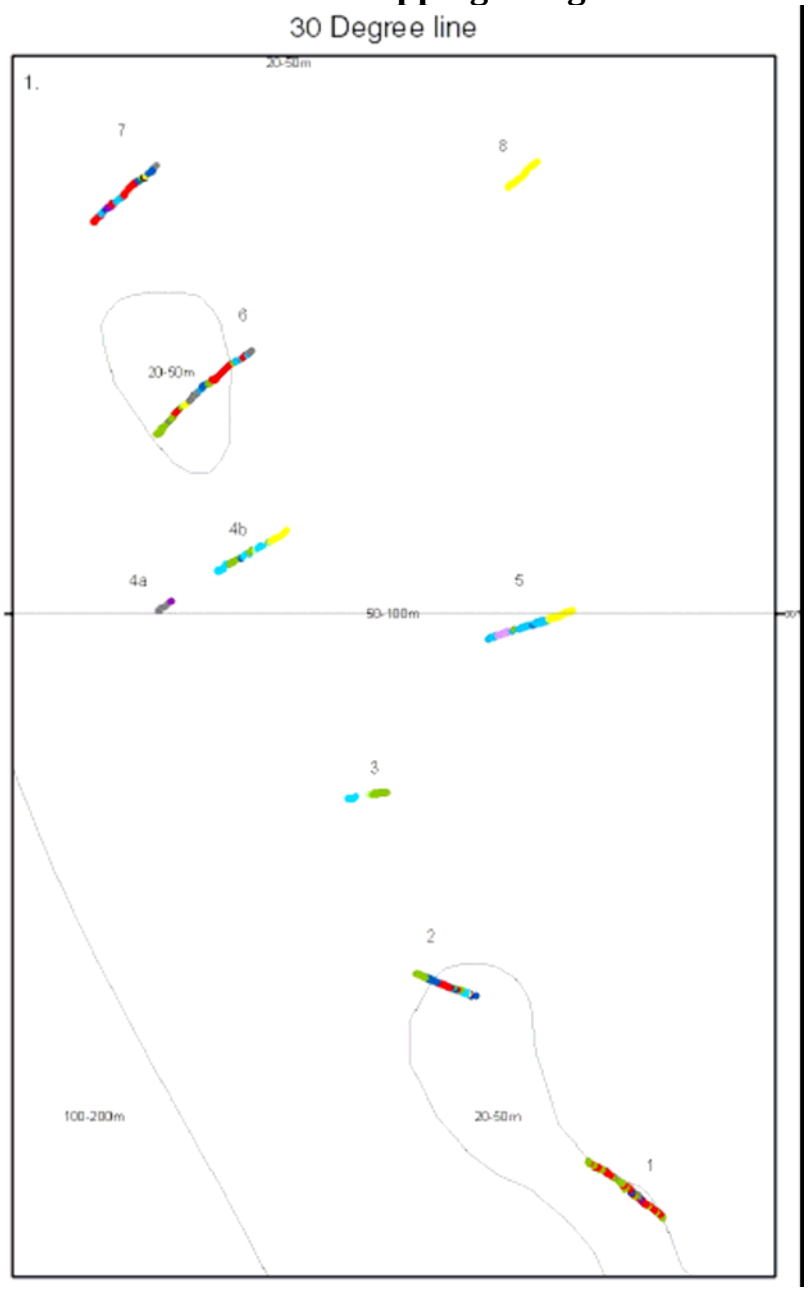


Size distribution of male and female Western rock lobsters caught in and adjacent to the 30 degree line closed area, using commercial lobster pots (escape gaps closed) and meshed pots during the independent breeding stock survey (October 2010).

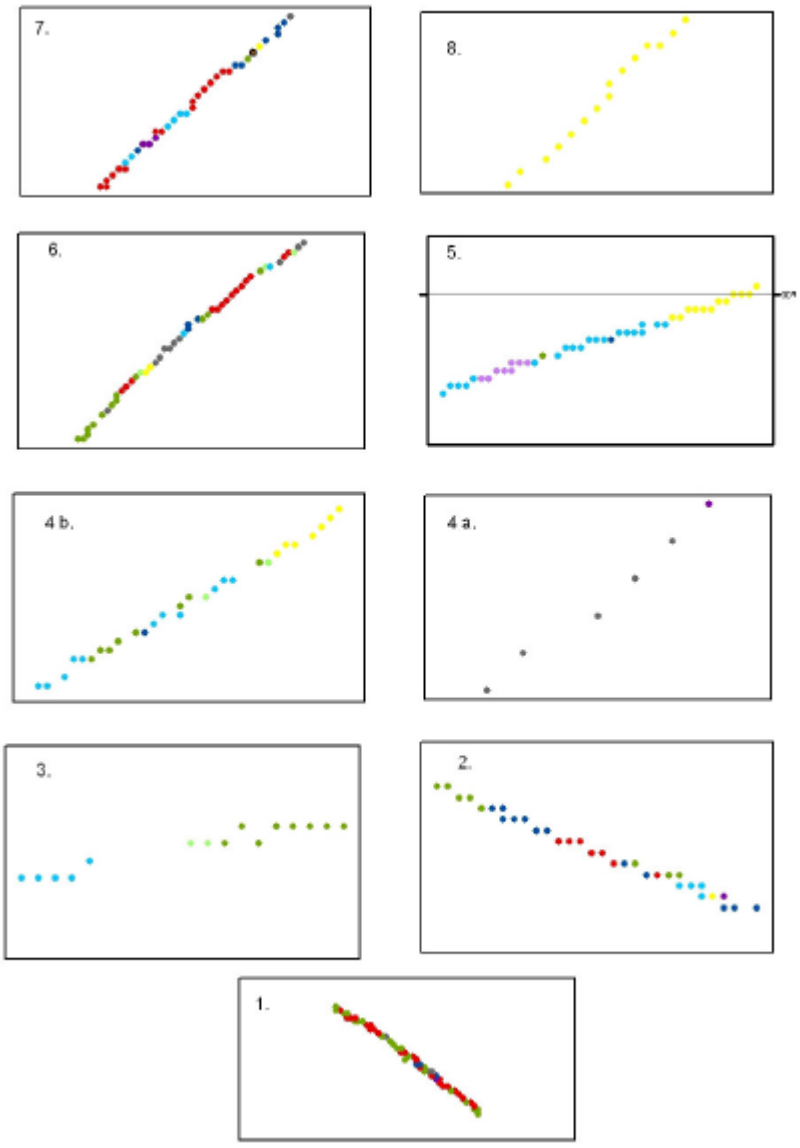


Catch rates (total lobsters pot^{-1}) of Western rock lobsters caught using commercial lobster pots (escape gaps closed) during the independent breeding stock surveys (October) 2008-2010 in and adjacent to the potential closed area

Attachment 2 Habitat mapping and ground-truthing



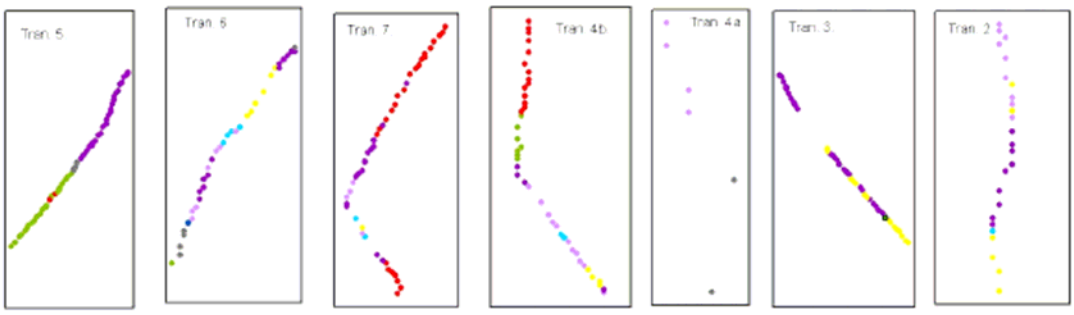
30 Degree line



Habitat composition (% contribution)

		30 degree line								Jurien IBSS	
	Transect no.	1	2	3	4a	4b	5	6	7	8	SR3	SR4
	Sand		3			24	29	4	3	100		
	Rubble / limestone	6			83			20			12	
	Mixed assemblage - (Ecklonia / Sponge)	46	21					30	47			12
	Mixed assemblage (Ecklonia / No Sponge) High	40	24	53		28		28			54	
	Mixed assemblage (Ecklonia / No Sponge) Medium			13		7	2	7	6			
	Mixed assemblage (No Ecklonia / Sponge) High	2	3		17				9			
	Mixed assemblage (No Ecklonia / Sponge) Medium						19					
	Mixed assemblage (No Ecklonia / No Sponge) High	6	36			3	2	7	18			
	Mixed assemblage (No Ecklonia / No Sponge) Medium		12	33		38	48	4	18			43

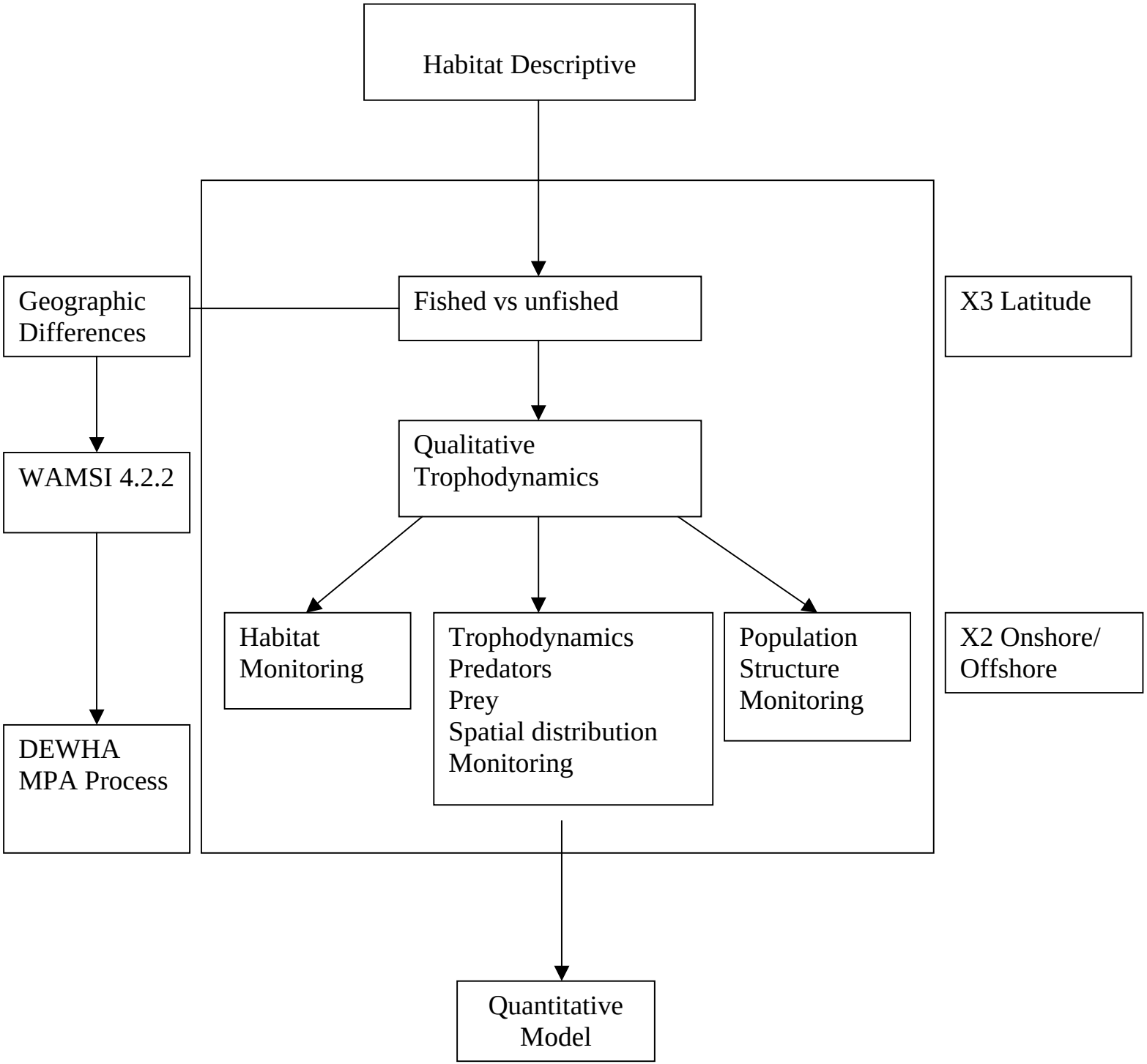
SE corner of Abrolhos



Habitat composition (% contribution)

	Abrolhos						
Transect no.	2	3	4a	4b	5	6	7
Sand	24	37		10		17	2
Rubble / limestone			33		6	14	
Mixed assemblage - (Ecklonia / Sponge)				33	4		54
Mixed assemblage (Ecklonia / No Sponge) High		2		17	43	3	
Mixed assemblage (Ecklonia / No Sponge) Medium							
Mixed assemblage (No Ecklonia / Sponge) High	36	61		10	47	33	30
Mixed assemblage (No Ecklonia / Sponge) Medium	36		67	26		19	9
Mixed assemblage (No Ecklonia / No Sponge) High						3	
Mixed assemblage (No Ecklonia / No Sponge) Medium	4			5		11	4

Attachment 3 – Conceptual Model for Effects of Fishing Research Plan



Attachment 4

Terms of reference and composition of Western Rock Lobster Effects of Fishing Advisory Group (EFAG)
(Established September 2010.)

Terms of Reference

The Effects of Fishing Advisory Group (EFAG) will meet as required, to provide advice on:

- the ecological effects of lobster fishing;
- how to improve the measurement and assessment of the risk to the environment from the removal lobster biomass; and
- the experimental designs / techniques that are necessary to gather data for analysis to address these questions.
- statistical techniques to address these questions

The EFAG will perform the following functions regarding the effects of fishing as required:

- an assessment of known and recently identified risks and review established projects against milestones and objectives;
- provide the Department of Fisheries and the Western Rock Lobster Council (WRLC) with advice on projects and issues associated with the removal of lobster biomass;
- provide advice to the Department of Fisheries and WRLC on risk ratings for any new risks or an already identified risk; and
- be a source of advice when changed circumstances may influence risk ratings

Composition

- Professor Neil Loneragan, Chair in Fisheries Science, Biological Sciences, Murdoch University
- Professor Gary Kendrick, Director, Oceans Institute, University of Western Australia
- Associate Professor Glen Hydnes, Senior Lecturer, Edith Cowan University
- Professor Colin Buxton, Director, TAFI Marine Laboratories, Hobart, Tasmania
- Dr Russ Babcock, Marine Ecologist, CSIRO, Cleveland, Queensland
- Dr Rick Fletcher, Director, Research Division, Department of Fisheries

Operational requirements

- The EFAG reports directly to the Department of Fisheries
- EFAG reports and minutes are to be made available to the Department of Fisheries and the WRLC as required.
- EFAG members are to formally sign off (signature or email confirmation) on every report before it is formally provided to the Department of Fisheries and the Chairman is to ensure any dissenting views are explicitly recorded in the report.
- EFAG (and if necessary other experts) will convene every two years for a comprehensive review of ecosystem-based projects relevant to Western Australia.
- In all other matters the EFAG is to operate in a manner that is consistent with *Fisheries Management Guide No. 3*.

Process for amending terms of reference or composition

Responsibility for amending the EFAG terms of reference or composition rests with Department of Fisheries.

Department of Fisheries should seek input from rock lobster stakeholders and the WRLC prior to amending the terms of reference or composition.

Section 2

Western Rock Lobster
Ecological Effects of Fishing Research Plan

Revised and Updated by the Effects of Fishing Advisory Group

2 – 3 November 2010

CONTENTS

Background

The commercial West Coast Rock Lobster Fishery (WCRLF) targets the Western rock lobster (WRL), *Panulirus Cygnus* with catches ranging from 5,500 to 14,000 tonnes a year. Currently approximately 300 boats operate in the Fishery in waters ranging from 5 m to 200 m depth adjacent to the Western Australian coast and stretching from Cape Leeuwin in the south to Shark Bay in the north. Up until the commencement of the 2010/11 season, the fishery was managed by the Department of Fisheries (DoF) in Western Australia, using an input control system, but it has now become a quota managed fishery, with most input controls still retained. Both management systems are designed to constrain exploitation/fishing effort and deliver sustainable catches. The annual value of the catch is estimated at between AUD $200 - $300 million.

In March 2000 the WCRLF became the first Fishery in the world to be certified by the Marine Stewardship Council (MSC) as a well managed and sustainable fishery. The status of the rock lobster stocks, the fishery's impact on the ecosystem and its management systems were independently assessed by a team of experts contracted to, Scientific Certifications Systems Inc (SCS) of Oakland California, which undertook the certification on behalf of the MSC. The fishery successfully underwent its second five-year assessment by SCS in November 2006 (i.e. it was recertified until November 2011) and in early December 2010 it commenced its third five year recertification.

The process to obtain MSC certification involved a number of key components, two of which were the development and implementation of an Ecological Risk Assessment (ERA)[3] and an Environmental Management Strategy (EMS)[4]. The development of these two documents involved a number of processes including public, stakeholder and expert consideration and comment.

The ERA reports were based on a risk assessment workshop of stakeholders that produced a register of the main potential ecological hazards that arise from the various activities carried out by the fishery. A subsequent workshop of scientific experts provided a risk ranking on all the hazards identified. The EMS was developed, using the ERA documents and comments from the peer reviewers, as a reference point from which continuous improvement of the fisheries management arrangements and a better understanding of related environmental / ecological processes could proceed. The EMS has in place objectives, actions, targets and management actions to deal with the hazards identified as risks.

The Ecological Effects of Fishing Research Plan (the plan) was developed to address knowledge gaps identified by the ERA processes and the former Ecological Effects of Fishing Scientific Reference Group and has now been reviewed / updated by the recently formed Effects of Fishing Advisory Group (EFAG). See Appendix A for the sections of the February 2005 and April 2007 ERAs that are relevant to the ecological effects of fishing.

[3] ERAs were conducted in Feb 2001 http://www.fish.wa.gov.au/docs/op/op063/index.php?0706, Feb 2005 http://www.fish.wa.gov.au/docs/op/op017/index.php and April 2007 http://www.fish.wa.gov.au/docs/op/op056/index.php?0706

[4] The first EMS covered the period July 2002 to July 2006 can be found at http://www.fish.wa.gov.au/docs/op/op017/index.php and is currently (November 2010) undergoing revision and updating.

Establishment of expert groups to provide advice on the Ecological Effects of Fishing

The Rock Lobster Industry Advisory Committee (RLIAC) established the Ecological Effects of Fishing Scientific Reference Group (Eco SRG or SRG) in August 2003. The Eco SRG has been responsible for providing RLIAC with independent ecological advice to ensure the Western rock lobster resource is managed in a manner that is consistent with the national principles of Ecologically Sustainable Development (ESD) and ecosystem based management.

In April 2010 the Minister for Fisheries dissolved RLIAC along with all its subcommittees and reference groups, including the Eco SRG. In September 2010 the Department of Fisheries established a new independent expert group, the Effects of Fishing Advisory Group (EFAG, see Appendix B for terms of reference and composition[5]) to provide it with advice on the ecological effects of fishing and in particular the possible impacts of the large scale removal of legal size lobsters on deep water benthic ecology.

Review and update of the Effects of Fishing Research Plan

EFAG reviewed and updated the Effects of Fishing Research Plan at its inaugural meeting on 2 and 3 November 2010 (see Section 1 above for a report of the meeting), in light of the new information that had become available since the development of the original plan in 2007. The new information included:

- final results and journal publications from DoF's completed deepwater project on the effects of fishing that tried to compare the ecological impacts of different lobster densities (FRDC 2004/049, see non technical summary at Appendix C and for the full report *The effect of Western rock lobster fishing on the deepwater ecosystems of the west coast of Western Australia*[6],
- final report of WA Marine Futures: Benthic modeling and mapping final report[7].
- finalisation of the area to be closed to fishing and the control areas that will be open to fishing,
- some preliminary results from the proposed closed area from DoF's new deepwater project (FRDC 2008/013, see Section 1, Attachment 2, above),
- Production of a document (*Western Rock Lobster Ecology – State of Knowledge*, see references for the web link) that has brought together all the marine habitat mapping and ecological research information that could be used to further the understanding of the effects of large scale removal (via fishing) of legal size lobster on the ecology of the WRL.
- completion of the shallow water trophodynamic model[8],
- Development of cost effective methods of monitoring deep water ecosystems (see reference *Western Rock Lobster Ecology – State of Knowledge*).

[5] The EFAG operates in a manner that is consistent with *Fisheries Management Guide No. 3*, which can be found at http://www.fish.wa.gov.au/docs/mp/mg003/index.php?0706

[6] The full FRDC report can be found at http://www.fish.wa.gov.au/docs/frr/frr199/index.php?0401

[7] *WA Marine Futures: Benthic modeling and mapping final report* at ftp://ftp.uwa.edu.au/mirrors/weboffice/marine_futures/0_Overview%20Information/MF_Spatial%20Report%20final.pdf

[8] Loneragan, N.R., Babcock, R.C., Lozano-Montes, H., Dambacher, J. M. 2010. Evaluating how food webs and the fisheries they support are affected by fishing closures in Jurien Bay, temperate Western Australia. FRDC Final Report 06/038.

The updated effects of fishing research plan

A detailed history of the development of the Eco SRG's 2007 Effects of Fishing Research Plan can be found at Appendix D and the complete plan (published November 2008) at http://www.fish.wa.gov.au/docs/op/op039/index.php?0706 .

The goal of the Eco SRG's plan was to provide an overview of the research that would be required to test the null hypothesis that:

> *Removal of Western rock lobsters on a scale experienced in Western Australia does not have a significant or irreversible effect on the ecosystem.*

Based on its strategic research framework the former Eco SRG recommended that an operational plan of research be developed and implemented to establish the necessary understanding of the critical natural history elements that would be necessary to address the null hypothesis. Initially this was done by trying to compare gradients in lobster abundance to see if different densities of lobsters had different ecological impacts[9], however, this approach was not successful so the former Eco SRG recommended comparing fished and unfished areas[10].

The key elements of the former Eco SRG's original 2007 operational plan included four points with associated focus questions and action plans to answer them (see below). The information updates that have been provided for each of the four points and answers to the focus questions (particularly regarding the use of fished and unfished area comparisons) and the comments the EFAG made (at the 2-3 November 2010 meeting) regarding the each point / focus questions, are provide in the boxes below them.

The updated plan should be read in conjunction with Section 1 above, the *Report of the EFAG meeting, 2-3 November 2010* and DoF's *Western Rock Lobster Ecology – State of Knowledge. Marine Stewardship Council – Principle 2: Maintenance of Ecosystem* (2010) document. http://www.fish.wa.gov.au/docs/op/op089/index.php?0706

Habitat Mapping
(now referred to as **Understanding Habitat Structure**)

Focus questions to be addressed

- What habitats do lobsters utilise?

Completed: This question has been adequately answered by research carried out in deep and shallow water. In summary lobsters utilise the extensive limestone reef systems (for shelter and foraging) and the associated sponge habitat, seagrass meadows and sand plains (for foraging) that occur in both shallow and deepwater areas off the central west coast of WA. See DoF's *Western Rock Lobster Ecology – State of Knowledge*, Chapter 2 – *Habitat Mapping* and Chapter 3 – *Behaviour of Western Rock Lobsters* (Draft November 2010, see references for web link) and *Marine Futures Benthic Modelling and Mapping Report*, June 2008 (see web link to report in the reference section).

- Is there a pattern in the habitat type that is related to lobster density and / or size structure?

[9] see the non technical summary of the project at Appendix C and the full report at http://www.fish.wa.gov.au/docs/frr/frr199/index.php?0401

[10] see current FRDC deepwater effects of fishing project 2008/013, referred to in *Western Rock Lobster Ecology – State of Knowledge*.

Completed. Answer - Yes. See Bellchambers et al (2010) – *Abundance and size of Western rock lobster (Panulirus cygnus) as a function of benthic habitat: implications for ecosystem-based fisheries management* and Appendices E, F, G, H, I and J. Research was undertaken in deep water (>20 m) at Dongara, Jurien Bay and Lancelin, in Western Australia between 2005 and 2007. Abundance of Western rock lobster was significantly but moderately related to benthic habitat (adjR2 =0.28), with high abundances associated with high cover of mixed assemblage and *Ecklonia* sp. Size was effectively predicted by habitat (adjR2 =0.65) with larger lobsters found in mixed assemblages with sponge and smaller lobsters in mixed assemblage with *Ecklonia* sp.

Action Plan

1. Produce a broad scale habitat map by collating information from existing data bases e.g. fishers' GPS, seismic surveys, etc.

Completed. See DoF's *Western Rock Lobster Ecology – State of Knowledge* Chapter 2 – *Habitat Mapping* (Draft November 2010) and *Marine Futures Benthic Modelling and Mapping Final Report*, June 2008 (see references for links). Work is currently being planned to fill the knowledge / map gaps by collating all available habitat and geomorphology data and using a habitat model to make maps with overlays of information (see report of EFAG meeting at Section 1 above)

2. Review existing benthic habitat and seabed data for the shelf waters between Mandurah and Kalbarri.

Completed. See DoF's *Western Rock Lobster Ecology – The State of Knowledge* Chapter 2 – *Habitat Mapping* (Draft November 2010) and *Marine Futures Benthic Modelling and Mapping Final Report*, June 2008(see references for web link). Work is currently being planned to fill the knowledge / map gaps by collating all available habitat and geomorphology data and using a habitat model to make maps with overlays of information (see report of EFAG meeting at Section 1 above)

3. Conduct broad large-scale rapid assessment protocols in waters between Mandurah and Kalbarri to determine areas of interest.

Completed. This was done as part of the protocol that was recommended by the former Eco SRG for the selection of the area to be closed to fishing. See DoF's *Western Rock Lobster Ecology – The State of Knowledge* Chapter 2 – *Habitat Mapping* (Draft November 2010), *Marine Futures Benthic Modelling and Mapping Final Report*, June 2008 (see references for web link) and the reports on the negotiations to establish the closed areas provided for the Western Australia Rock Lobster Fishery 2009 MSC Special/Surveillance Audit Report.

4. Choose a minimum of three representative transects with replicates at each location.

Due to limited resources, one site was chosen, which is considered representative of the central west coast, where large areas of limestone reefs, extensive *Eklonia* dominated assemblages, seagrass meadows and sand predominate. It is recognised that the site would not be representative of coral habitats that are found at the Abrolhos Is., however, the Abrolhos also has large areas of limestone reefs, extensive *Eklonia* dominated assemblages and seagrass meadows very similar to central west coast generally.

Because the deep and shallow water habitats have been shown to be much more similar than previously thought and the shallow water research indicates that large scale lobster removal does not effect the ecology (Section 1 – Report of EFAG meeting and *Western Rock Lobster Ecology – The State of Knowledge,* 2010), as rock lobsters are neither

ecological drivers nor key stone species, EFAG (and the former Eco SRG) recommended that the effects of fishing work in deepwater should be undertaken in detail at one site and the results analysed, to determine if there was a need to replicate the research at other sites. EFAG felt that it is likely that the current DoF Deepwater Effects of Fishing research project will show that the large scale removal of lobsters from deepwater does not have a significant impact on the ecology and if this was the case no further work on this aspect would need to be undertaken. See Section 1 Report of EFAG meeting.

5. Conduct detailed habitat mapping of chosen sites that include:
   - acoustic survey of hard structure and associated ground truthing of epifauna and infauna 'habitat' using video techniques; and
   - limited grab sampling to later determine infaunal composition and sediment type.

Completed. This has been done for the selected fished and unfished sites. See FRDC project 2004/049 report at http://www.fish.wa.gov.au/docs/frr/frr199/index.php?0401 for details and Appendix J.

Addressing these questions would provide information on the distribution and density of lobsters of different sizes relative to benthic habitats[11] and prey resources.

Completed. These questions have been addressed and have provided important information on the distribution and density of lobsters of different sizes relative to benthic habitats and prey resources. See map of the experimental sites (Appendix E and catch rates and size structures at Appendix F and H, habitat types at Appendix J and the referenc *Abundance and size of Western rock lobster (Panulirus cygnus) as a function of benthic habitat: implications for ecosystem-based fisheries management (*Bellchambers et al 2010*)* and the results of FRDC project 2004/049 on the effects of fishing in deep water at http://www.fish.wa.gov.au/docs/frr/frr199/index.php?0401

Size structure and density of lobsters

Focus questions to be addressed

- What is the current size structure and density of lobsters in the chosen site?

Completed. Potting trials over the past two years have determined the size structure of the rock lobster populations in the closed area and from the Independent Breeding Stock Survey (IBSS) open area. See Appendix E for a map of the closed and open areas, Appendices F and H for size and sex distributions and Appendices G and I for catch rates of lobsters in the area to be closed and the open control area. Lobster sampling in both areas will continue using standard pots (with closed escape gaps) and pots with small mesh to obtain an information on the abundance of small lobsters (1+, 2+ and 3+ that are not well selected by the standard pots. Longer pot soak times will also be tested to see if they sample larger lobsters more effectively.

- Is potting an appropriate measure of abundance and size structure of the population (selectivity of pots)?
- What is/are the relationship(s) between pot catch rates and size composition?

Research will be undertaken to compare pot and dive sampled lobster abundances and size structures. Pots with small mesh will be used to sample small juveniles (1+ 2+, 3+ etc) and longer pot soak times will be tested to see if they sample larger lobsters (> 120 mm

[11] The former Eco SRG defined the term "habitat" in this context to include the physical (e.g., rocks and sand waves) and biological (e.g. sponge gardens, emergent bivalves) features on the seafloor that provide structural complexity (on > 1m spatial scale) and are likely to act as surrogate variables enabling broad-scale rapid assessment of benthic communities.

carapace) more effectively.

- What is/are the impact(s) of habitat on catchability?

Habitat type affects lobster abundance and size structure as reported by Bellchambers et al (2010) in *Abundance and size of Western rock lobster (Panulirus cygnus) as a function of benthic habitat: implications for ecosystem-based fisheries management* and therefore it has implications for sampling methods. See response directly above.

- What is the degree of movement (foraging/home range) of lobsters and is it size dependent?

Information on lobster movement is provided in Chapter 2 of DoF's *Western Rock Lobster Ecology – State of Knowledge* document. The great majority of local movements are less than 200 to 300 m from the home reef. The annual westward migration of pale shelled (white) immature lobsters from shallow juvenile nursery reefs inshore to the deep water breeding grounds that occurs between December and mid February can also include a northward migration of several hundred km. Larger mature lobster, which comprise the majority of the population and breeding stock in the deepwater experimental areas have already undergone their migration and only a small proportion are likely to undertake a second 'whites' migrate that would take them out of the area.
A variety of tagging methods will be used to obtain an understanding of the movement of lobsters into and out of the experimental areas (See Section 1 Report of the EFAG meeting for further details).

Action plan

1. Use a range of methods to estimate selectivity and catchability (depletion experiments using different fishing gear (e.g. pots with larger necks or tangle nets) and multiple tagging.

This research is continuing.

2. Use video to observe localised lobster behaviour with habitat types and interaction with baited pots.

A considerable amount of work on this issue has been completed and it is ongoing (see above).

3. Using existing catch records and environmental data assess the influence of climate variation on catchability at sites.

This information is being sourced from DoF's stock assessment and modelling projects, which incorporate environmental factors to estimate catchability.

4. Use existing length based fishery models to investigate possible size compositions for unfished stocks.

This information would be used to relate lobster density (and size structure) to fisheries data to facilitate the scaling up of information from specific study sites to the fishery. It would also be combined with information collected in "1" above to determine relationships between habitat and lobster size and density.

This aspect of the project is being progressed in cooperation with DoF's stock assessment and modelling team.

Trophic Dynamics

Focus questions to be addressed

- What is the size dependent diet of lobsters in the chosen sites?

Completed for the pre-closure period. This has been reported in Waddington et al (2008) *Western rock lobsters (Panulirus cygnus) in Western Australian deep coastal ecosystems (35–60 m) are more carnivorous than those in shallow coastal ecosystems* and the results of FRDC project 2004/049 on the effects of fishing in deep water at http://www.fish.wa.gov.au/docs/frr/frr199/index.php?0401 See also *Western Rock Lobster Ecology – State of Knowledge* document.
This research will continue in both closed and open areas after the implementation of the closure in 2011.

- What are the trophic dynamics of lobsters in these regions?
- Are there relationships between lobster size-structure compositions and prey density and composition?

Research on these aspects is continuing as part of DoF's current FRDC project (2008/13) on the effects of fishing. See *Western Rock Lobster Ecology – State of Knowledge* and Section 1 the Report of EFAG meeting 2-3 November 2010. A trophic dynamic model that has been developed for shallow water ecosystems (Loneragan, et al 2010) will be used to gain an initial understanding of the trophic interactions in deepwater ecosystems, as the two ecosystems are similar in many respects.

Action plan

1. Conduct carbon and nitrogen isotope analysis of lobsters to provide information on diets, trophic relationship and whether the basis of lobster diets is plant, animal, detritus or a combination.

Completed for the pre-closure period.
Ongoing as part of DoF's current FRDC project (2008/13) on the effects of fishing. See *Western Rock Lobster Ecology – State of Knowledge* and Section 1 the Report of EFAG meeting.

2. Conduct gut analysis studies to examine diets and compare with long-term trophic source both on a seasonal and inter-annual basis.

Completed for the pre-closure period.
Ongoing as part of DoF's current FRDC project (2008/13) on the effects of fishing. See *Western Rock Lobster Ecology – State of Knowledge* and Section 1 the Report of EFAG meeting.

3. Conduct aquarium tests to investigate relationship(s) between lobster size and prey size.

This information would be used to assess whether large lobsters exploit a different range of food resources than smaller individuals.

Information to date from research in shallow and deepwater does not indicate that large lobsters exploit a significantly different range of food resources than smaller individuals. Field research in this area will be ongoing as part of DoF's current FRDC project (2008/13) on the effects of fishing. See *Western Rock Lobster Ecology – State of Knowledge* and Section 1 the Report of EFAG meeting.
Aquarium studies do not need to be conducted.

Lobster behaviour

Focus question to be addressed

- What size and sex specific behaviours are relevant to the issue of sustainability of the resource?

Action plan

1. Observe behaviour of small lobster in areas where there is an absence of large lobster, then seed some of those areas with large lobsters and observe any changes in behaviour / abundance of small lobsters.

This aspect has not been investigated using translocation of lobsters, because when they are moved they often do not stay at the site they have been moved to.

2. Use video techniques to observe lobster behaviour.

Baited Remote Underwater Videos and videos mounted on pots will be used to obtain information on the interaction of lobsters generally and between large and small lobsters.

This information would be used to assess interactions between different sized lobsters and determine the relevant space and time scales for manipulative studies.

The Former Eco SRG's strategic research plan - 2007

At its August 2007 meeting the former Eco SRG reviewed the results available from DoF first Deepwater Effects of Fishing project (FRDC 2004/049) and noted that the project had been successful in obtaining baseline information on rock lobster ecology in deepwater (see Non Technical Summary Appendix C). However, it was clear that the abundance gradients identified during the course of the project were confounded by habitat differences and consequently could not be used to evaluate the effects of fishing, as originally proposed. The former Eco SRG concluded that future research on the ecological effects of rock lobster fishing, would require a comparison of areas open and closed to fishing.

Development of a research plan for the new DoF effects of fishing project

The former Eco SRG discussed and development a research plan for the new Department of Fisheries FRDC funded project (*FRDC 2008/013*), to investigate the ecological effects of fishing using fished and unfished area comparisons (see the report at http://www.fish.wa.gov.au/docs/op/op053/index.php?0706) The former SRG made the following recommendations for the project:

- as per the first DoF project (FRDC 2004/049), the new research project should be carried out in deepwater (>30m), as this was the area likely to show the most significant ecological impacts due to removal of legal size lobsters by the fishery (large lobsters constitute the majority of the population in these depths), and
- experimental sites needed to be replicated.

The Eco SRG also:

- developed site selection criteria;
- recommend the development of methodologies using macro algae and macro invertebrates indicators to detect indirect habitat-level changes in communities;
- recommend the continued investigation of lobster trophic pathways to detect direct changes in communities via the prey items in lobster diets;
- recommend the development of a framework for a conceptual model to help identify the ecosystem parameters that would need to be monitored;
- developed project objectives; and
- listed the potential benefits of the project.

The development and implementation of DoF's new deep water project on the effects of fishing (FRDC 2008/13) has been based on the above points. **Completed. All relevant points have been completed for the pre closure period.**

Site Selection Criteria
The former Eco SRG also developed a set of site selection criteria that would need to be satisfied in the selection of potential research areas open and closed to fishing. The site would need to:

1. be representative in terms of lobster demographics, *i.e.* have the potential for high adult biomass (relative to undersize biomass), as indicated by good or high catch rates of mature lobster;
2. be central to and generally representative of the fishery (*e.g.* region between Lancelin and Dongara);
3. have optimal accessibility – needs to be as close to shore/a 'port' as practical while satisfying other criteria;
4. be representative of lobster habitat based on information obtained from previous habitat mapping (structure and function);
5. have replicates of closed areas in different locations;
6. be in an optimum location for enforcing compliance of the closure;
7. meet the following size of site-criteria:
    a. complementary to the size of the lobster's foraging area;
    b. large enough to allow measurements of indicator responses (both up/down the lobster food web, e.g. predators of lobster and key prey for lobster;
    c. must encompass representative habitats; and
8. minimise the relative level of economic loss to industry.

The use of these criteria facilitated site selection and help answer inshore/offshore/depth questions.

Completed. The selection of the site that will be closed was based on the above criteria.

Methodologies
The former Eco SRG suggested that macro algae and macro invertebrates should be monitored and compared at fished and unfished sites, as it should be feasible to detect indirect habitat-level changes in these communities. If no change in these indicators were observed, given adequate sampling of appropriate variables over sufficient space and time, then it would be unlikely that there were significant ecosystem effects. However, it was also recognised that it would be necessary to continue investigation of lobster trophic pathways, as it may not be possible to detect, or understand any large scale changes without more detailed data on the composition of the rock lobster's prey communities.

This is the strategy that is being pursued in FRDC project 2008/13. See the sampling methodology in *Western Rock Lobster Ecology – State of Knowledge* and see also Section 1 the Report of EFAG meeting.

Conceptual model development
The former Eco SRG recommended that the development of a conceptual model to help identify the ecosystem parameters that need to be monitored, should be one of the first objectives of the new project. The sampling methods will depend on the ecosystem parameters that are selected for monitoring. Prior knowledge of the nature of the data to be collected will also help inform the level of sampling required to detect responses in the taxa targeted for monitoring. The former Eco SRG recommended that Dr Jeff Dambacher

of CSIRO, or another suitably qualified qualitative modeller, be approached to help develop the conceptual model.

A conceptual / qualitative model was developed at an expert workshop held on 4 June 2009. See the list of workshop participants at Appendix K and a paper, currently in press, on *The identification of indicators of the effects of fishing using alternative models, uncertainty and aggregation error*. The proposed methods that have been developed to sample the deepwater ecosystem is provided in *Development of cost effective methods to measure deep water ecosystems in both fished and unfished reference areas,* as part of *FRDC 2008/013 – Assessing the ecological impact of the Western rock lobster fishery in fished and unfished areas* (see also *Western Rock Lobster Ecology – State of Knowledge*).

At its 2-3 November 2010 meeting, EFAG developed a conceptual model (Appendix L) for DoF's new FRDC project (2008/013) – *Assessing the ecological impact of the Western rock lobster fishery in fished and unfished areas.*

Project objectives

1. Develop a conceptual/qualitative model for the main components affecting lobsters and their ecosystem in deep waters.

Completed. EFAG's updated conceptual model is provided at Appendix L along with a table listing the current and planned research projects on the effects of rock lobster fishing on the ecology that will underpin it and this research plan. The table has been copied form the *Western Rock Lobster Ecology – State of Knowledge document,* which can be found at: http://www.fish.wa.gov.au/docs/op/op089/index.php?0706

2. Identification and assessment of areas to be closed to fishing and those acting as controls. Assessment will include examination of habitat and lobster catch rates.

Completed. See Appendices E to J and *Western Rock Lobster Ecology – State of Knowledge*.

3. Measurement of the distribution and abundance of lobsters, major habitat forming taxa and taxa identified by conceptual modelling as high priorities for monitoring.

Completed for pre closure period. See Appendices E to J and *Western Rock Lobster Ecology – State of Knowledge*.

4. An increased understanding of the dynamic role of lobsters in key ecosystem processes. This should include more work on interactions of habitat and biogeochemical processes. Techniques such as acoustic tagging and isotope analysis should be included.

Completed for pre closure period. See *Western Rock Lobster Ecology – State of Knowledge*.

5. Development of a long-term monitoring plan for the research areas, with secure funding.

Completed. See *Western Rock Lobster Ecology – State of Knowledge*.

The former Eco SRG noted that there would need to be a coordinated effort to bring the information from the new DoF project together and integrate it with other projects through the use of ecological modelling, e.g. Ecopath. Some integration of the existing data and information will be achieved through Western Australian Marine Science Institution (WAMSI) Project 4.3 on trophic interactions and ecosystem modelling.

Completed for pre closure period and ongoing. The WAMSI Node 4 has been used as an 'umbrella' for the ecological research projects on the central west coast of WA, including those associated with rock lobster. See WAMSI 4.3 projects at http://www.wamsi.org.au/research/nodes/node4

Current Status of the Effects of Fishing Research Project

DoF effects of fishing research project *FRDC 2008/013 Assessing the ecological impact of the Western Rock lobster fishery in fished and unfished area*, was developed as a draft based on the research framework set down by the former Eco SRG in 2007 (http://www.fish.wa.gov.au/docs/op/op053/index.php?0706) and was revised in light of comments received from the WA Fisheries Research Advisory Body. A successful application for FRDC funding was subsequently made and the project officially commence on 1 January 2009.

EFAG noted that DoF's FRDC Project (2008/13) had undertaken, was undertaking, or was proposing to undertake, all the work agreed in this updated Effects of Fishing Research Plan and discussed in Section 1 Report of the EFAG meeting. It is anticipated that the closed area will be implemented in March/April 2011.

Effect of Fishing Advisory Group's General Comments

1. Habitat mapping should be provided in an overlay form, from the very basic bathymetry through to full habit maps of specific areas. This will help to show were the knowledge gaps are. Modelling should be used to fill in blank areas as the geomorphology of the central west coast is the same, i.e. it consists of a series of ancient submerged limestone coastlines, running in a north south direction parallel to the coast. These limestone reefs are separated by sand plains of varying thickness over bed rock. Macro-algal, sponge and seagrass assemblages are similar along the entire central coast and to those found in shallow water.
2. Since the first Effects of Fishing project in 2004 there has been significant advances in underwater video technology, e.g. BRUVs and AUVs that allows cost effective monitoring of macro ecological parameters. It is planned to use this technology to monitor the closed areas for changes in macro indicator species, due to the expected increase in lobster population density and size structure in the closed area.
3. The trophodynamic model developed for shallow water should be used as a 'first cut' to model the deepwater ecology, as recent information has shown that the deep and shallow water ecosystems are more similar than previously thought.
4. Based on over thirty years of research work in shallow water where rock lobsters were not found to be either ecological drivers or keystone species, it is likely that a similar situation will exist in deepwater.

References

Bellchambers, L., Evans S., Meeuwig, J., 2010. Abundance and size of Western rock lobster (*Panulirus cygnus*) as a function of benthic habitat: implications for ecosystem-based fisheries management. *Marine and Freshwater Research*, 2010, **61**, 279–287.

Bellchambers, L., Bridgwood, S., How, J., Lewis, P., de Lestang, S., Mackie, M and Coutts, T., 2009. Development of a long-term program to monitor coastal communities within the Swan region. Fisheries Research Report No. 183. Department of Fisheries, Western Australia. 144p. http://www.fish.wa.gov.au/docs/frr/frr183/index.php?0401

Loneragan, N.R., Babcock, R.C., Lozano-Montes, H., Dambacher, J. M. 2010. Evaluating how food webs and the fisheries they support are affected by fishing closures in Jurien Bay, temperate Western Australia. FRDC Final Report 06/038.

Radford, B., Van Neil, K. P., Holmes, K., 2008. WA Marine Futures: Benthic modeling and mapping final report. UWA. ftp://ftp.uwa.edu.au/mirrors/weboffice/marine_futures/0_Overview%20Information/MF_Spatial%20Report%20final.pdf

Waddington, K. I., Bellchambers, L. M., Vanderklift, M. A. and Walker, D. I. 2008. Diet and trophic position of Western rock lobsters (*Panulirus cygnus* George.) in Western Australian deep-coastal ecosystems (35-60 m) indicates they are more carnivorous than their counterparts in shallow water ecosystems. *Estuarine, Coastal and Shelf Science*. 79: 114–179.

Western Rock Lobster Ecology – State of Knowledge. Marine Stewardship Council – Principle 2: Maintenance of Ecosystem (2010). http://www.fish.wa.gov.au/docs/op/op089/index.php?0706

Appendices

Appendix A – Ecological Risk Assessments

February 2005 Ecological Risk Assessment

Hazard identification and risk ranking

6.4.1c Central West – Deep (page 64)

This region experiences the largest potential change in size structure and relative abundance of large lobsters (the abundance of lobsters in this region is replenished each year during the annual whites migration). Furthermore, because we don't yet know the trophic relationships in this region, it is possible (L4) that the removals may be making some identifiable changes to species relative abundance (C2) in this region. There is, however, no suggestion that different species now exist in this location compared to previous years, an outcome that would suggest severe impacts may have occurred. Thus, this was considered by most of the group to be a moderate risk (Figure 6.30d). The deepwater work currently underway may assist in either confirming or adjusting this risk by the next review when further information on this section of the fishery will be available.

For full details of the risk assessment of the effect of fishing on the general ecology see Western Rock Lobster Fishery Ecological Risk Assessment 2005 Report July 2005, Section 6.4 General environment, page 51 to 64, by Professor Mark Burgman, School of Botany, University of Melbourne, Australia, 3010, at:
http://www.fish.wa.gov.au/docs/op/op025/index.php?0706

April 2007 Ecological Risk Assessment

Hazard identification and risk ranking

Hazard # 22 and 23, Central west coast and Kalbarri–Big Bank, deepwater

The risk to deep-water communities is the potential for changes in the relative abundance of species in these regions. The fishery is currently managing this risk with a Fisheries Research and Development Corporation (FRDC) research project to investigate deep water ecology, and a Marine Futures (Natural Heritage Trust) project to undertake habitat mapping and biodiversity sampling at the Abrolhos Islands, Jurien, Rottnest and Capes areas. The Western Rock Lobster Effects of Fishing on the Ecosystem Scientific Reference Group (Eco SRG) has made investigations into deepwater ecology a research priority due to a lack of data.

The following commitments have been made to address the data gaps in deep water ecology, with research to begin informing management decisions beginning about 2008 as expressed in the MSC Action Plan timetable to address this issue:

- A workshop was undertaken following the 2007 ERA Workshop with international experts and the Eco SRG. The agenda included a review of deepwater research, and developed ongoing project proposals using fished and unfished areas.
- The Western Australian Marine Science Institution (WAMSI) is developing research projects to inform the scientific understanding of deepwater ecology in the areas of interest.

In view of the research priority to develop information to inform fishery management in this region, no other information is currently available to better inform fishery management. This hazard should be re-assessed when the results of research activities become available.

It is noted that the ERAEF Level 2 methodology does not currently address community-level ecological components (Hobday et al. 2007, and personal communication with the

author). As such, there is no prospect for a Level 2 assessment of these hazards at the present time.

Recommendation 2:	No further risk assessment of hazards to the central west coast or Kalbarri–Big Bank deep-water ecological communities is recommended in the short term. The hazards of fishing activity interactions with deep-water ecological communities has been assessed in an Eco SRG workshop (August 2007, chairman's report in preparation), which recommended ongoing research of fished and unfished areas. If new information becomes available as a result of future research, the risk level should be reviewed and validated by the WA Department of Fisheries and WAFIC in consultation with independent experts.

For full details of the risk assessment of the effect of fishing on the general ecology see Western Rock Lobster Fishery Ecological Risk Assessment April 2007, by Richard Stocklosa of E-Systems Pty Limited, 205 Davey Street, Hobart, Tasmania 7000, at: http://fishnet/ics-wpd/exec/icswppro.dll?AC=GET_RECORD&XC=http://fishnet/ics-wpd/exec/icswppro.dll&BU=http%3A%2F%2Ffishnet%2Flibrary%2FREFsearch_3&TN=referenc&SN=AUTO12124&SE=1045&RN=84&MR=20&TR=0&TX=1000&ES=0&CS=1&XP=&RF=WebDisplayTable&EF=&DF=A_REPORT&RL=1&EL=0&DL=1&NP=1&ID=PUBLIC&MF=CSEngMsg.ini&MQ=QUERY_ALL_WEB&TI=1&DT=&ST=0&IR=17436&NR=0&NB=4&SV=0&BG=&FG=&QS=&OEX=ISO-8859-1&OEH=ISO-8859-1

Appendix B – EFAG Terms of reference

Terms of reference and composition of Western Rock Lobster Effects of Fishing Advisory Group (EFAG)

Terms of Reference

The Effects of Fishing Advisory Group (EFAG) will meet as required, to provide advice on:

- the ecological effects of lobster fishing;
- how to improve the measurement and assessment of the risk to the environment from the removal lobster biomass; and
- the experimental designs / techniques that are necessary to gather data for analysis to address these questions.
- statistical techniques to address these questions

The EFAG will perform the following functions regarding the effects of fishing as required:

- an assessment of known and recently identified risks and review established projects against milestones and objectives;
- provide the Department of Fisheries and the Western Rock Lobster Council (WRLC) with advice on projects and issues associated with the removal of lobster biomass;
- provide advice to the Department of Fisheries and WRLC on risk ratings for any new risks or an already identified risk; and
- be a source of advice when changed circumstances may influence risk ratings

Composition

- Professor Neil Loneragan, Chair in Fisheries Science, Biological Sciences, Murdoch University
- Professor Gary Kendrick, Director, Oceans Institute, University of Western Australia
- Associate Professor Glen Hydnes, Senior Lecturer, Edith Cowan University
- Professor Colin Buxton, Director, TAFI Marine Laboratories, Hobart, Tasmania
- Dr Russ Babcock, Marine Ecologist, CSIRO, Cleveland, Queensland
- Dr Rick Fletcher, Director, Research Division, Department of Fisheries

Operational requirements

- The EFAG reports directly to the Department of Fisheries
- EFAG reports and minutes are to be made available to the Department of Fisheries and the WRLC as required.
- EFAG members are to formally sign off (signature or email confirmation) on every report before it is formally provided to the Department of Fisheries and the Chairman is to ensure any dissenting views are explicitly recorded in the report.
- EFAG (and if necessary other experts) will convene every two years for a comprehensive review of ecosystem-based projects relevant to Western Australia.
- In all other matters the EFAG is to operate in a manner that is consistent with *Fisheries Management Guide No. 3*.

Process for amending terms of reference or composition

Responsibility for amending the EFAG terms of reference or composition rests with Department of Fisheries.

Department of Fisheries should seek input from rock lobster stakeholders and the WRLC prior to amending the terms of reference or composition.

Appendix C - Non Technical Summary – The effect of Western rock lobster fishing on the deepwater ecosystems of the west coast of Western Australia. FRDC Project 2004/049

Department of Fisheries Western Australia
Principal Investigator: Dr Lynda Bellchambers

NON TECHNICAL SUMMARY:

Outcomes achieved to date

This study has resulted in the collection of biological, population and habitat data that improves our understanding of the role of Western rock lobster in the deepwater ecosystem. The relationship between Western rock lobster size and abundance and habitat variables established in this study is important for the effective management of the fishery in an ecosystem based fisheries management (EBFM) framework. For fisheries managers this information has application in two main areas. Firstly, it enables the examination of the spatial distribution of lobster abundance and size by habitat type and in combination with fine resolution fishing effort data may allow the assessment of standing biomass and harvest rate. Secondly, it provides invaluable information for the design and implementation of marine protected areas as a tool for research and species conservation. For researchers this study provides an assessment of different techniques to assess the benthic habitat of deepwater ecosystems that has previously been a costly exercise requiring specialised equipment. For industry this information is the first step in the process of assessing the impact of lobster biomass removal in the deepwater and provides detailed information for the ecological risk assessment (ERA) process required to meet Department of Water Resources, Heritage and Arts (DEWHA) regulations and maintain marine stewardship certification (MSC).

Similarly, depletion estimates for Western rock lobster in shallow and deep water at the Abrolhos can be used to improve the stock assessments by using length-based models that will lead to a more robust assessment of the management of the fishery that will be of benefit to fisheries managers and industry alike. The Results confirm a high level of pot saturation at the Abrolhos, particularly in shallow water. This result suggests that there may be some economic benefit from further pot reductions in shallow waters at the Abrolhos Islands and these are currently being examined for the 2008/09 season.

The Western rock lobster fishery was awarded Marine Stewardship Council (MSC) certification as a well-managed fishery in 2000 and has since been successfully re-certified in 2006. It was the first fishery in the world to receive this certification, which was awarded after an extensive review of the sustainability of the fishery and its impact on the marine environment. This certification largely reflects the significant data available on the shallow (<40 m) water ecology of lobsters and the impact of fishing and biomass removal. However, there remains a knowledge gap with respect to the deep-water ecology of Western rock lobsters. Most Western rock lobster undertake a substantial offshore migration as they approach sexual maturity which coincides with the size at which they reach legal minimum size and are targeted by the commercial and recreational fishery. This study seeks to fill in some of the knowledge gaps to assist with answering the question “what is the effect of lobster biomass removal on the ecosystem?”.

The benthic biota of deepwater ecosystems (35-75 m) was classified using towed video and diver sampling at Dongara, Jurien and Lancelin. While differences in sponge/algal

assemblages and macro invertebrate community composition were detected between study locations, a direct link between sponge/algal assemblage structure and macro invertebrate community composition could not be established. Macro invertebrates are important prey items for Western rock lobsters, therefore differences in macro invertebrate community composition will have implications for prey available to Western rock lobsters. The two methods used to classify assemblage structure were also compared. Both methods of classifying assemblage structure yielded similar outcomes, suggesting a single method of classifying habitat can be employed in future studies to determine assemblage structure.

Two components of this report were focused on examining the relationship between the abundance and size of Western rock lobster and the habitats in which they are found. In the first component the relationship between lobster abundance and size, from the annual Western rock lobster independent breeding stock survey (IBSS), and habitat variables were quantified using towed video transects at Dongara, Jurien and Lancelin. All three locations vary both with respect to the composition of habitats and the abundance and size of lobster, with Dongara being significantly different from the other two sites. The largest lobsters were found at Dongara while the highest abundance of lobsters was at Lancelin. In addition, lobsters vary both qualitatively and quantitatively with habitat. Qualitative characteristics of the benthos rather than the density of a particular habitat type determined lobster size.

In the second component Western rock lobster size and abundance data was derived from the annual Western rock lobster independent breeding stock survey at the five subregions of the IBSS at Jurien. Two habitat datasets were used: (1) a towed video survey to derive benthic habitat data and (2) a full coverage habitat map derived from a multi-beam hydroacoustic survey and towed video. Abundance and size of lobsters varied significantly across the five subregions of the IBSS at Jurien. Habitat classification from both towed video and the habitat map indicated that subregions also varied significantly in habitat composition. Multivariate statistical techniques show a strong association between Western rock lobster abundance and size and habitat types with 74% of the variation being explained by the combination of *Ecklonia* and sponges.

Both components of the study illustrated that low numbers of larger lobsters are present in areas associated with sponge and high numbers of smaller lobsters are present in more structurally complex *Ecklonia* dominated habitats.

We used stable isotope analysis and gut content analysis to determine the diet and trophic position of Western rock lobsters at three locations (Dongara, Jurien and Lancelin). Lobsters were primarily carnivorous, and no consistent differences in diet were detected with varying lobster size, sex or among locations. The main components of the diet were bait (from the fishery) and small crustaceans such as crabs and amphipods/isopods. Foliose red algae, bivalves, gastropods and sponges were minor contributors to diet. The diet of lobsters in deepwater differed to results of previous studies of lobsters from shallow water ecosystems. Coralline algae and molluscs are important prey in studies of lobsters from shallow water but were minor components of the diet. These differences are likely to reflect differences in food availability between these systems and potentially, differences in choice of prey by lobsters that inhabit deeper water. Given the high contribution of bait to lobster diet, bait is likely to be subsidising lobster production in deep coastal ecosystems during the fishing season.

A desk top study was conducted to examine changes in the catchability of Western rock lobster. The Abrolhos Islands region was used to examine catchability dynamics between shallow (< 20 fm) and deep (>= 20 fm) water Western rock lobster using the DeLury depletion model. This region was chosen as a significant decline in CPUE due to fishing in a relatively short period (3.5 months) occurs in this location. As a result of the high exploitation and the large number of pots operating in a relatively restricted area, the catchability of rock lobsters in shallow water was significantly increased by the 18% pot reduction in 1993/94. This study indicates that the increase is confined to the shallow water component of the fishery. This indicates that there is a significant level of pot saturation occurring in the shallow waters of the Abrolhos. This result suggests that there may be some economic benefit from further pot reductions in shallow waters at the Abrolhos Islands and these are currently being examined for the 2008/09 season.

Appendix D - History of the Development of the Research Plan

[For Appendices and Attachments to the Eco SRG's 2007 Effects of Fishing Research Plan see the complete plan at http://www.fish.wa.gov.au/docs/op/op039/index.php?0706]

2003

At its inaugural meeting on the 5th and 7th August 2003 the Eco SRG identified that there was a general lack of knowledge / information on the interaction of the WCRLF with the deepwater ecosystem and therefore it was necessary for initial research to focus on identifying and observing ecosystem patterns before attempting to research ecosystem processes. The Eco SRG considered observing ecosystem patterns to be the important first step for all forms of ecosystem research whether based on gradients in effect (caused by different densities of lobsters) or fished versus unfished areas. Without first undertaking this basic research there would be no scientific guidance on which to base the design of future studies comparing fished and unfished fished areas. For example, what size the closed areas should be, the levels of replication required and what should be used as potential response variables.

The Eco SRG produced a strategic research framework (Attachment 2) to help develop a more detailed research plan to improve the information base to enable a more robust scientific assessment of the ecosystem effects of rock lobster fishing, i.e. the effects of large scale lobster biomass removal in deepwater (>30m)[12]. The goal of the research plan was to provide an overview of the research that would be required to test the null hypothesis that:

> *Removal of Western rock lobsters on a scale experienced in Western Australia does not have a significant or irreversible effect on the ecosystem.*

Based on its strategic research framework the Eco SRG recommended that an operational plan of research be developed and implemented to establish the necessary understanding of the critical natural history elements that would be necessary to address the null hypothesis. The key elements of the operational plan included four points with associated focus questions and action plans to answer them:

1. Habitat mapping

Focus questions to be addressed

- What habitats do lobsters utilise?
- Is there a pattern in the habitat type that is related to lobster density and / or size structure?

Action Plan

6. Produce a broad scale habitat map by collating information from existing data bases e.g. fishers' GPS, seismic surveys, etc.
7. Review existing benthic habitat and seabed data for the shelf waters between Mandurah and Kalbarri.
8. Conduct broad large-scale rapid assessment protocols in waters between Mandurah and Kalbarri to determine areas of interest.
9. Choose a minimum of three representative transects with replicates at each location.
10. Conduct detailed habitat mapping of chosen sites that include:

[12] The Eco SRG decided the research plan should concentrate on the impact of lobster removal in deepwater, as it was likely to be more significant because the biomass of undersize animals was much less than in shallow water and the SRFME projects were investigating the shallow water impacts.

- acoustic survey of hard structure and associated ground truthing of epifauna and infauna 'habitat' using video techniques; and
- limited grab sampling to later determine infaunal composition and sediment type.

Addressing these questions would provide information on the distribution and density of lobsters of different sizes relative to benthic habitats[13] and prey resources.

2. Size structure and density of lobsters

Focus questions to be addressed

- What is the current size structure and density of lobsters in the chosen sites?
- Is potting an appropriate measure of abundance and size structure of the population (selectivity of pots)?
- What is/are the relationship(s) between pot catch rates and size composition?
- What is/are the impact(s) of habitat on catchability?
- What is the degree of movement (foraging/home range) of lobsters and is it size dependent?

Action plan

5. Use a range of methods to estimate selectivity and catchability (depletion experiments using different fishing gear (e.g. pots with larger necks or tangle nets) and multiple tagging.
6. Use video to observe localised lobster behaviour with habitat types and interaction with baited pots.
7. Using existing catch records and environmental data assess the influence of climate variation on catchability at sites.
8. Use existing length based fishery models to investigate possible size compositions for unfished stocks.

This information would be used to relate lobster density (and size structure) to fisheries data to facilitate the scaling up of information from specific study sites to the fishery. It would also be combined with information collected in "1" above to determine relationships between habitat and lobster size and density.

3. Trophic Dynamics

Focus questions to be addressed

- What is the size dependent diet of lobsters in the chosen sites?
- What are the trophic dynamics of lobsters in these regions?
- Are there relationships between lobster size-structure compositions and prey density and composition?

Action plan

4. Conduct carbon and nitrogen isotope analysis of lobsters to provide information on diets, trophic relationship and whether the basis of lobster diets is plant, animal, detritus or a combination.
5. Conduct gut analysis studies to examine diets and compare with long-term trophic source both on a seasonal and inter-annual basis.
6. Conduct aquarium tests to investigate relationship(s) between lobster size and prey size.

This information would be used to assess whether large lobsters exploit a different range of food resources than smaller individuals.

[13] The SRG defined the term "habitat" in this context to include the physical (e.g., rocks and sand waves) and biological (e.g. sponge gardens, emergent bivalves) features on the seafloor that provide structural complexity (on > 1m spatial scale) and are likely to act as surrogate variables enabling broad-scale rapid assessment of benthic communities.

4. Lobster behaviour

Focus question to be addressed

- What size and sex specific behaviours are relevant to the issue of sustainability of the resource?

Action plan

3. Observe behaviour of small lobster in areas where there is an absence of large lobster, then seed some of those areas with large lobsters and observe any changes in behaviour / abundance of small lobsters.
4. Use video techniques to observe lobster behaviour.

This information would be used to assess interactions between different sized lobsters and determine the relevant space and time scales for manipulative studies.

2004

The research plan was further developed at the SRG's second meeting on 14th May 2004 and a conceptual model was also developed to show how the research process would evolve and develop knowledge that was directly applicable to testing the null hypothesis. The proposed research approach was to try and find a "meaningful gradient" in biological assemblage structure across sites that were otherwise indistinguishable based on physical attributes, which could be associated with differences in rock lobster densities. The examination of gradients was to be structured in such a way that it took into account both physical and biological habitat structure. The starting point was the data from sites identified during the fishery Independent Breeding Stock Survey (IBSS, i.e. independent egg production field surveys) conducted annually by DoF in 40 to 60m along the west coast (Jurien Bay in particular) and more detailed habitat mapping studies. The SRG noted however, that pattern focussed studies, which did not require areas to be closed to fishing, assumed that gradients in effect could be found, however, if they could not the only recourse would be to use fished versus unfished areas comparisons.

The Department of Fisheries' project "*The effects of Western rock lobster fishing on the deepwater ecosystem off the west coast of Western Australia"* (FRDC[14] funded project # 2004/049) was developed using the Eco SRG's research framework. It commenced in July 2004 and was completed in July 2007.

2005

At its third meeting on 3rd February 2005 the Eco SRG received detailed briefings on the SRFME[15] shallow and the DoF deepwater water ecology projects. The SRG redrafted its research plan and it was circulated out of session to all members for final comment. A copy of the final draft that was to have been signed off at the SRG's 2006 meeting is provided at Attachment 5.

2006

The Eco SRG did not meet during 2006 and the draft research plan was not signed off.

2007 to 2009

Eco SRG's strategic research plan - 2007

The Eco SRG had not formally endorsed the draft of the original research plan for the effects of rock lobster fishing that was developed and circulated in 2005. Since then

[14] FRDC – Fisheries Research and Development Corporation http://www.frdc.com.au/
[15] SRFME – Strategic Research Fund for the Marine Environment http://www.srfme.org.au/

FRDC Project 2004/049 has collected a lot of new information that has been analysed and discussed in the final report to FRDC. In view of these considerations, the Eco SRG decided that the plan should be redrafted based on the discussion that would take place at the meeting and then re-submitted to them for review and comment.

The Eco SRG reviewed the results of FRDC Project 2004/049 and noted that the project had been successful in obtaining baseline information on rock lobster ecology in deepwater (the Non Technical Summary of the report on the project is provided at Appendix D). However, it was clear that the gradients identified during the course of the project were confounded by habitat differences and consequently could not be used to evaluate the effects of fishing, as originally proposed by the SRG. The SRG concluded that future research on the ecological effects of rock lobster fishing, would require a comparison of areas open and closed to fishing (i.e. as per the conceptual model / decision making process developed at the May 2004 meeting).

Development of a research plan for the new DoF effects of fishing project

At its August 2007 meeting, the Eco SRG discussed and development a research plan for the new Department of Fisheries FRDC funded project (*FRDC 2008/013*), to investigate the ecological effects of fishing using fished and unfished area comparisons. The SRG made the following recommendations for the project:

- as per the first DoF project (FRDC 2004/049), the new research project should be carried out in deepwater (>30m), as this was the area likely to show the most significant ecological impacts due to removal of legal size lobsters by the fishery (information was provided on specific issues raised by SRG members regarding the new project – including information on rock lobster length frequency by depth); and
- experimental sites needed to be replicated;

At the meeting the SRG also:

- developed site selection criteria;
- recommend the development of methodologies using macro algae and macro invertebrates indicators to detect indirect habitat-level changes in communities;
- recommend the continued investigation of lobster trophic pathways to detect direct changes in communities via the prey items in lobster diets;
- recommend the development of a framework for a conceptual model to help identify the ecosystem parameters that would need to be monitored;
- developed project objectives; and
- listed the potential benefits of the project.

Site Selection Criteria

A set of site selection criteria that would need to be satisfied in the selection of potential research areas open and closed to fishing was developed. The site would need to:

- be representative in terms of lobster demographics, *i.e.* have the potential for high adult biomass (relative to undersize biomass), as indicated by good or high catch rates of mature lobster;
- be central to and generally representative of the fishery (*e.g.* region between Lancelin and Dongara);
- have optimal accessibility – needs to be as close to shore/a ‘port’ as practical while satisfying other criteria;

- be representative of lobster habitat based on information obtained from previous habitat mapping (structure and function);
- have replicates of closed areas in different locations;
- be in an optimum location for enforcing compliance of the closure;
- meet the following size of site-criteria:
    - complementary to the size of the lobster's foraging area;
    - large enough to allow measurements of indicator responses (both up/down the lobster food web, e.g. predators of lobster and key prey for lobster;
    - must encompass representative habitats; and
- minimise the relative level of economic loss to industry.

The use of these criteria facilitated site selection and help answer inshore/offshore/depth questions.

Methodologies

The Eco SRG suggested that macro algae and macro invertebrates should be monitored and compared at fished and unfished sites, as it should be feasible to detect indirect habitat-level changes in these communities. If no change in these indicators were observed, given adequate sampling of appropriate variables over sufficient space and time, then it would be unlikely that there were significant ecosystem effects. However, it was also recognised that it would be necessary to continue investigation of lobster trophic pathways, as it may not be possible to detect, or understand any large scale changes without more detailed data on the composition of the rock lobster's prey communities.

Conceptual model development

The development of a conceptual model to help identify the ecosystem parameters that need to be monitored, should be one of the first objectives of the new project. The sampling methods will depend on the ecosystem parameters that are selected for monitoring. Prior knowledge of the nature of the data to be collected will also help inform the level of sampling required to detect responses in the taxa targeted for monitoring. The SRG recommended that Dr Jeff Dambacher of CSIRO, or another suitably qualified qualitative modeller, be approached to help develop the conceptual model.

Project objectives

1. Develop a conceptual/qualitative model for the main components affecting lobsters and their ecosystem in deep waters.
2. Identification and assessment of areas to be closed to fishing and those acting as controls. Assessment will include examination of habitat and lobster catch rates.
3. Measurement of the distribution and abundance of lobsters, major habitat forming taxa and taxa identified by conceptual modelling as high priorities for monitoring.
4. An increased understanding of the dynamic role of lobsters in key ecosystem processes. This should include more work on interactions of habitat and biogeochemical processes. Techniques such as acoustic tagging and isotope analysis should be included.
5. Development of a long-term monitoring plan for the research areas, with secure funding.

The SRG noted that there would need to be a coordinated effort to bring the information from the new DoF project together and integrate it with other projects through the use of ecological modelling, e.g. Ecopath. Some integration of the existing data and information will be achieved through Western Australian Marine Science Institute (WAMSI) Project 4.3 on trophic interactions and ecosystem modelling[16].

Project benefits

A research area(s) of suitable size and location that was closed to fishing would enable the types of ecological research to be undertaken (e.g. the effects of fishing) that would be needed to satisfy the requirements for MSC recertification. Furthermore, it is likely that closed areas along the west coast will be an output of the Commonwealth's bioregional marine planning initiative and the proposed project would allow the Western rock lobster industry to provide a high level of scientific input into that planning process.

The information from this project would significantly enhance the DoF's ability to manage the rock lobster stocks in the best possible way, to meet its ESD obligations and to ensure the long-term sustainability of the fishery.

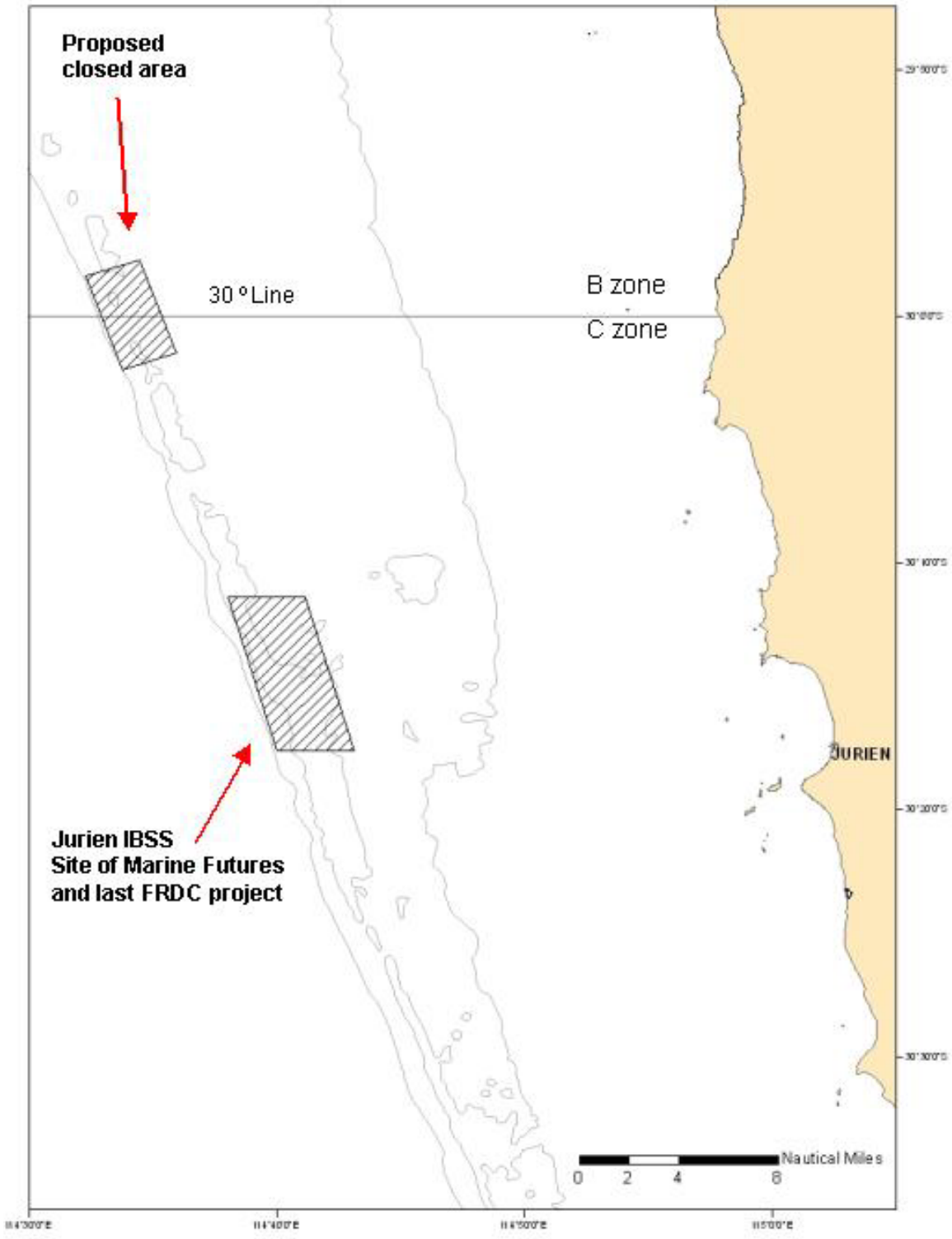
The Eco SRG recognised that the acceptance of the project by industry and the community generally would require its benefits to be clearly articulated. It was anticipated that the benefits would be part of the need/outcomes statement of the new project proposal.

Current Status of the DoF Effects of Fishing Research Project (*FRDC 2008/013*)

DoF effects of fishing research project *FRDC 2008/013 Assessing the ecological impact of the Western Rock lobster fishery in fished and unfished area*, was developed based on the research framework produced by the Eco SRG in 2007 and was circulated to SRG members for comment. The project was revised in light of the comments received from the SRG and the WA Fisheries Research Advisory Body and a successful application for FRDC funding was subsequently made (Attachment 2 – FRDC application). The project officially commence on 1 January 09.

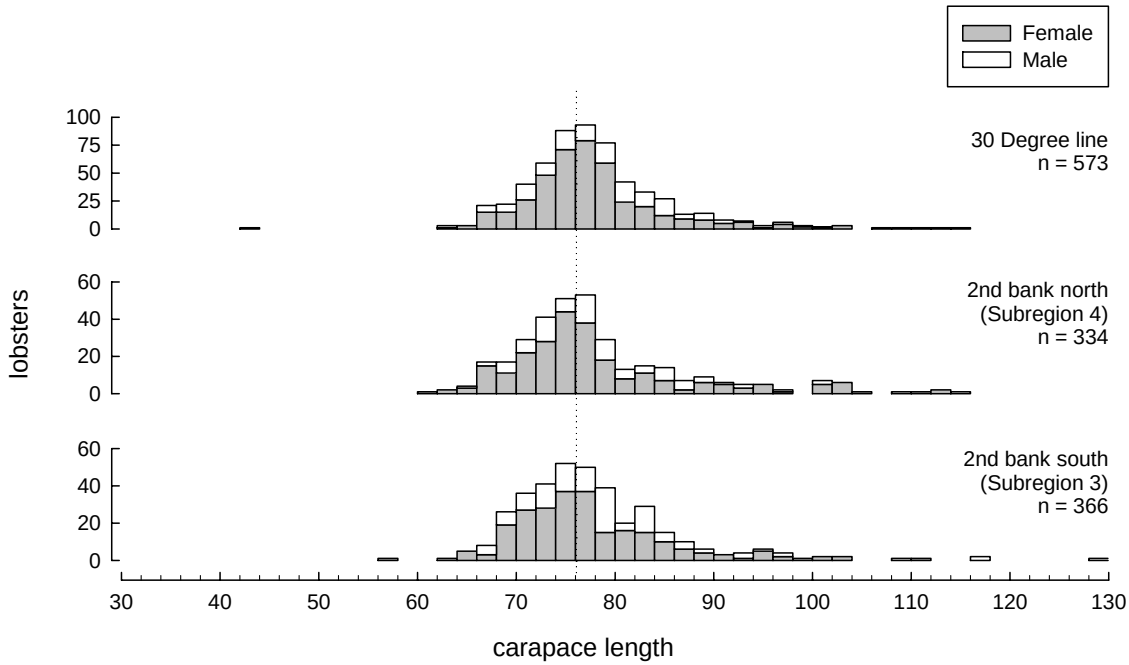
[16]More information on WAMSI Project 4.3 can be found at http://www.wamsi.org.au/research/nodes/node4

Appendix E. - Map of study area



Appendix F – Rock lobster size and sex structure

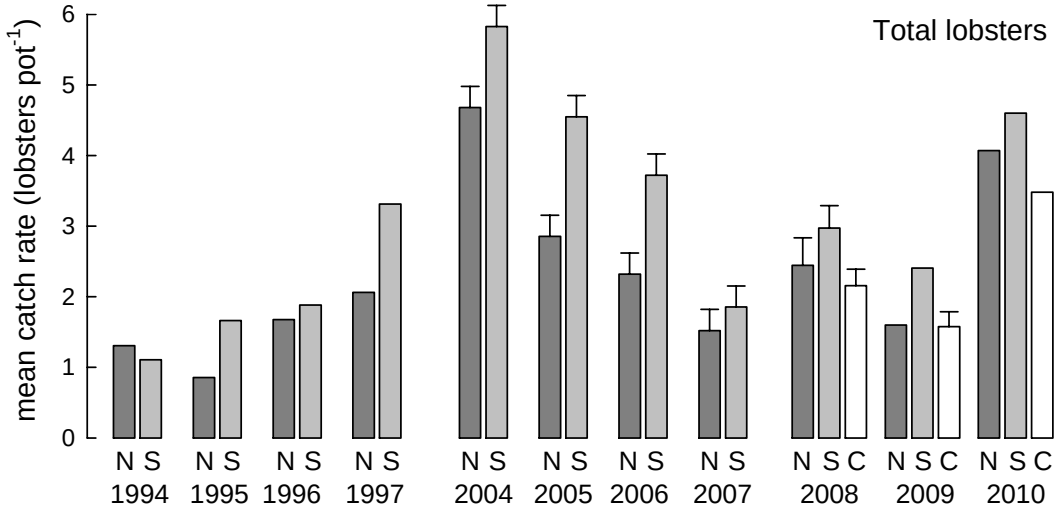
ORIGINAL 2008 COMPARISON OF SIZE STRUCTURE



Size distribution of male and female Western rock lobsters caught using commercial lobster pots (escape gaps closed) during the independent breeding stock survey (October 2008) in and adjacent to the potential closed area (30 degree line) and the Jurien control areas (2nd bank north & 2nd bank south).

Appendix G – Rock lobster catch rates

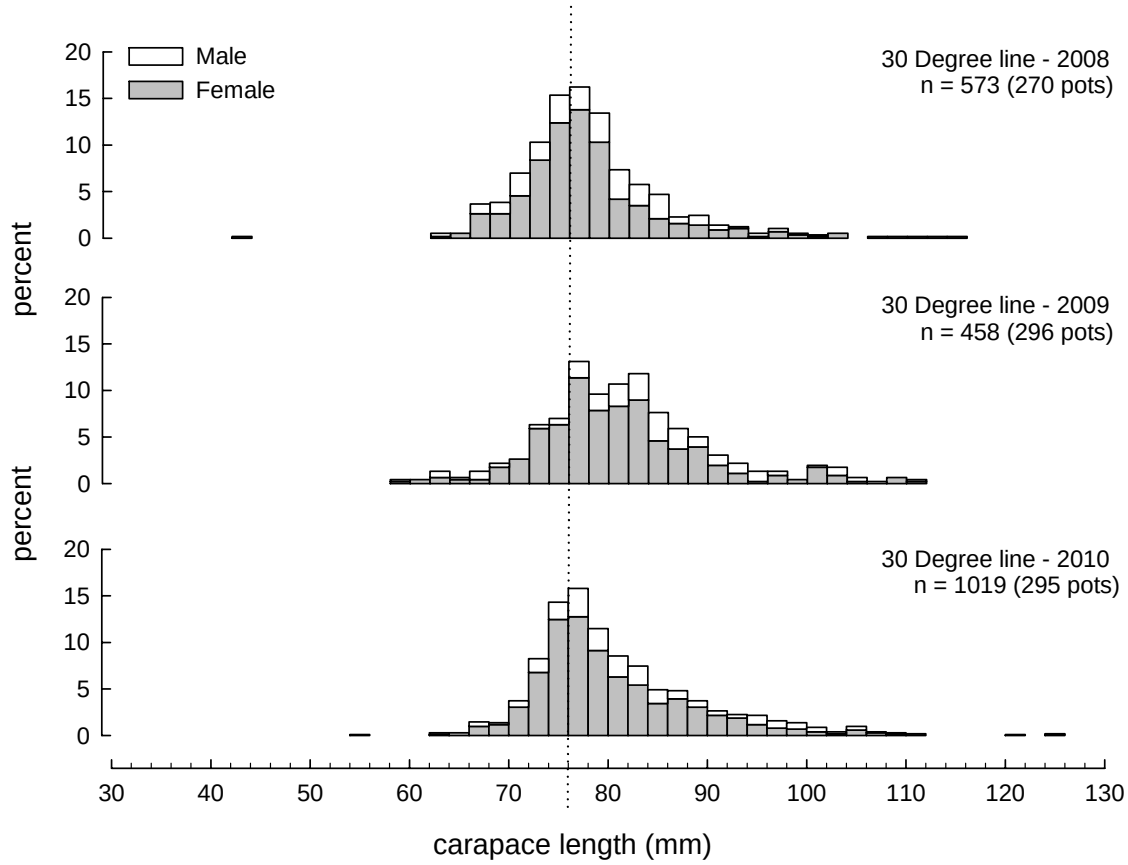
CATCH RATE COMPARISON - ALL YEARS



Catch rates (total lobsters pot^{-1}) of Western rock lobsters caught using commercial lobster pots (escape gaps closed) during the independent breeding stock surveys (October) 2008-2010 in and adjacent to the potential closed area (C) and the northern and southern Jurien control areas (N & S). Catch rates at the Jurien control sites are also given for the periods 1994-1997 and 2004-2007.

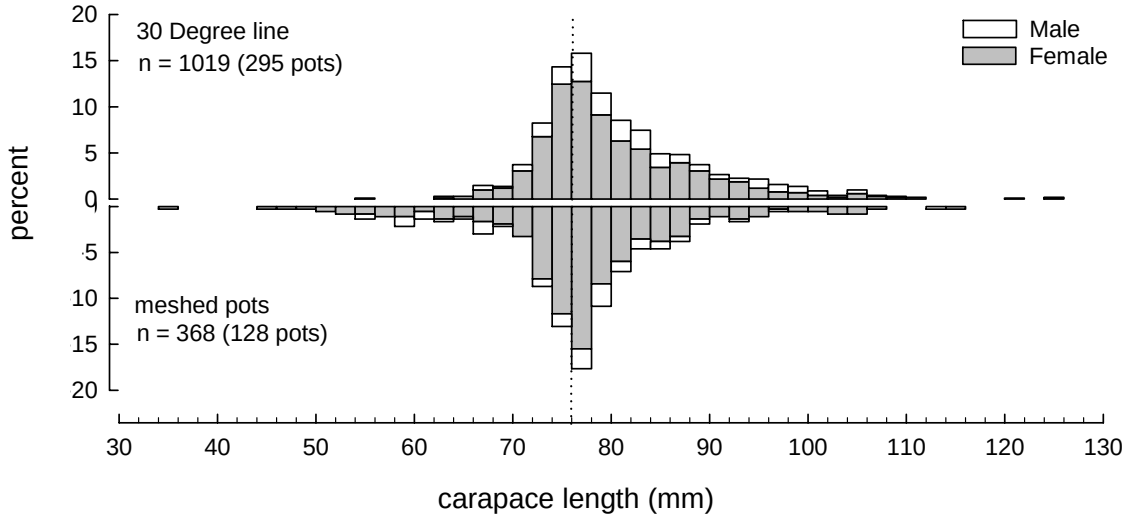
Appendix H – Rock lobster closed area size structure

COMPARISON OF SIZE STRUCTURE – CLOSED AREA ONLY 2008-2010

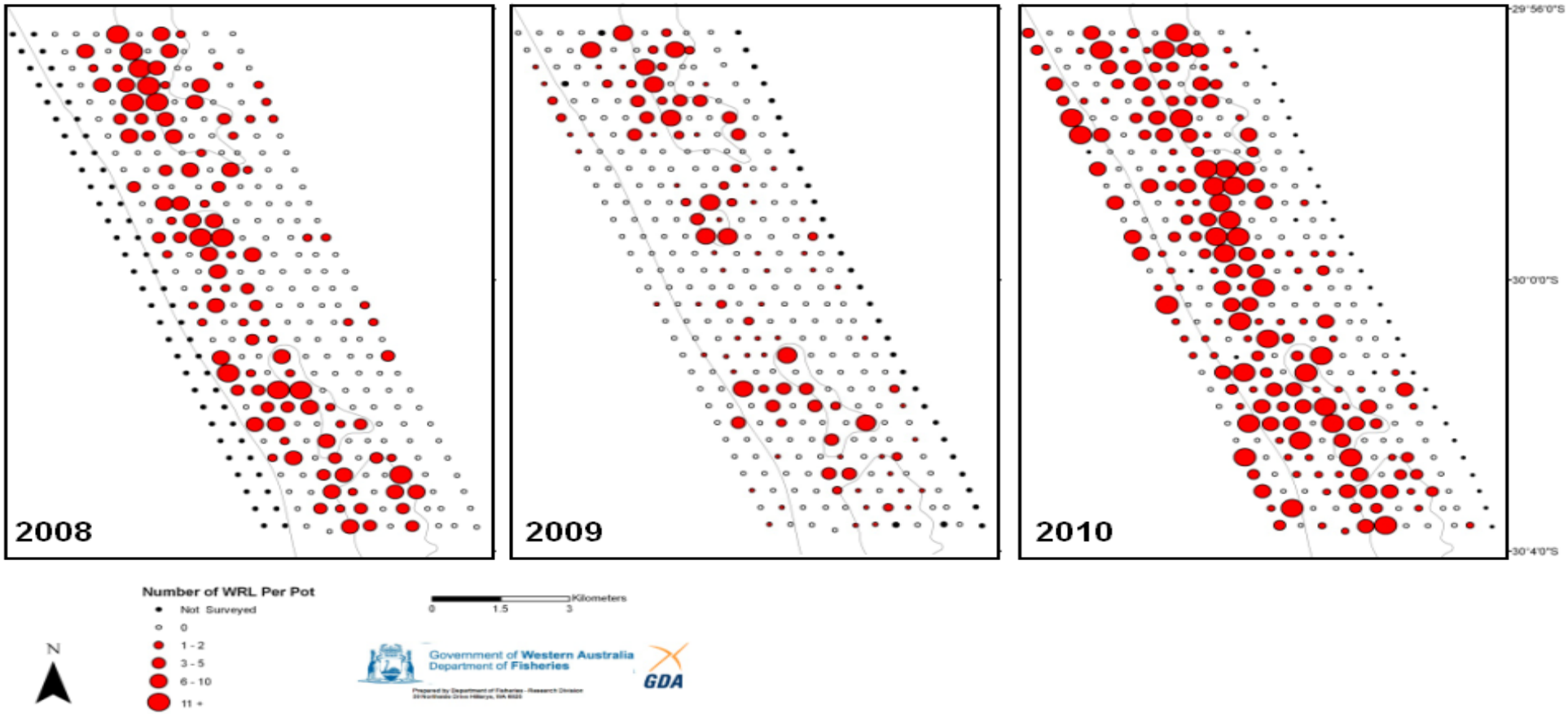


Size distribution of male and female Western rock lobsters caught in and adjacent to the 30 degree line closed area, using commercial lobster pots (escape gaps closed) during the independent breeding stock survey (October) 2008-2010.

COMPARISON OF SIZE STRUCTURE - MESHED POTS– CLOSED AREA ONLY 2010



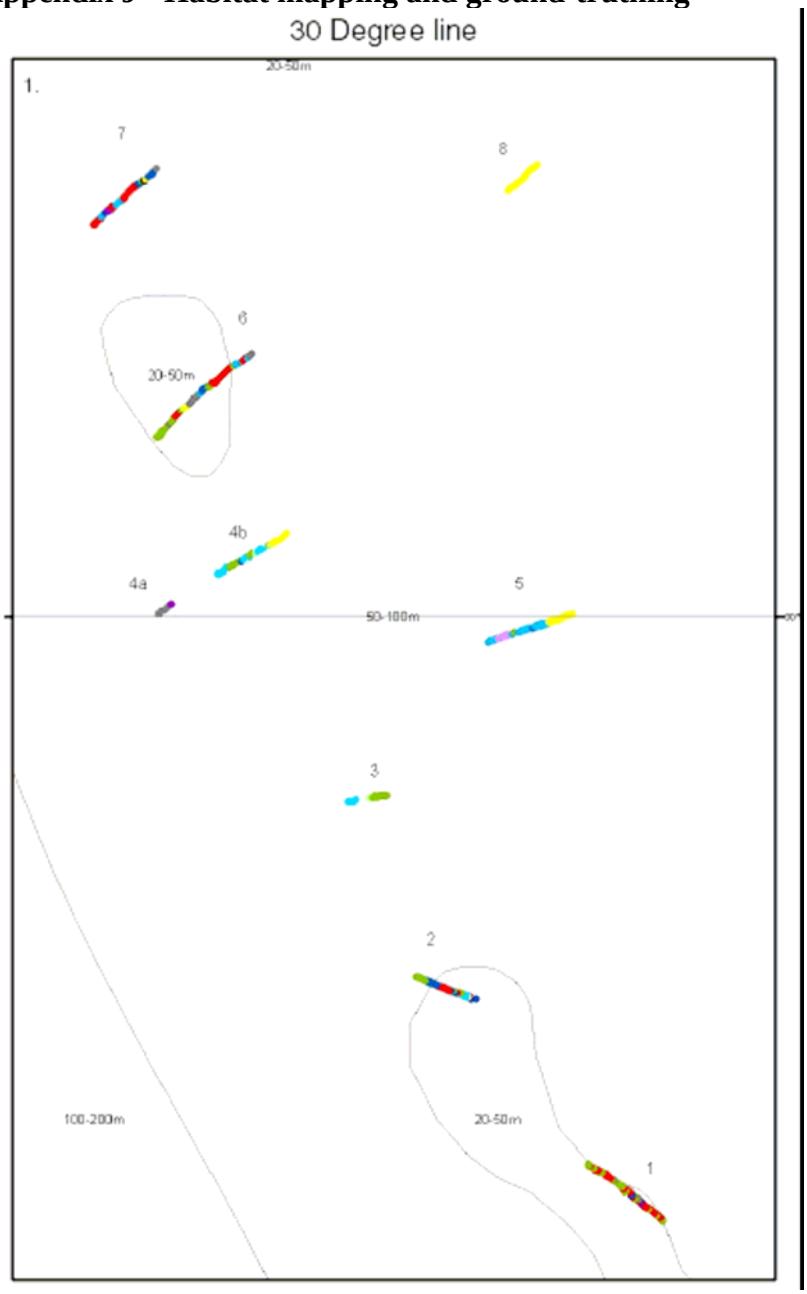
Size distribution of male and female Western rock lobsters caught in and adjacent to the 30 degree line closed area, using commercial lobster pots (escape gaps closed) and meshed pots during the independent breeding stock survey (October 2010).

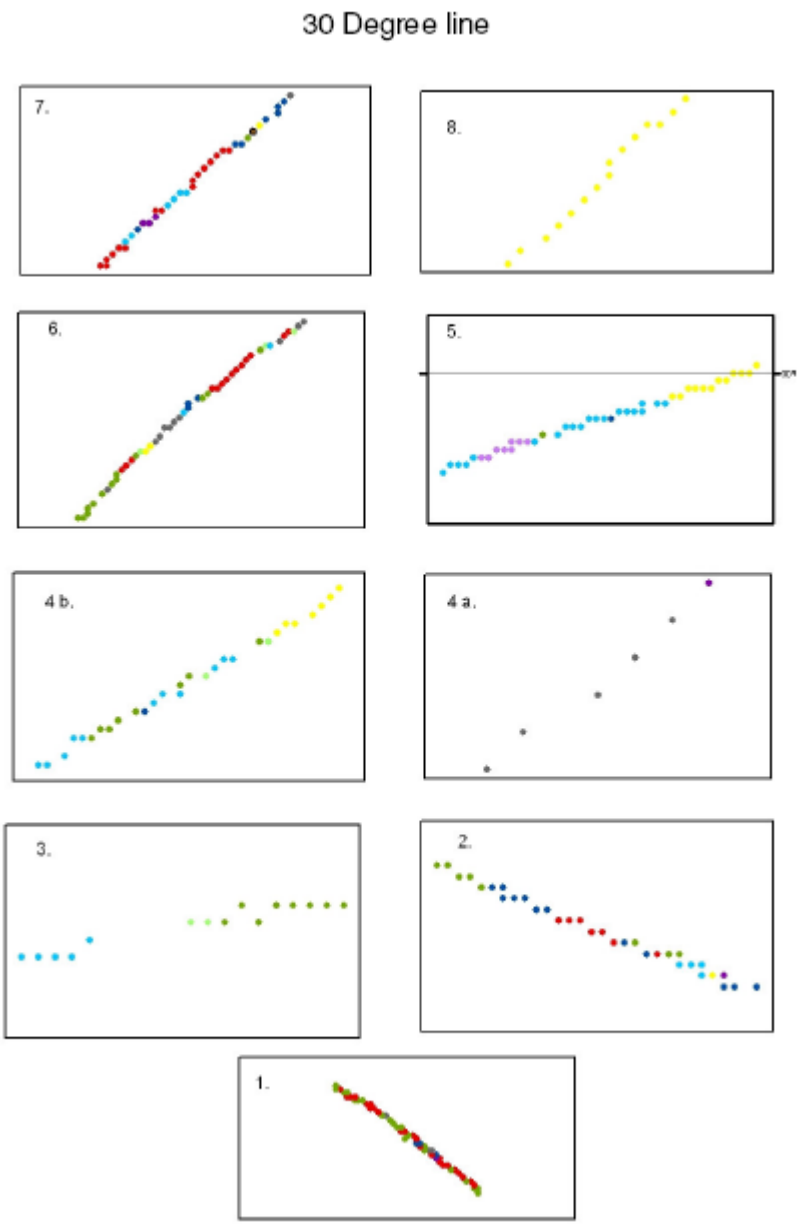


Appendix I – Rock lobster catch rates in the proposed closed area

Catch rates (total lobsters pot^{-1}) of Western rock lobsters caught using commercial lobster pots (escape gaps closed) during the independent breeding stock surveys (October) 2008-2010 in and adjacent to the potential closed area

Appendix J - Habitat mapping and ground-truthing

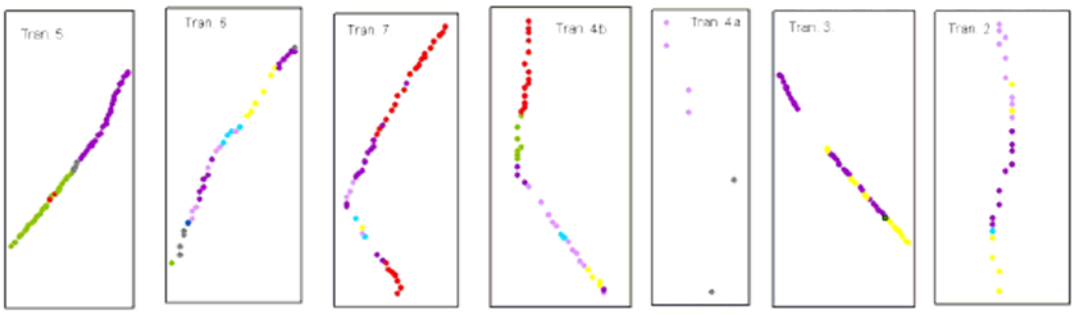



30 Degree line
7.
8.
6.
5.
4 b.
4 a.
3.
2.
1.

Habitat composition (% contribution)

		30 degree line								Jurien IBSS	
	Transect no.	1	2	3	4a	4b	5	6	7	8	SR3	SR4
	Sand		3			24	29	4	3	100		
	Rubble / limestone	6			83			20			12	
	Mixed assemblage - (Ecklonia / Sponge)	46	21					30	47			12
	Mixed assemblage (Ecklonia / No Sponge) High	40	24	53		28		28			54	
	Mixed assemblage (Ecklonia / No Sponge) Medium			13		7	2	7	6			
	Mixed assemblage (No Ecklonia / Sponge) High	2	3		17				9			
	Mixed assemblage (No Ecklonia / Sponge) Medium						19					
	Mixed assemblage (No Ecklonia / No Sponge) High	6	36			3	2	7	18			
	Mixed assemblage (No Ecklonia / No Sponge) Medium		12	33		38	48	4	18			43

SE corner of Abrolhos



Habitat composition (% contribution)

		Abrolhos						
	Transect no.	2	3	4a	4b	5	6	7
	Sand	24	37		10		17	2
	Rubble / limestone			33		6	14	
	Mixed assemblage - (Ecklonia / Sponge)				33	4		54
	Mixed assemblage (Ecklonia / No Sponge) High		2		17	43	3	
	Mixed assemblage (Ecklonia / No Sponge) Medium							
	Mixed assemblage (No Ecklonia / Sponge) High	36	61		10	47	33	30
	Mixed assemblage (No Ecklonia / Sponge) Medium	36		67	26		19	9
	Mixed assemblage (No Ecklonia / No Sponge) High						3	
	Mixed assemblage (No Ecklonia / No Sponge) Medium	4			5		11	4

Appendix K - Participants at qualitative modeling workshop

Table 1. Participants in deepwater rock lobster qualitative modeling workshop held June 4, 2009.

Attendees	**Institution**
Dr Jeff Dambacher	CSIRO Mathematical and Information Sciences.
Dr Verena Trenkel; Dr Marie-Joelle Rochet	Laboratoire Mahera, IFREMER (Institut Français de Recherche pour l'Exploitation de la MER)
Dr Michael Fogarty	Northeast Fisheries Science Center, NOAA (National Oceanic and Atmospheric Administration)
Assoc/Prof Stewart Frusher	Tasmanian Aquaculture and Fisheries Institute
Dr Dan Gaughan,; Dr Nick Caputi; Dr Simon de Lestang; Dr Lynda Bellchambers, Dr Sarah Metcalf; Dr Matt Pember	Department of Fisheries, Western Australia

Appendix L - Conceptual model developed by EFAG (at its meeting 2-3 November 2010)
(Copied from *Rock Lobster Ecology – State of Knowledge* document (for MSC Principle 2), which can be found at: http://www.fish.wa.gov.au/docs/op/op089/index.php?0706)

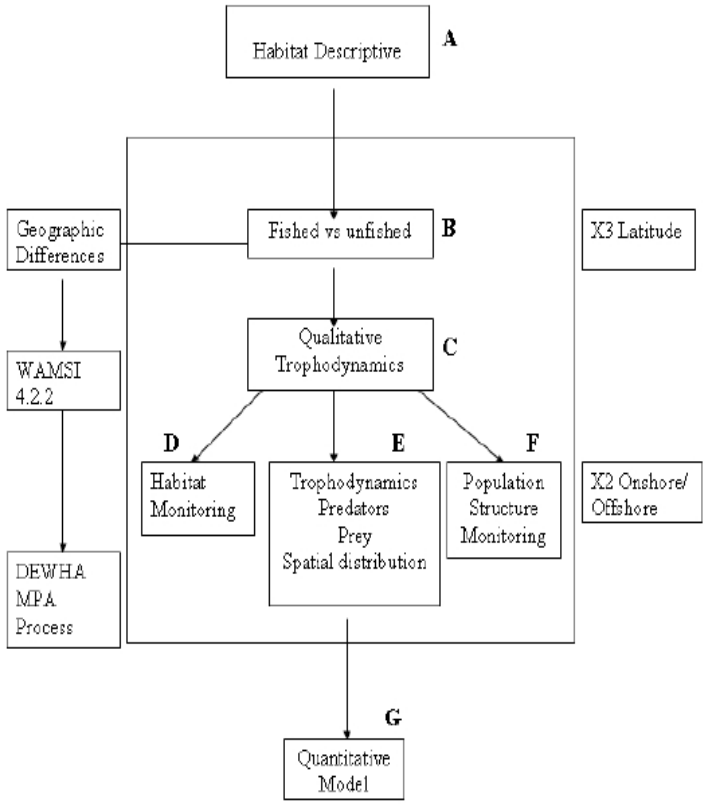


Figure 1. Effects of Fishing Advisory Group (EFAG) conceptual model for ecosystem research on western rock lobster. Bold letters correspond to current research projects listed in Table 8.

Below is Table 8 copied from the *Western Rock Lobster Ecology – State of Knowledge* document (for MSC Principle 2,) that describes the research on or associated with the effects of fishing that is currently being or will be undertaken by DoF and other organisations that underpins the conceptual model and this research plan. The letters in the Conceptual Model column of the table should be read in conjunction with the corresponding letters on the figure above. The *Western Rock Lobster Ecology – State of Knowledge.* Marine Stewardship Council – Principle 2: Maintenance of Ecosystem (2010) draft document can be found at: http://www.fish.wa.gov.au/docs/op/op089/index.php?0706

Table 8. Summary of current and planned research on effects of fishing for western rock lobster on the ecosystem. Letters in column marked conceptual model correspond to bold type letters on the conceptual model (see Appendix; Figure 1).

Project Title	Lead Agency	Funding Source	Study Location	Objectives / Project Description	Status	Conceptual Model
Assessing the ecological impact of the Western Rock Lobster fishery in fished and unfished areas	DoF	FRDC	Jurien (30° line)	1. Identification and assessment of suitable unfished reference areas to exclude rock lobster fishing in deep water 2. Development of a qualitative trophodynamic model that will provide a conceptual framework for determining sampling protocols, indictors and targets. 3. To provide cost effective methods to measure deep water ecosystems in both fished and unfished reference areas	Funded 2010/2012	A, B, C, E, F
Trophic interactions and ecological modelling for EBFM	DoF and ECU	WAMSI 4.2	Jurien (deepwater) + Metro region (shallow water)	1. Improve understanding of the possible indirect impacts of fishing or other affects on trophic interactions (e.g. removal of keystone species)? 2. To determine what are the main processes leading to changes in trophic interactions 3. To design experiments to examine the potential impact of fishing on benthic habitats, community structure or biodiversity.	Funded 2009/2011	B, E, F
Indicative Development Plan, including baseline habitat and	DoF	State NRM	Abrolhos Islands	Map the shallow water benthic habitats of the Abrolhos Islands using	Funded 2010/2011	A

human use maps, to guide future development within the Houtman Abrolhos Islands				remote sensing techniques and field based ground truthing.		
Abrolhos Islands long term monitoring	DoF	Internal	Abrolhos Islands	Long term monitoring of benthic habitats using a series of permanent transects. Transects are surveyed annually and the percentage cover of benthic habitats are recorded using diver operated stereo video.	2006- ongoing	A, D
Spatio – temporal variability in assemblages of mobile invertebrates colonizing artificial habitats along the coastline of Western Australia	DoF/UWA	FRDC	Various coastal locations	Monitoring community composition of marine flora and fauna colonizing puerulus collectors along the Western Australian coastline Determine the influence of environmental parameters on the floral and faunal communities colonizing puerulus collectors.	Funded 2010/2011	F
Prey Preferences of the Western Rock Lobster *Panulirus cygnus*	UWA	UWA Hons	Laboratory based	Prey preferences were investigated for small juvenile (sub-legal) lobsters, as well as medium and large legal sized mature lobsters to identify size associated differences in lobster prey preference	Completed Nov 2010	E
IMOS	National	National	WAIMOS (Jurien/Abrolhos/Rottnest)	Monitoring benthic habitats using AUV	Funded	A, D
Catchability of Western Rock lobster *(Panulirus cygnus)*; the influence of temperature, light intensity, habitat and commercial fishing apparatus	Murdoch	FRDC		To examine the effects of a number of factors on the catchability of lobsters	Funded, to be completed in 2012	F
Development of an industry-based habitat mapping/monitoring system	DoF	FRDC	Statewide	1. Development of a cost-effective digital monitoring system 2. Comparison of functionality and effectiveness with conventional	FRDC Full Proposal 2010/11	A, D, F

				habitat mapping methods 3. Trial use of system by industry and development of habitat maps		
Understanding processes that affect recruitment of western rock lobster to the fishery over a latitudinal gradient	DoF/UWA	FRDC	Statewide	Determine the relationship between benthic habitat composition and the abundance and distribution of different life stages of the western rock lobster Develop a low cost monitoring program for on going assessment of on benthic habitats and western rock lobster	Proposed FRDC EOI 2011/12. Some components currently being conducted by DoF	A, D, F