

**An assessment of the finfish catch by recreational fishers, tour operators, commercial lobster fishers and commercial wetline fishers from the Houtman Abrolhos Islands during 2006**

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*Fish for the future*

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# **An assessment of the finfish catch by recreational fishers, tour operators, commercial lobster fishers and commercial wetline fishers from the Houtman Abrolhos Islands during 2006**

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## **Abstract**

The catch of finfish from the Houtman Abrolhos Islands was estimated for recreational boats, tour operators, commercial rock lobster fishers and occupants of their camps on the islands. Separate methods were used for each of the different sectors due to the variation in fishing activities. Recreational boats and commercial rock lobster fishers were surveyed to determine catches, whereas the catches by tour operator and commercial wet-line fishers were determined from their compulsory catch and effort returns submitted to the Department of Fisheries.

The reported commercial wetline catch for pink snapper, sweetlip emperor and Western Australian dhufish greatly exceeded the combined catch from the other sectors. The commercial wetline catch of pink snapper comprised 69.9 tonnes out of a total catch of 85.7 tonnes. The commercial wetline catch of sweetlip emperor comprised 61.0 tonnes out of a total catch of 66.0 tonnes. The commercial wetline catch of dhufish comprised 27.9 tonnes out of a total catch of 39.0 tonnes

Baldchin groper was also a major component of the catch from the islands. Baldchin groper was the dominant species caught by persons staying at the commercial rock lobster fisher's camps on the islands (27.6 tonnes). Baldchin groper was also caught by commercial wetline fishers (15.1 tonnes), as by-product in rock lobster pots (11.7 tonnes), by recreational boats (8.3 tonnes) and tour operators (3.5 tonnes).

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## 1.0 Introduction

The Houtman Abrolhos Islands are located between 28°S and 29°S latitude off the Mid West coast of Western Australia, 60 kilometres west of Geraldton. The Houtman Abrolhos comprises 122 islands extending north parallel to the coastline for 100 kilometres (Webster *et al.*, 2002). The surrounding ocean supports both tropical and temperate marine species, with the Leeuwin Current maintaining winter water temperatures above 20°C (Pearce, 1997).

The Houtman Abrolhos Islands are an A-class reserve managed by the Department of Fisheries for the conservation of flora and fauna, for tourism (including recreational fishing), and for purposes associated with fishing industries. Under the Fish Resources Management Act 1994, a fish habitat protection area (FHPA) was established in state waters surrounding the Houtman Abrolhos Islands (Abrolhos Islands Management Advisory Committee and Department of Fisheries, 1997) (Figure 1). The waters surrounding the islands have special status as an area for the conservation of fish and the aquatic ecosystem, and for the management of aquatic tourism and recreational activities.

The ocean surrounding the Houtman Abrolhos Islands supports commercial rock lobster fishing, scallop trawling, wetline fishing, purse seining for sardines and aquaculture for the cultivation of pearls. Commercial rock lobster fishers, and in many cases their families and or friends, live on some of the islands during the rock lobster season, which extends from March 15 to June 30 each year. There are approximately 120 rock lobster fishers' camps on the islands. Commercial rock lobster fishers keep some fish brought to the surface in rock lobster pots (i.e. retained by-product of edible species) and may also fish with a line from commercial rock lobster boats and tenders.

Recreational fishers mainly visit the Houtman Abrolhos Islands during the rock lobster season when the weather is more favourable for boating. Recreational fishers at the Houtman Abrolhos Islands can be placed in four groups: 1) recreational fishers that stay for one or more nights on large private power boats or yachts; 2) commercial rock lobster fishers and their friends and family that stay on the islands in camps; 3) recreational fishers that visit the islands on day trips from the mainland in smaller boats, and 4) recreational fishers on vessels owned by tour operators<sup>1</sup>.

This 2006 survey, funded by the Northern Agricultural Catchments Council, was undertaken since the 2005/06 survey of boat ramps in the West Coast bioregion (Sumner *et al.*, In prep.) did not estimate the recreational take of finfish from the Houtman Abrolhos Islands. This 2006 survey included larger recreational boats kept in pens and on moorings that visited the Houtman Abrolhos Islands and stayed for several days.

This study is the first to specifically target finfish fishing at the Houtman Abrolhos Islands, including by-product caught in lobster pots.

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<sup>1</sup> Tour operators take groups to the Houtman Abrolhos Islands for a variety of reasons including snorkelling, scuba diving, wildlife observation, sight seeing and fishing (Webster, *et al.*, 2002).

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## **2.0 Methods**

Separate methods were used for each of the different sectors due to the different types of fishing activities.

### **2.1 Area and time frame included in this study**

#### **Study area**

The area within the Houtman Abrolhos Islands FHPA (Figure 1) was included in this study. The catch and fishing effort was recorded for blocks on a 5×5 nautical mile grid for recreational boats, commercial rock lobster fishers and occupants of camps.

The larger commercial blocks that most closely approximated the FHPA were used for commercial wetline boats and charter boats. This area comprised blocks 97012, 97013 and 97014 (Figure 2). These blocks included the FHPA and surrounding ocean.

The study area used for this report is different to Wise *et al.* (2007) who reported the catch and fishing effort for commercial wetline boats and charter boats for commercial blocks 97011, 97012, 97013, 97014, 97015 (Figure 2).

#### **Study time frame**

This study included the 2006 calendar year for all sectors to fit within the time frame for funding required by the Northern Agricultural Catchments Council. Sumner *et al.* (In prep.) and Wise *et al.* (2007) reported on the 2005/06 financial year. All studies reported on a full 12-month period.

### **2.2 Recreational boats**

The recreational catch (numbers of fish) and fishing effort (fisher days) during the rock lobster season was estimated from an on-site survey of recreational boat crews. A roving survey that included all island groups and surrounding ocean in the FHPA was conducted by boat (Figure 1). Six five-day trips between April 4 and June 7 were conducted during 2006. Three five-day trips between April 1 and June 5 were conducted during 2007 to provide additional data required to estimate catch rates. As the study area was traversed by boat, the location, size and activity of recreational boats encountered were recorded for blocks on a 5×5 nautical mile grid. It was assumed that recreational boats of less than six meters (i.e. runabouts and dingies) originated from one of the camps on the islands while larger recreational boats of over six meters stayed at the anchorages and moorings. Recreational boat crews were interviewed at moorings, anchorages and jetties when they had finished fishing for the day in order to collect catch and effort data and measure the lengths of all finfish kept (Appendix A – Questionnaire form).

Skippers of recreational boats that were interviewed were also provided with a diary to record the catch and effort for the rest of their stay at the Houtman Abrolhos Islands. The diaries were then posted back to the Department of Fisheries. Data from the diaries was combined with the interview data to estimate an average daily catch rate per boat (Appendix B).

The estimation of boat numbers obtained during the on-site surveys were supplemented with two aerial surveys on April 21 and 23 during the school holidays in 2006. The number of recreational power boats and yachts were counted during flights transects that covered the

entire island groups (Figure 1). The aerial-survey recreational-boat counts were combined with the roving survey counts to estimate the average number of recreational boats at the Houtman Abrolhos Islands during the 2006 rock lobster season.

The average number of recreational boats engaged in fishing per day during the rock lobster season was estimated by multiplying the average number of recreational boats by the proportion of boats fishing. The fishing effort was estimated by multiplying the average number of recreational boats fishing per day by the number of days in the rock lobster season. A constant visitation rate was assumed for the rock lobster season. To estimate the total catch, the estimated total effort was multiplied by the average daily catch rate per boat (Appendices B and C).

For the rest of the 2006 calendar year a phone/diary survey of skippers visiting the islands was conducted. Outside the rock lobster season all persons visiting the Houtman Abrolhos Islands were required to notify the Geraldton Office of the Department of Fisheries. Skippers that submitted a notification were given a diary to record catch and fishing effort information for their stay at the Houtman Abrolhos Islands. The skippers were contacted by phone when they returned to the mainland so this data could be collected.

The fishing effort outside the lobster season was estimated from the number of boats visiting the Houtman Abrolhos Islands, their length of stay and whether they participated in fishing activities. The calculated effort was converted from boat days to fisher days by multiplying by the average number of fishers per recreational boat.

To estimate the total catch, the estimated total effort was multiplied by the average daily catch rate per boat during this period. The off-season catch was added to the catch derived during the rock lobster season to estimate the total recreational catch for the Houtman Abrolhos Islands for the 2006 calendar year. Measured lengths of kept species were converted to weights, using the species length/weight relationship (Appendix D). The total weight in tonnes for each species kept was estimated by multiplying the total number of retained fish by the average weight per fish.

### **2.3 Commercial rock lobster fishers and occupants of camps**

A door-to-door survey was conducted of camps belonging to commercial rock lobster fishers. To ensure comprehensive coverage, every occupied camp on each island visited was included in the survey: when necessary, the interview team would await the return of fishers to their camp. Sometimes it was not possible to visit every island on a single trip, in which case those islands were visited on a subsequent trip. All islands except Beacon Island, Leo Island and Pelican Point on West Wallabi Island were included in the survey. These islands were less accessible because of their isolated locations away from the main group of camps. The camps surveyed included the pearl farm camps on Rat Island and Basile Island.

The survey included the commercial rock lobster skippers, deck hands and any visitors staying in their camps. Information on fish caught from angling and as by-product in rock lobster pots and was recorded separately (Appendix A - Questionnaire form). The data on fish caught by angling or as by-product in rock lobster pots was also analysed and reported separately.

The catch and fishing effort for persons staying at the camps was estimated from the data collected (Appendices E and F). An average catch was determined from the data collected during the interviews. This was then multiplied by the number of days in the rock lobster season and the number of rock lobster fishers operating at the Abrolhos during the season to estimate the total catch. Measured lengths of kept species were converted to weights, using the species



length/weight relationship (Appendix D). The total weight in tonnes for each species kept was estimated by multiplying the total number of retained fish by the average weight per fish.

It was not possible to separate the recreational catch from commercial fishers from that of the visitors staying in their camps since they fished together and the catches were combined. Camp visitors mostly fished from the rock lobster boats and tenders.

For the rest of the year a phone/diary survey of skippers visiting the islands was conducted. Commercial fishers that lodged an off-season notification were surveyed using the same method as for recreational boats. If they were fishing commercially to sell the fish, it was assumed that the catch would be reported in their return for that month. Since at this time of the year commercial fishers were targeting finfish rather than lobsters the catch of finfish was likely to be reported.

## **2.4 Tour operators**

Under the Fish Resources Management Regulations 1995, tour operators were required to provide a daily trip return as a condition of their licence. Estimates of catch and effort (fisher days) were obtained from the compulsory tour operator logbooks for the 2006 calendar year. Tour operators (including sea and air operations) were required to report daily catch and effort using 5x5 nautical mile blocks (if no block was reported, then data was not included in the analysis). For analysis purposes the Abrolhos area has been defined using commercial fishing blocks 97012, 97013, 97014 (Figure 2). The total effort and number of retained fish for tour operators was estimated by collating the information provided. Reported lengths of kept species were converted to weights, using the species length/weight relationship (Appendix D). The total weight in tonnes for each species kept was estimated by multiplying the total number of retained fish by the average weight per fish species.

## **2.5 Commercial wetline boats**

Under the Fish Resources Management Regulations 1995, the owners of commercial wetline boats were required to provide a return as a condition of their licence. The returns provide monthly landed weight for each species and effort as days fished in that month. The location of fishing is broadly identified by commercial fishing statistical blocks, which generally extend well beyond the island groups. The catch and effort from commercial wet-line fishers was estimated by collating the information provided for the 2006 calendar year.

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## 3.0 Results

### 3.1 Recreational boats

The total fishing effort from crews on large recreational boats and yachts was estimated as 4,242 (SE 870) fisher days per year (1,433 boat days (SE 294)). Most of the recreational fishing effort (90%) occurred during the rock lobster season. This does not include small boats (Table 1) used by persons staying at the camps on the islands and tenders for commercial rock lobster boats, which are included in section 3.2.

An extensive boat ramp survey on the mainland from 1/7/05 to 30/6/06 (Sumner *et al.*, In prep.) included coverage of boat ramps in the Geraldton region. During this survey only 14 recreational boat crews that reported fishing at the Houtman Abrolhos Islands were identified. The small number of trailer boats detected that were fishing at the Houtman Abrolhos Islands indicated that effort from trailer boats was likely to be small. For this reason, trailer boats making day trips to the Houtman Abrolhos Islands from the mainland were not included in these estimates. The catch from these boats will be included in estimates of recreational catch for the West Coast bioregion from the previous survey.

Due to the small sample size (Table 1) it was not possible to separate power boats and yachts. However, it was observed that fishing activities of these types of boats were different. Large power boats contributed most of the effort with a focus on deep water (approximately 40m) bottom fishing for Western Australian dhufish, pink snapper and baldchin groper. These crews also participated in shallow water bottom fishing for baldchin groper and trolling for narrow barred Spanish mackerel and yellowfin tuna. Yacht crews fished from moorings and occasionally trolled for mackerel species between destinations.

**Table 1.** Number and type of boats encountered during the roving survey

Date#	Tour Operators	Recreational Power (< 6m)	Recreational Power (> 6m)	Recreational Yacht
7-11 April 2006	6	0	15	0
13-17 April 2006	7	0	46	6
21 April 2006	7	7	31	7
23 April 2006	3	3	44	6
29 April – 3 May 2006	5	1	14	3
9-13 May 2006	2	3	0	5
20-24 May 2006	3	1	5	1
3-7 June 2006	3	0	2	4
1-5 April 2007	3	4	22	5
12-16 April 2007	10	0	9	5
1-5 June 2007	4	8	0	3

# Aerial surveys were conducted on April 21 and 23, 2006. All other surveys were on-site.

Catch records for 196 fishing events were collected from interviews and diaries. Recreational boat crews primarily caught demersal species such as baldchin groper, dhufish and pink snapper

(Tables 2 and 3). A list of all species kept by recreational fishers is shown as Appendix G. The survey indicated that recreational fishers consumed most of the catch (88%) while at the Houtman Abrolhos Islands rather than taking it back to the mainland (12%).

Only one recreational boat crew reported taking western rock lobster using pots during the survey. Diving for rock lobster was not permitted at the Houtman Abrolhos Islands.

**Table 2.** Estimated number of fish caught from recreational boats

Species	No. Kept	Std Error (kept)	No. Released	Std Error (released)
Baldchin groper	2,471	507	1,133	233
Pink snapper	1,382	283	680	140
Dhufish	717	147	168	35
Coral trout	424	87	241	50
Spangled emperor	351	72	168	35
Sweetlip emperor	314	64	1,835	377
Chinaman cod	241	50	212	44

**Table 3.** Estimated weight of fish kept from recreational boats

Species	Weight kept (tonnes)
Baldchin groper	8.3
Dhufish	3.5
Pink snapper	3.2
Coral trout	1.0
Spangled emperor	0.9
Sweetlip emperor	0.2
Chinaman cod	0.2

## **3.2 Commercial rock lobster fishers and occupants of camps**

### **Line fishing**

The line fishing effort from commercial rock lobster fishers and persons staying at their camps was 8,407 (SE 283) days. A small amount of spearfishing activity was also recorded. Most of the line fishing occurred from commercial boats and tenders.

The number of species kept was estimated from the data provided by commercial rock lobster fishers and occupants of their camps when interviewed. During the survey 112 commercial fishers or occupants of the camps that had been angling were interviewed. The predominant species caught were baldchin groper and pink snapper (Tables 4 and 5).

The survey indicated that commercial fishers and visitors staying at their camps consumed most of the catch (88%) taken by line on the islands rather than sending it back to the mainland as commercial consignment (1%) or recreational catch (11%) with friends and family. The proportion of line fishing catch eaten on the islands by commercial rock lobster fishers and occupants of camps was similar to recreational fishers.

**Table 4.** Number of fish caught by commercial rock lobster fishers and guests staying at their camps

Species	No. Kept	Std Error (kept)	No. Released	Std Error (released)
Baldchin groper	8,181	672	4,644	382
Pink snapper	2,953	243	2,368	195
Skipjack trevally	1,999	165	400	33
Coral trout	800	66	123	10
Spangled emperor	800	66	123	10
Sweetlip emperor	800	66	2,953	243
Squid	677	56	0	0
Dhufish	584	48	92	8
Chinaman cod	431	35	431	35

**Table 5.** Estimated weight of fish kept by commercial rock lobster fishers and guests staying at their camps

Species	Weight kept (tonnes)
Baldchin groper	27.6
Pink snapper	6.9
Dhufish	2.8
Spangled emperor	2.0
Coral trout	1.8
Skipjack trevally	1.3
Sweetlip emperor	0.6
Chinaman cod	0.4

### By-product from lobster pots

Fish were also caught by commercial rock lobster fishers in rock lobster pots. The predominant species kept were baldchin groper and octopus (Tables 6 and 7). The results were based on 339 interviews with commercial rock lobster fishers after pulling their pots. Large numbers of chinaman cod, eels and wobbegong were released after capture.

The survey indicated that commercial rock lobster fishers consumed most (84%) of the by-product of fish from rock lobster pots on the islands rather than sending it back to the mainland as commercial consignment (10%) or recreational catch (6%) with friends and family.

**Table 6.** Estimated number of fish caught in commercial rock lobster pots (by-product)

Species	No. Kept	Std Error (kept)	No. Released	Std Error (released)
Octopus	8,766	244	431	12
Baldchin groper	3,475	97	523	15
Chinaman cod	1,630	45	3,568	99
Pink snapper	707	20	185	5
Sweetlip emperor	646	18	246	7
Spangled emperor	523	15	215	6
Eels	492	14	4,121	115
Sweetlip	154	4	31	1
Squid	123	3	0	0
Wobbegong	92	3	2,091	58

**Table 7.** Estimated weight of fish kept from commercial rock lobster pots (by-product)

Species	Weight kept (tonnes)
Baldchin groper	11.7
Octopus	7.2
Pink snapper	1.6
Chinaman cod	1.4
Spangled emperor	1.3
Sweetlip emperor	0.5

### 3.3 Tour operators

During the 2006 calendar year, 23 tour operators reported fishing at the Houtman Abrolhos Islands and conducted 373 fishing tours. The reported effort from tour operators during 2006 was 3,243 fisher days. This included angling and spearfishing (pers. comm. N. Sumner). Tour operators visited the Houtman Abrolhos Islands more often in April and May than other times of the year, based on the number of tour operator boats observed (Table 1) and off-season notifications. The catch reported by tour operators was primarily demersal species such as dhufish, pink snapper, sweetlip emperor and baldchin groper (Tables 8 and 9). The catch of iconic pelagic game fishing species such as narrow barred Spanish mackerel and yellowfin tuna was small (less than 0.5 tonne per species) and not included in the results for this reason. A list of all species reported as kept by tour operators is shown as Appendix H. Tour operators did not report taking western rock lobster during 2006.

**Table 8.** Reported number of fish kept by tour operators

Species	No. Kept	No. Released
Sweetlip emperor	2,973	1,588
Pink snapper	2,252	886
Baldchin groper	1,127	265
Dhufish	843	159
Spangled emperor	284	17
Wrasse/gropers general	276	113
Chinaman cod	267	147
Emperor, general	95	87
Coral trout	134	26
Breaksea cod	96	14

**Table 9.** Estimated weight of fish kept from tour operators

Species	Weight kept (tonnes)
Dhufish	4.8
Pink snapper	4.1
Sweetlip emperor	3.7
Baldchin groper	3.5
Spangled emperor	1.2
Coral trout	0.4
Chinaman cod	0.2
Breaksea cod	0.1

### 3.4 Commercial wetline boats

The reported commercial wetline catch includes all methods using lines. A small component caught with gill nets (11.0 tonnes) by the West Coast Demersal Gill Net and Demersal Long Line Fishery has also been included for completeness. The total reported commercial wetline and gill net catch for the Houtman Abrolhos during 2006 was 239 tonnes.

The main species kept were pink snapper, sweetlip emperor, dhufish and baldchin groper (Table 10). Due to the way the catch was reported it was not always possible to identify the catch to the species level. For example, finfish reported as emperor general (north west snapper) could be sweetlip emperor, spangled emperor or other emperor species.

**Table 10.** Reported weight of fish kept from commercial wetline boats

Species	Weight kept (tonnes)
Pink snapper	69.9
Sweetlip emperor	61.0
Dhufish	27.9
Baldchin groper	15.1
Sweetlip general	9.6
Emperor general	9.4
Samson fish	8.5
Spangled emperor	6.7
Ruby snapper	5.2
Spanish mackerel	5.1
Mulloway	2.5
Coral trout	2.1

### 3.5 Comparison of catches

The reported commercial wetline catch for most species including pink snapper, sweetlip emperor and dhufish greatly exceeded the combined catch from the other sectors (Figures 3, 4, 5 and Table 11). The commercial wetline catch of pink snapper comprised 69.9 tonnes out of a total catch of 85.7 tonnes. Similarly, The commercial wetline catch of sweetlip emperor comprised 61.0 tonnes out of a total catch of 66.0 tonnes. The commercial wetline catch of dhufish comprised 27.9 tonnes of a total catch of 39.0 tonnes.

**Table 11.** Comparison of catches for main species

Sector	Pink snapper	Sweetlip emperor	Dhufish	Baldchin groper
Commercial wetline	69.9	61.0	27.9	15.1
Commercial rock lobster fishers camps	6.9	0.6	2.8	27.6
By-product from lobster pots	1.6	0.5	0.0	11.7
Tour Operators	4.1	3.7	4.8	3.5
Recreational	3.2	0.2	3.5	8.3
TOTAL	85.7	66.0	39.0	66.2

Baldchin groper (Figure 6) was the dominant species caught by persons staying at the commercial rock lobster fisher's camps on the islands (27.6 tonnes). Baldchin groper were also caught by commercial wetline fishers (15.1 tonnes), as by-product in rock lobster pots (11.7 tonnes), by recreational boats (8.3 tonnes) and tour operators (3.5 tonnes).

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## 4.0 Discussion

This survey of fishing at the Houtman Abrolhos Islands was conducted during the 2006 calendar year and overlapped the survey of boat ramps on the West Coast (Sumner *et al.*, In prep.) that was conducted during the 2005/06 financial year. Since most of the recreational catch and effort at the Abrolhos occurred during the rock lobster season from March 15 to June 30, 2006 the recreational catch from the two surveys may be combined to provide an estimate for the total recreational catch for the West Coast bioregion. The West Coast survey only included trailered boats launched at boat ramps while this survey includes larger recreational boats kept in pens or on moorings. For this reason the two reports compliment each other.

The spatial extent for which catch and effort has been reported for the tour operators, commercial wetline boats, recreational boats and commercial rock lobster fishers and occupants of camps are not the same due to differences in the way that the data was collected. However, since most of the fishing effort from each sector is focussed on the waters near the islands it is still reasonable to make comparisons between these sectors.

The results for recreational fishers were based on the catch reported to the survey interviewers and diaries sent to the Department of Fisheries. The results for commercial rock lobster fishers were also based on the catch reported to the survey interviewers. It was not possible to separate the catch from commercial fishers from visitors staying in their camps since they often fished together and the catch was combined.

Almost all the catch for fishers, family and visitors staying at the commercial rock lobster fisher's camps and retained bycatch from rock lobster pots was reported as being consumed on the islands. A total of 39.3 tonnes of baldchin groper was kept by commercial rock lobster fishers. Since this catch was not reported as sold it was not considered by the occupants of the camps to be "commercial" (i.e. would not appear in historical commercial catch records). Most of this catch (between 84% and 88%) was reported as consumed at the Houtman Abrolhos Islands.

The total catch of all finfish for the Abrolhos from all sectors during 2006 was estimated at 350 tonnes. Most of the catch was taken by the commercial wetline sector (68%), followed by commercial rock lobster fishers and occupants of camps (20%), recreational fishers (6%) and tour operators (6%). The key indicator species, pink snapper, dhufish and baldchin groper were the predominant species in the catch. Sweetlip emperor was not a key indicator species for the West Coast bioregion, although the total catch for this species was similar to the total catch of baldchin groper and larger than the total catch of dhufish at the Houtman Abrolhos Islands.

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## **5.0 Conclusions**

This is the first study that has estimated the catch of finfish and fishing effort from commercial fishing camps at the Houtman Abrolhos Islands. The study has provided quantitative estimates of catch and fishing effort for recreational fishers, tour operators and the catch of finfish by commercial rock lobster fishermen. This study enables comparisons to be made between the catch shares for these sectors. The baseline data collected will provide a reference point for similar studies in the future.



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## 8.0 Appendices

### Appendix A Questionnaire form



FISHERIES  
WESTERN AUSTRALIA

### Abrolhos Islands Recreational Fishing Survey 2006

Group: \_\_\_\_\_

Island: \_\_\_\_\_

Date: \_\_\_/\_\_\_/\_\_\_

Time (24hr): \_\_\_\_\_

Surveyer's names: \_\_\_\_\_

\_\_\_\_\_

#### LENGTHS OF RANDOM SAMPLE (mm)

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Species: \_\_\_\_\_

Lengths: \_\_\_\_\_

Fishing Today	
<b>N:</b>	Not fishing today
<b>C:</b>	Completed fishing
<b>F:</b>	Fishing currently
<b>L:</b>	Will fish later
Intended Use	
<b>E:</b>	Eat on Island
<b>R:</b>	Recreational catch to mainland
<b>C:</b>	Commercial catch to mainland

Group Number	1	2	3	4
Shack number				
Fishing today (N/C/F/L)				
Number in group				
Number persons fishing				
Time spent fishing (decimal hours)				
Boat / Shore				
Number of lines used				
Spearfishing (Y/N)				
Intended use (E/R/C)				
Block number				
Species targeted				
<b>Species 1</b>				
Total number kept				
Number released				
<b>Species 2</b>				
Total number kept				
Number released				
<b>Species 3</b>				
Total number kept				
Number released				
<b>Species 4</b>				
Total number kept				
Number released				
<b>Species 5</b>				
Total number kept				
Number released				
<b>Species 6</b>				
Total number kept				
Number released				
<b>Species 7</b>				
Total number kept				
Number released				
<b>Species 8</b>				
Total number kept				
Number released				
<b>Species 9</b>				
Total number kept				
Number released				

## Appendix B Catch and effort calculations for recreational boats

### Estimation of total effort

The fishing effort (days) was estimated by the roving creel survey method (Pollock *et al.*, 1994) as follows:

$$e = IT \quad (1)$$

where  $I$  is the count of boats and  $T=1$  day is the length of the shift. The estimated variance is (Pollock *et al.*, 1994)

$$s^2 = \frac{1}{n-1} \sum_{m=1}^{n_k} (e_m - \bar{e})^2 \quad (2)$$

where  $n$  is the sample size (days),  $e_m$  the effort on day  $m$  and  $\bar{e}$  the mean daily fishing effort. The variance associated with the estimate of the mean, with finite population correction (Neter *et al.*, 1988), was calculated as

$$Var(\bar{e}) = \frac{s^2}{n} \left( \frac{N-n}{N} \right) \quad (3)$$

where  $N$  is the total number of days. The total effort was estimated as

$$\hat{E} = \frac{N}{n} \sum_{m=1}^{n_k} e_m \quad (4)$$

The variance associated with  $\hat{E}$  was estimated by

$$Var(\hat{E}) = N^2 Var(\bar{e}) \quad (5)$$

The standard error was calculated by the usual method

$$SE(\hat{E}) = \sqrt{Var(\hat{E})} \quad (6)$$

### Estimation of total catch

Since the catch was recorded at the end of the day the probability of sampling a boat was independent of trip length. The catch rate was estimated by (Crone and Malvestuto, 1991)

$$\hat{R} = \frac{\bar{c}}{\bar{L}} = \frac{\sum_{j=1}^{n_k} c_j / n}{\sum_{j=1}^{n_k} L_j / n} \quad (7)$$

where  $n$  is the number of boats where the catch was recorded,  $c_j$  the catch for boat  $j$  and  $L_j$  the effort, in days, for boat  $j$ . The variances for  $\bar{c}$  and  $\bar{L}$  were calculated by the usual method (see (2) and (3) without the finite population correction factor). The variance for  $\hat{R}$  was estimated using the formulae described in Kendall and Stuart (1969)

$$Var(\hat{R}) \approx \hat{R}^2 \left( \frac{Var(\bar{c})}{\bar{c}^2} + \frac{Var(\bar{L})}{\bar{L}^2} - \frac{2Cov(\bar{c}, \bar{L})}{\bar{c}\bar{L}} \right) \quad (8)$$

The covariance term was assumed to be zero.

The total catch was estimated as

$$\hat{C} = \hat{E} \hat{R} \quad (9)$$

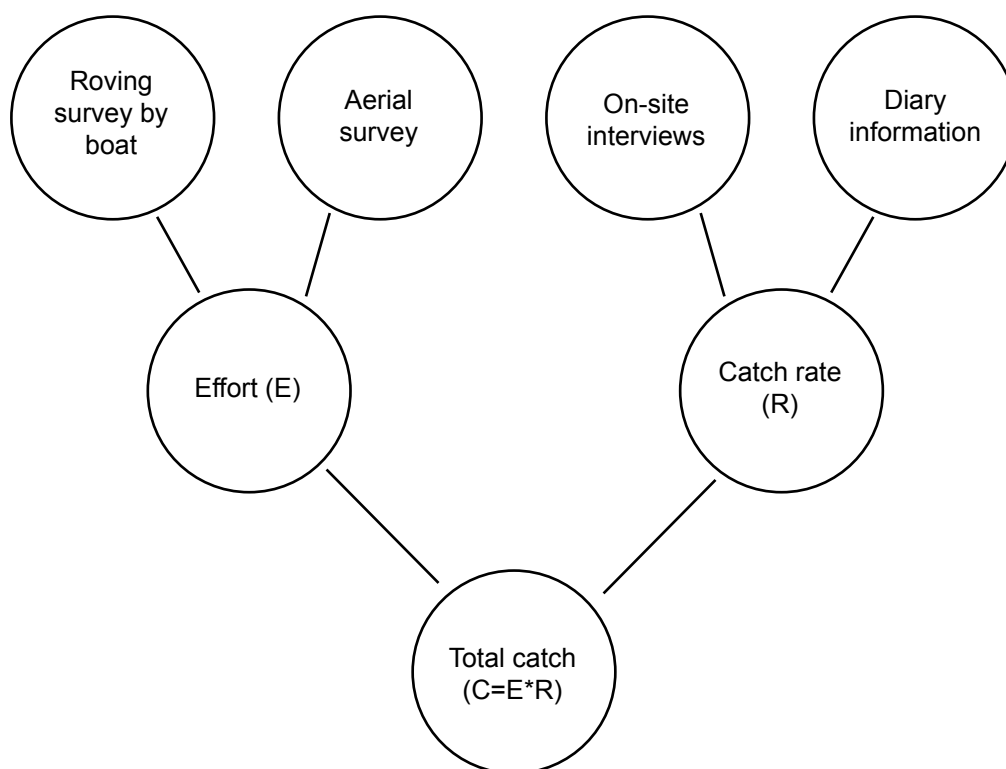
The variance was estimated using the formulae described in Kendall and Stuart (1969)

$$Var(\hat{C}) \approx \hat{C}^2 \left( \frac{Var(\hat{E})}{\hat{E}^2} + \frac{Var(\hat{R})}{\hat{R}^2} + \frac{2Cov(\hat{E}, \hat{R})}{\hat{E}\hat{R}} \right) \quad (10)$$

The standard error of  $\hat{C}$  was calculated by the usual method

$$SE(\hat{C}) = \sqrt{Var(\hat{C})} \quad (11)$$

## Appendix C Schematic representation of catch and fishing effort calculations for recreational boats



## Appendix D – Length-weight relationships used to estimate weight of catch

Common name	Length-weight relationship	Source for length-weight relationship
Dhufish	$W=0.0000483L^{2.837}$ Fem: $W=0.0000417L^{2.859}$ Male: $W=0.0000322L^{2.898}$	Hesp <i>et al.</i> , 2002
Pink snapper	$W=0.0467727((L-0.7)/11.79)^{2.781}$	Moran & Burton, 1990
Baldchin groper	$W=0.012132(L/10)^{3.15867}$	Nardi <i>et al.</i> , 2006
Sweetlip emperor	$\log W=18.2500+3.06507x\log FL$ $TL = 3.2 + 1.0732FL$	Leigh <i>et al.</i> , 2006
Sweetlip emperor (Tour operators)	$W=0.0000512L^{2.84}$	Moran <i>et al.</i> , 1988
Spangled emperor	$W=0.000065FL^{2.78}$ $FL=0.312+0.89TL$	Grandcourt, 1999
Spangled emperor (Tour operators)	$W=0.0173(L/10)^{3.01}$	Carpenter and Allen, 1989
Chinaman cod	$W=1.04x10^{-5}FL^{3.04}$	Mackie, 2000
Skipjack trevally	$\ln W=2.992\ln L-11.331$	Farmer <i>et al.</i> , 2005
Coral trout	$W=0.0079(FL/10)^{3.157}$ , $FL\sim 0.97TL$	Ferreira & Russ, 1993
Breaksea cod	$W=33.938e^{0.0085L}$	Eastman, 2001

Note: W is weight in g; L is total length in mm; FL is fork length in mm;



## Appendix E - Catch and effort calculations for commercial rock lobster fishers

### Estimation of total effort

The fishing effort (days) was estimated by a direct expansion as follows:

$$\hat{E} = \frac{DNF}{B} \quad (1)$$

where  $D$  is the number of days in rock lobster season,  $N$  the number of commercial rock lobster fishers during 2006,  $F$  the total number of camps that participated in fishing (separate analysis for angling and fishing for rock lobster) and  $B$  the total number of camps interviewed. The estimated proportion of camps that participated is

$$p = \frac{F}{B} \quad (2)$$

with variance from the binomial distribution (Neter *et al.*, 1988)

$$s^2 = \frac{p(1-p)}{B} \quad (3)$$

The variance associated with  $\hat{E}$  is estimated by

$$\text{Var}(\hat{E}) = (DN)^2 s^2 \quad (4)$$

The standard error was calculated by the usual method

$$SE(\hat{E}) = \sqrt{\text{Var}(\hat{E})} \quad (5)$$

### Estimation of total catch

Since the catch was recorded at the end of the day the probability of sampling a camp was independent of trip length. The catch rate was estimated by (Crone and Malvestuto, 1991)

$$\hat{R} = \frac{\bar{c}}{\bar{L}} = \frac{\sum_{j=1}^{n_k} c_j / n}{\sum_{j=1}^{n_k} L_j / n} \quad (6)$$

where  $n$  is the number of camps where the catch was recorded,  $c_j$  the catch for camp  $j$  and  $L_j$  the effort, in days, for camp  $j$ . The variances for  $\bar{c}$  and  $\bar{L}$  were calculated by the usual method (see

(2) and (3) in Appendix B without the finite population correction factor). The variance for  $\hat{R}$  was estimated using the formulae described in Kendall and Stuart (1969)

$$Var(\hat{R}) \approx \hat{R}^2 \left( \frac{Var(\bar{c})}{\bar{c}^2} + \frac{Var(\bar{L})}{\bar{L}^2} - \frac{2Cov(\bar{c}, \bar{L})}{\bar{c}\bar{L}} \right) \quad (7)$$

The covariance term was assumed to be zero.

The total catch was estimated as

$$\hat{C} = \hat{E} \hat{R} \quad (8)$$

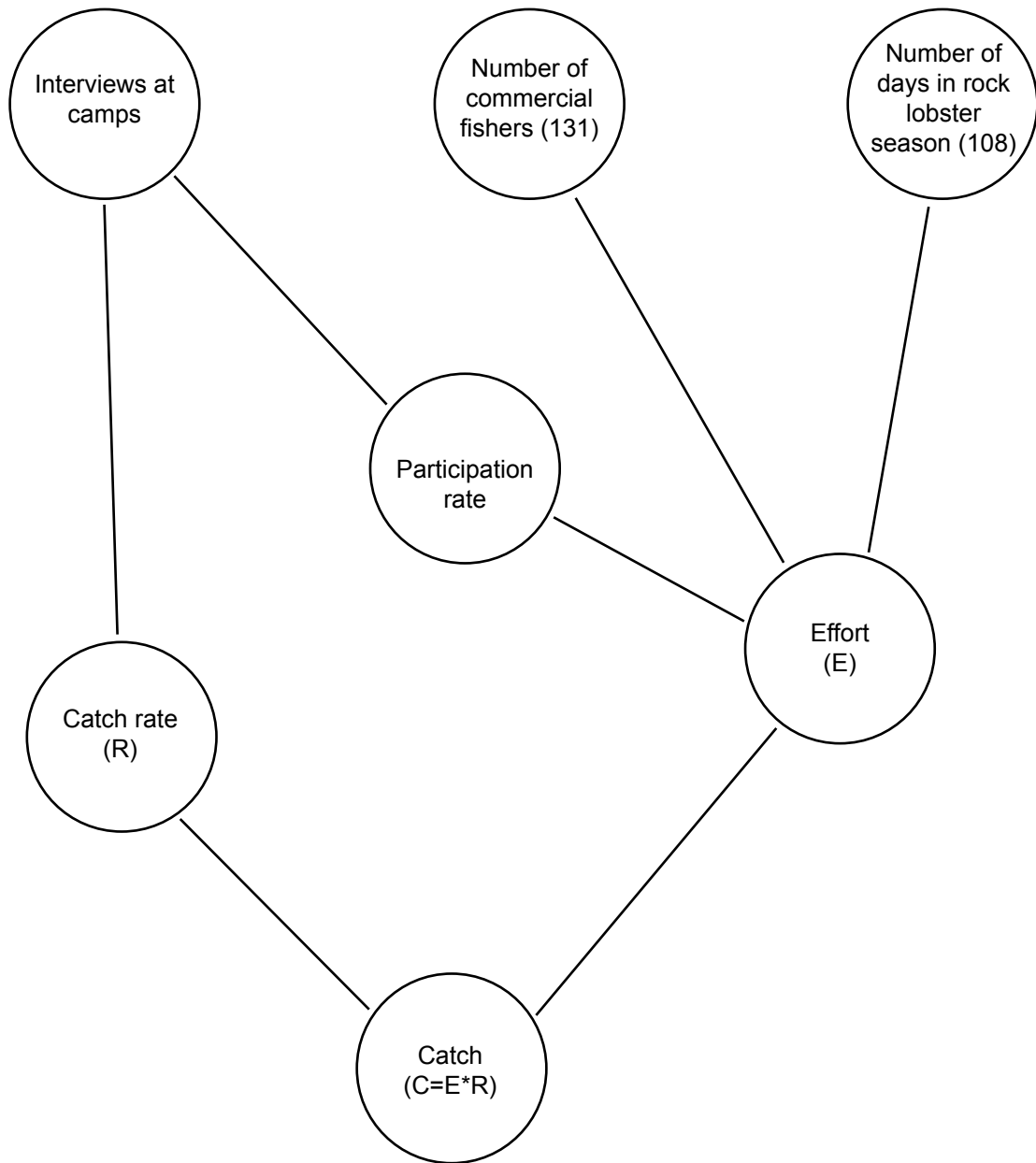
The variance was estimated using the formulae described in Kendall and Stuart (1969)

$$Var(\hat{C}) \approx \hat{C}^2 \left( \frac{Var(\hat{E})}{\hat{E}^2} + \frac{Var(\hat{R})}{\hat{R}^2} + \frac{2Cov(\hat{E}, \hat{R})}{\hat{E}\hat{R}} \right) \quad (9)$$

The standard error of  $\hat{C}$  was calculated by the usual method

$$SE(\hat{C}) = \sqrt{Var(\hat{C})} \quad (10)$$

**Appendix F – Schematic representation of catch and fishing effort calculations for commercial rock lobster fishers**

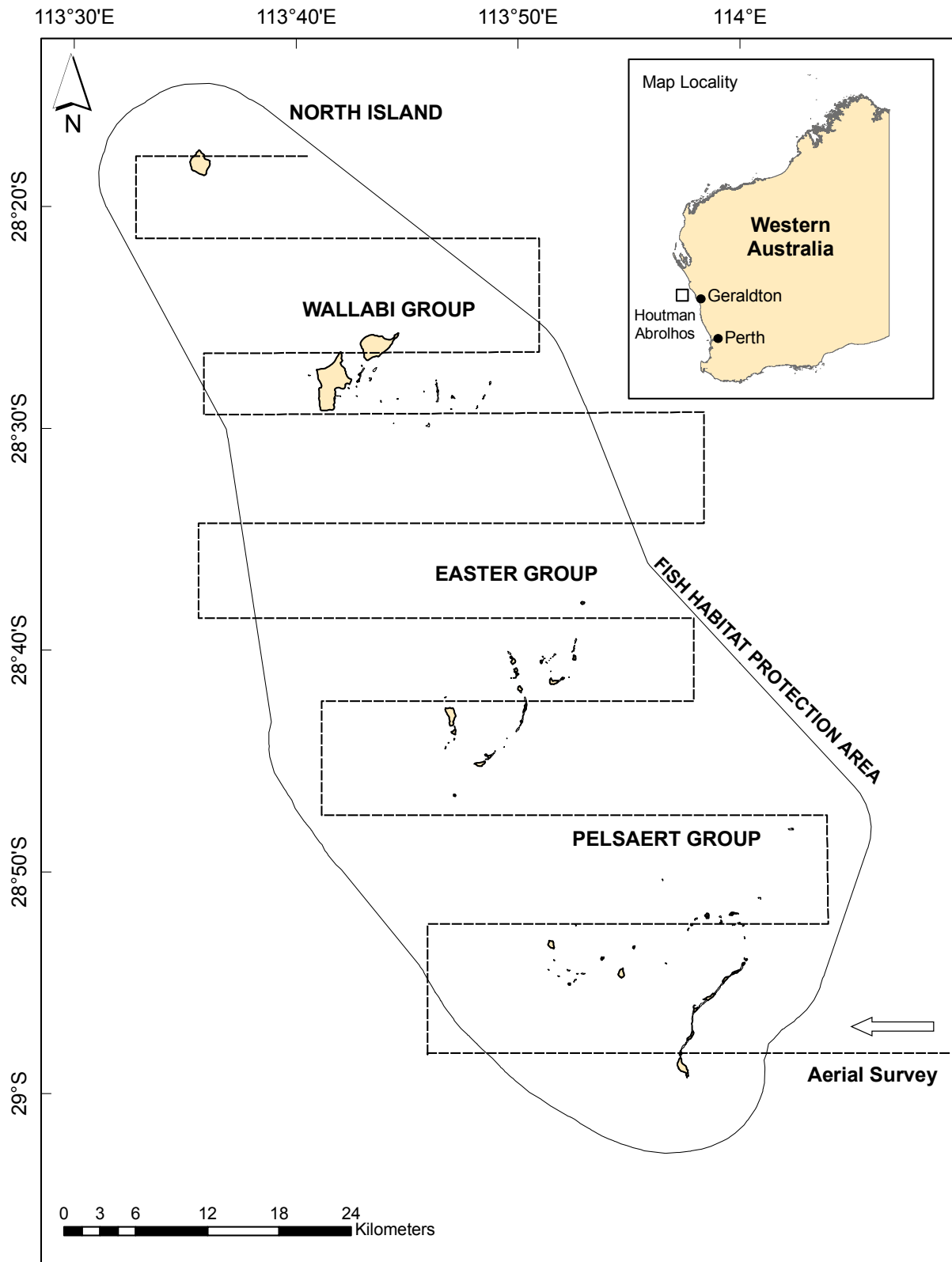


## Appendix G – Species kept by recreational fishers

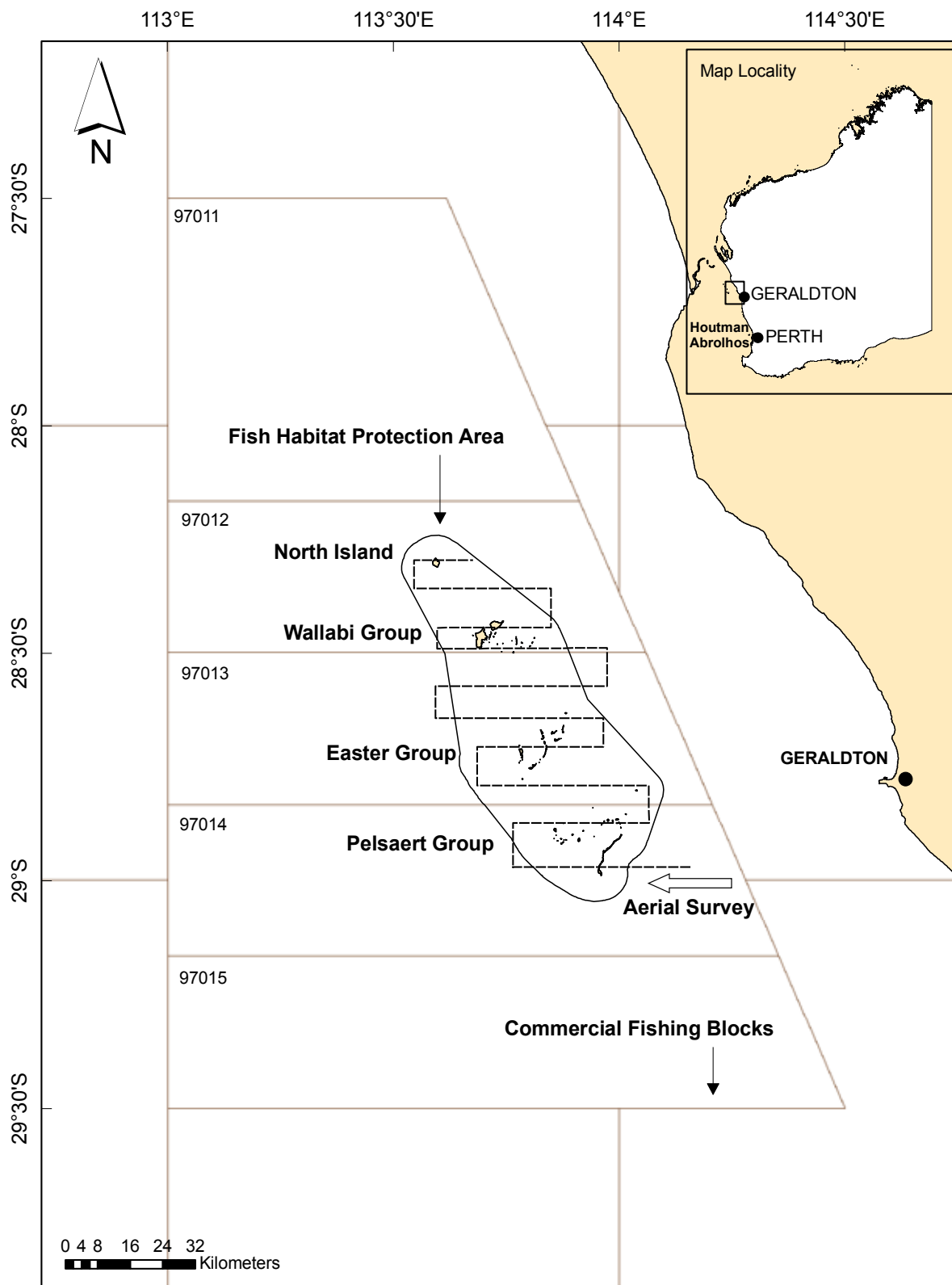
Common name	Scientific name
Groper, Baldchin	<i>Choerodon rubescens</i>
Snapper, Pink	<i>Pagrus auratus</i>
Dhufish, Western Australian	<i>Glaucosoma hebraicum</i>
Trout, Coral	<i>Plectropomus leopardus</i>
Emperor, Spangled	<i>Lethrinus nebulosus</i>
Emperor, Sweetlip (Red Throat)	<i>Lethrinus miniatus</i>
Cod, Chinaman	<i>Epinephelus rivulatus</i>
Blowfish, Common	<i>Torquigener pleurogramma</i>
Squids, general	Family - Cephalopodidae
Rock Lobster, Western	<i>Panulirus cygnus</i>
Parrotfish, General	Family - Scaridae
Mackerel, Narrow-Barred Spanish	<i>Scomberomorus commerson</i>
Wrasse/Groper, general	Family - Labridae
Eels, General	Family Muraenidae
Wrasse, Western King	<i>Coris auricularis</i>
Sweetlips, general	Family - Haemulidae
Cod, Breaksea (Black-arse Cod)	<i>Epinephelides armatus</i>
Trevally, Skipjack/Silver	<i>Pseudocaranx</i> spp.
Wrasse, Brown-Spotted	<i>Notolabrus parilus</i>
Herring, Australian	<i>Arripus georgianus</i>
Sergeant Baker	<i>Aulopus purpurissatus</i>
Emperor, Red	<i>Lutjanus sebae</i>
Tuna, Yellowfin	<i>Thunnus albacares</i>
Mackerel, Australian Spotted	<i>Scomber munroi</i>
Mackerel, Shark	<i>Grammatorcynus bicarinatus</i>
Bream, Silver (Tarwhine)	<i>Rhabdosargus sarba</i>
Tailor	<i>Pomatomus saltatrix</i>
Mackerel, Blue	<i>Scomberomorus australasicus</i>
Sweetlips, Painted	<i>Diagramma labiosum</i>
Butterfish, Western	<i>Pentapodus vitta</i>
Snapper, Queen (Blue Morwong)	<i>Nemadactylus valenciennesi</i>
Cod, Flowery	<i>Epinephelus fuscoguttatus</i>
Cuttlefish	<i>Sepia</i> spp.

## Appendix H – Species kept by tour operators

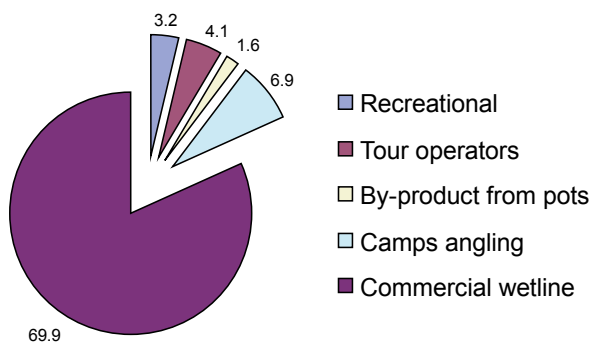
Common name	Scientific name
Emperor, Sweetlip (Red Throat)	<i>Lethrinus miniatus</i>
Snapper, Pink	<i>Pagrus auratus</i>
Groper, Baldchin	<i>Choerodon rubescens</i>
Dhufish, Western Australian	<i>Glaucosoma hebraicum</i>
Emperor, Spangled	<i>Lethrinus nebulosus</i>
Wrasse/Groper, general	Family - Labridae
Cod, Chinaman	<i>Epinephelus rivulatus</i>
Emperor, general	<i>Lethrinus</i> spp.
Trout, Coral	<i>Plectropomus leopardus</i>
Cod, Breaksea (Black-arse Cod)	<i>Epinephelides armatus</i>
Mackerel, Narrow-Barred Spanish	<i>Scomberomorus commerson</i>
Sweetlips, Painted	<i>Diagramma labiosum</i>
Sweetlips, general	Family - Haemulidae
Trevally, Skipjack/Silver	<i>Pseudocaranx</i> spp.
Tuna, Yellowfin	<i>Thunnus albacares</i>
Trout, Coronation	<i>Variola louti</i>
Emperor, Blue-lined	<i>Lethrinus laticaudis</i>
Shark, general	Family - Carcharhinidae
Groper, Western blue	<i>Achoerodus gouldii</i>
Trevally, general	Family - Carangidae
Emperor, Red	<i>Lutjanus sebae</i>
Foxfish, Western	<i>Bodianus frenchii</i>
Rockcod, tomato	<i>Cephalopholis sonnerati</i>
Mackerel, Shark	<i>Grammatorcynus bicarinatus</i>
Cods, general	Family - Serranidae
Bonito, general	Family - Scombridae
Snappers/Bream, general	Family - Sparidae
Mackerel, Australian Spotted	<i>Scomberomorus munroi</i>
Mulloway	<i>Argyrosomus hololepidotus</i>
Samson Fish	<i>Seriola hippos</i>
Goatfish, general	Family - Mullidae
Shark, Black-tip reef	<i>Carcharhinus melanopterus</i>
Shark, Sandbar	<i>Carcharhinus plumbeus</i>
Tuna, skipjack	<i>Katsuwonis pelamis</i>
Amberjack	<i>Seriola dumerili</i>
Seabream, Robinson's	<i>Gymnocranius grandoculus</i>
Shark, bronze whaler	<i>Carcharhinus brachyurus</i>
Shark, Whiskery	<i>Furgaleus ventralis</i>
Rockcod, Rankin's	<i>Epinephelus multinotatus</i>
Jobfish, Rosy	<i>Pristipomoides filamentosus</i>
Tuskfish, Blackspot	<i>Choerodon schoenleinii</i>
Bream, Silver (Tarwhine)	<i>Rhabdosargus sarba</i>
Seapearch, Stripey	<i>Lutjanus carponotatus</i>
Sweetlips, Gold-spotted	<i>Plectorhinchus flavomaculatus</i>
Sweep, Sea	<i>Scorpius aequipinnis</i>
Shark, School	<i>Galeorhinus australis</i>
Sergeant Baker	<i>Aulopus purpurissatus</i>
Fusiliers, Jobfishes	
Mackerels, general	Family - Scombridae
Squids, general	Family - Cephalopodidae
Tuna, southern bluefin	<i>Thunnus maccoyii</i>
Octopus, general	<i>Octopus</i> spp.



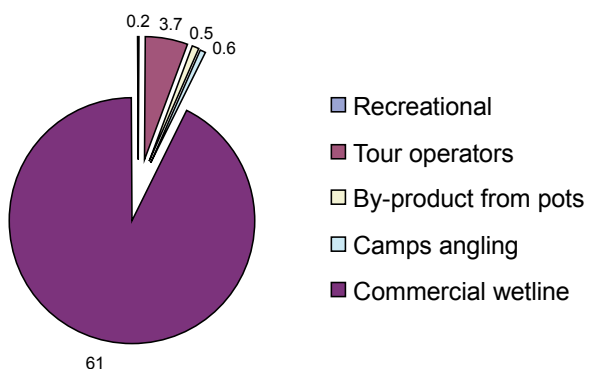
**Figure 1.** Houtman Abrolhos Islands fish habitat protection area with flight path for aerial survey.



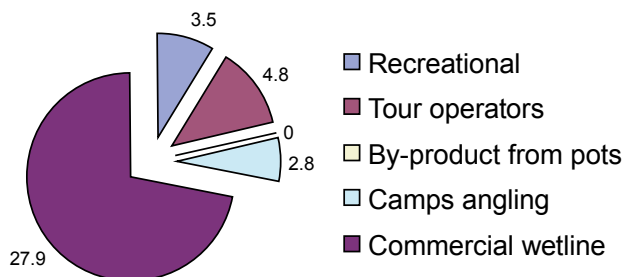
**Figure 2.** Houtman Abrolhos Islands fish habitat protection area with commercial fishing blocks and flight path for aerial survey.



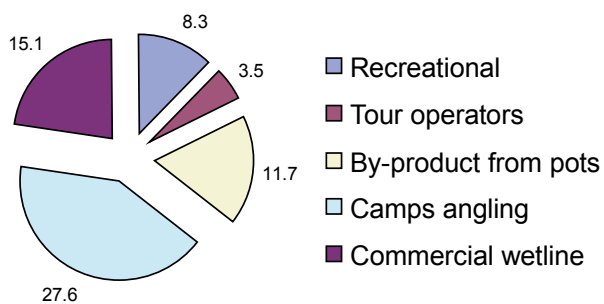
**Figure 3.** Catch of pink snapper (85.7 tonnes)



**Figure 4.** Catch of sweetlip emperor (66.0 tonnes)



**Figure 5.** Catch of Western Australian dhufish (39.0 tonnes)



**Figure 6.** Catch of baldchin groper (66.2 tonnes)