TRAWLING FOR SCIENCE AND SUSTAINABLE FISHERIES

Scientists from the Department of Fisheries and WA Museum have completed a three-year biodiversity survey in Shark Bay and the Exmouth Gulf, using the RV *Naturaliste* to undertake an extensive trawling program. Their findings have shown little difference in species abundance and biodiversity between trawled and untrawled areas, shedding new light on the relationship between fishing effort and the abundance of bycatch species. Marcia van Zeller reports:

Testing their "sea legs" in strong swells and working through ink-black nights, a small team of scientists and crew aboard the RV *Naturaliste* has physically handled some 412,000 marine fish representing over 374 different species, approximately 180,000 marine invertebrates representing over 400 species and a small number of marine reptiles. This high diversity of species exists even though trawling within Shark Bay and Exmouth Gulf has been undertaken for more than 30 years.

Their huge catch, taken during research sampling over the past three years, is providing valuable data on the diversity and abundance of bycatch species in trawled and untrawled areas of the Shark Bay scallop and prawn and the Exmouth Gulf and Onslow prawn fisheries.

This $670,000 project, which was supported by industry, is a collaboration between the Department of Fisheries Western Australia, the Western Australian Museum and funded by the Fisheries Research Development Corporation (FRDC).

The project leaders are principal investigator Dr Mervi Kangas from the Department of Fisheries and co-investigator Sue Morrison from the Western Australian Museum. Phil Unsworth from Fisheries is providing technical support for the project.

The fieldwork began in Shark Bay during October 2002. The target areas identified were 26 sites throughout the bay, of which 17 were trawled and nine were untrawled (Figure 1). The *Naturaliste* crew and research staff conducted three trawls of 10 minutes each per site when possible, and they counted and identified the total target species (prawns and scallops) and bycatch hauled up in the nets. Standard trawl nets without bycatch reduction devices were used to assess the bycatch abundance.

'Handle with caution'

There was no shortcut to the task of sorting, counting and recording the data for around 600,000 animals. Every animal had to be individually handled – sometimes at the peril of the research team.

"All of us received stings and cuts from

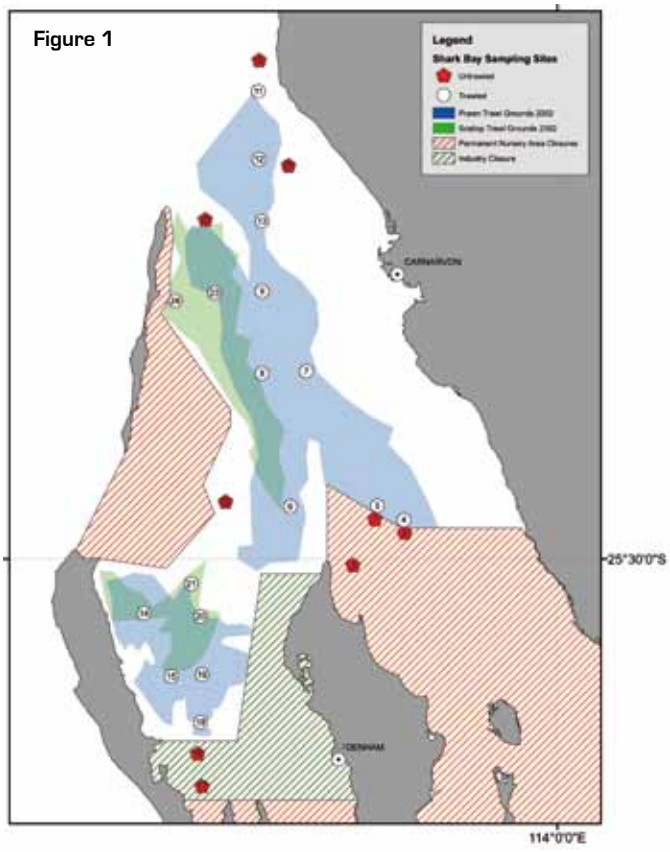
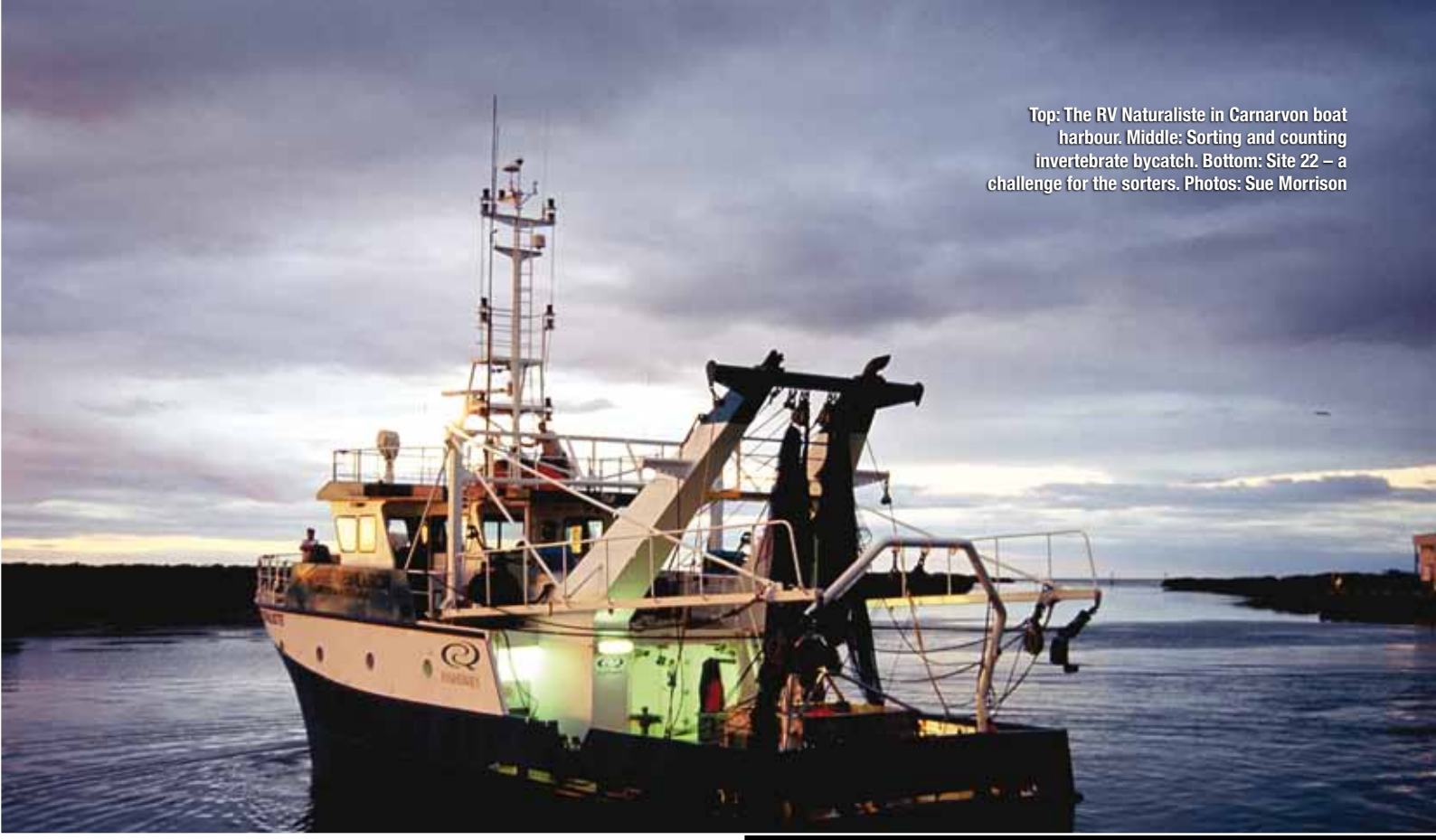


Figure 1



Top: The RV Naturaliste in Carnarvon boat harbour. Middle: Sorting and counting invertebrate bycatch. Bottom: Site 22 – a challenge for the sorters. Photos: Sue Morrison

spiny fish, and we encountered large rays, sea snakes and other species that needed to be handled with extreme caution," said Sue Morrison.

Crew and scientists worked on deck together, spreading their catch on sampling tables, sorting species into buckets, bagging and freezing selected specimens for further analysis, and to lodge in the Museum Aquatic Zoology collections.

"Some of the species captured had never been sampled from these areas before and are therefore of great interest to marine scientists at the Museum," said Sue. "The project helped us increase our knowledge of the fauna of the region."

Project aims

The project's aim is to provide baseline data on and off the trawl grounds; to allow for an assessment of the effects of trawling on the biodiversity of the bycatch (non-target species); and to establish reference sites for long-term monitoring of the impact of trawling. These objectives include a comparison of the abundance and biodiversity of bycatch species at different times of year – particularly at the start, middle and end of the trawling season. The project ran for 12 months in Shark Bay between October 2002 and October 2003, and then moved up to Exmouth Gulf where further trawls took place in March, July and November of 2004.

This work was undertaken with the recognition that these trawl fisheries are closely managed, unlike most trawl fisheries elsewhere in the world. In Shark Bay and Exmouth Gulf, the trawl grounds are predominantly mud and sand habitats and in both areas, extensive permanent trawl closures are in place with a series of temporary closures to regulate the size and quantity of prawns taken. This management measure facilitates reduced trawling effort in areas.

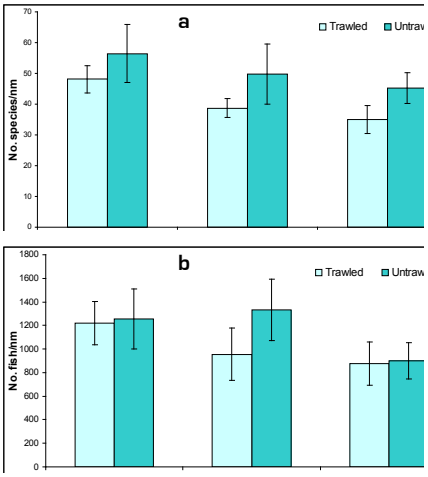
Fishing boats are also required to reduce overall impact on bycatch species through the use of bycatch reduction devices including grids and secondary devices (square mesh panels in nets to reduce fish bycatch). In addition, in Exmouth Gulf, most boats have installed "hoppers" – in-water sorting systems which provide an improved quality of prawns and reduce mortality for some bycatch species.

The diversity of fish (number of species) caught in Shark Bay at the beginning of the trawl season in February 2003 (around 185 species) exceeded the diversity caught at the end of the season in September 2003

(around 160 species). This result occurred in both trawled and untrawled sites and was a pattern also seen in the Exmouth and Onslow prawn fisheries (Figure 2).

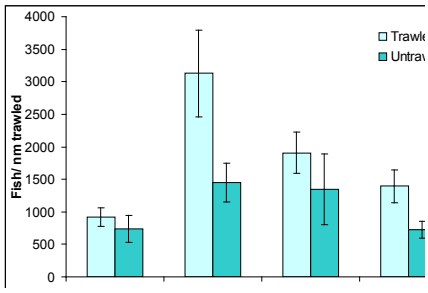
The overall number of species of fish in Exmouth and Onslow (around 300 species) was higher than that observed in Shark Bay (around 241 species). This trend is likely to be the result of the more tropical influence in the areas further north. For fish, preliminary statistical analyses do not show any significant differences in diversity or abundance between trawled and untrawled sites in the Exmouth Gulf. There are several other factors besides trawling that are likely to affect fish abundance and diversity during the year, particularly seasonal variation in breeding cycles and migration. Size and mobility of some of the more abundant species were examined, to help interpret these results.

Figure 2 Seasonal species diversity (a) and abundance (b) in Exmouth trawled and untrawled areas (nm = nautical mile)



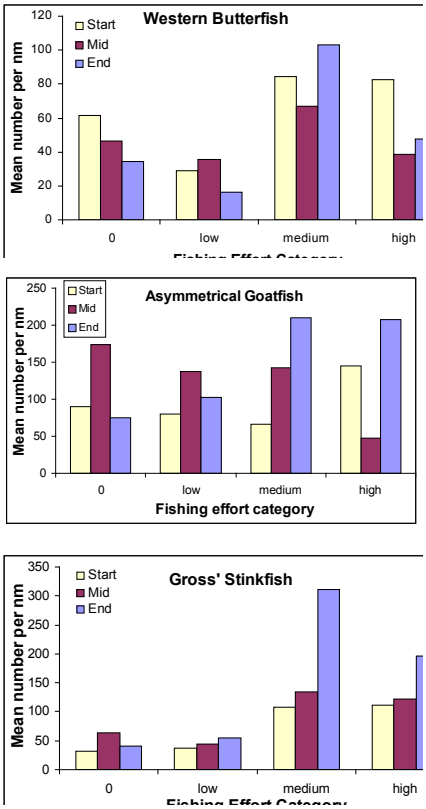
Interestingly, in Exmouth Gulf, slightly higher numbers were observed in untrawled sites compared to trawled sites; whereas in Shark Bay, the abundance of fish (number of individuals per nautical mile) was higher in trawled sites compared to untrawled sites (Figure 3). At the start of the season in 2003, the high numbers in trawled areas were primarily attributed to a high abundance of trumpeters and threadfin emperor at one trawl site in particular.

Figure 3 Seasonal fish abundance in Shark Bay in trawled and untrawled areas



Additional results include latitudinal differences in the communities and number of fish species seen in Shark Bay. In the Eastern Gulf and Northern Shark Bay, the numbers of individual fish and numbers of species recorded were generally higher on the trawl grounds compared with adjacent untrawled areas. The larger populations in trawled areas were mainly due to five to 10 fish species (such as lizardfish, leatherjackets, bullrouts and goatfish). Some species appear to prefer trawled habitats and consequently become more abundant in these areas with increased trawling activity (see Figure 4). This phenomenon suggests that trawling activity creates habitat conditions which are favourable to some species.

Figure 4 Seasonal abundance in asymmetrical goatfish, western butterfish and stinkfish in areas of low, medium and high fishing effort areas



However, in Denham Sound, the number of species and total number of fish were higher in the untrawled areas compared with adjacent trawl grounds. Overall this region had fewer fish species compared with other parts of Shark Bay.

Invertebrate species assemblages were also grouped into latitudinal or east-west areas related to the environmental gradients found in the bay (Figure 5).


Sorting fish bycatch species.

Sand dollar: a valuable find for museum

The trawl survey not only shed light on biodiversity – it also harvested some species of value to the WA Museum. Sue Morrison describes one of the more significant finds:

This spectacular sand dollar, *Clypeaster latissimus*, is a species of flattened sea urchin. This specimen was collected during the biodiversity surveys in Exmouth Gulf, from trawl grounds just south of Exmouth in 15 metres of water. Although the species is not uncommon, it is infrequently seen as it inhabits areas of soft sediment and is often buried just below the surface.

In Australia it only occurs between Shark Bay and Port Hedland, preferring muddy sand habitats between 25 and 56 metres depth. It also occurs in Indonesia and Vietnam.

At a maximum of 235mm in length, this species of sand dollar is the largest in its genus. It is an important addition to the Western Australian Museum collection, since few have been collected and due to their fragile nature they are rarely in such good condition.

This specimen is now registered in the Aquatic Zoology marine invertebrate section, and will be stored permanently for future reference and research.

The study also shed light on the comparative impact of trawling on invertebrates. It is reasonable to expect that stock levels of less mobile species, such as sea cucumbers, commensal crabs and small gastropod molluscs are likely to decrease in trawled areas. The effects of trawling on invertebrates such as soft corals and sponges, which are permanently attached to the seabed, will be greater still.
In Exmouth Gulf for invertebrates, the crabs and prawns dominate in numbers at any site and generally there are more crabs and prawns on trawl sites compared to untrawled sites and both groups show a decline in abundance during the season (Figure 6). For other invertebrate groups, such as sedentary animals such as sponges, soft corals and ascidians (sea squirts) and less mobile groups such as echinoderms (including sea stars, sea urchins and sea cucumbers) they occur in slightly higher numbers at untrawled sites (Figure 7 a,b).

Figure 6 Abundance of all prawn species in trawled and untrawled areas in Exmouth Gulf during the start, middle and end of the fishing season in 2004.

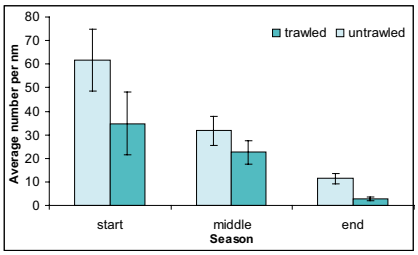
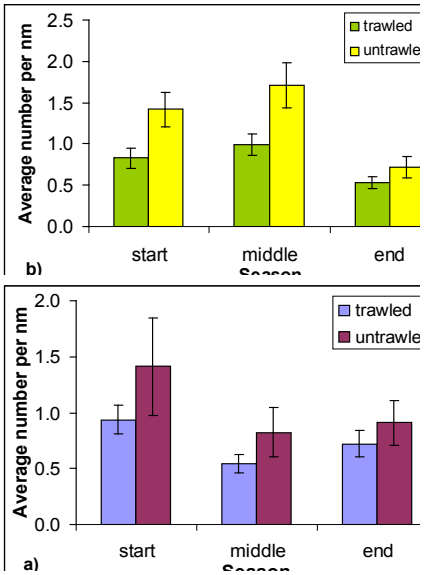


Figure 7 Abundance of selected invertebrate groups in trawled and untrawled areas in Exmouth Gulf during the start, middle and end of the fishing season in 2004. a) Sedentary animals b) Echinoderms.



With the sampling phase now over, the task of full analysis of the data from the voyages is underway and detailed results will be reported in 2006.

"The baseline data gathered will provide a better basis for fishery management decisions, and return trips can be done every five to 10 years to provide comparative data over time," said Mervi Kangas.

"For selected common species, sizes were also measured. This information will give us a better understanding of the faunal composition, recruitment patterns and habitat preferences of bycatch species in trawled and untrawled areas.

"Overall, when all species are taken into account, there do not appear to be significant differences in biodiversity and stock numbers between trawled and untrawled areas. Some individual species show an increased abundance on trawled sites whereas a few show a higher abundance in untrawled sites," said Mervi Kangas.

"Given the varied impact on trawling amongst different species, the project results will assist in the understanding of the impact that trawling may have on bycatch species and in turn assist in developing management strategies to minimise this impact."

The labour-intensive nature of the work makes this type of project extremely expensive. These two fisheries were targeted in the first instance because of their high commercial and export value and the industry support for the research.

The research methodology has provided a model for possible further projects in other fisheries around the coast.

Mervi Kangas said that the voyages, which lasted from eight days to two weeks, were exhausting to all on board, but a sense of common purpose helped keep motivation levels high. "It was good to have a crew who understood the ethos of what we were doing and who worked as rigorously as the scientists did," said Mervi. ■

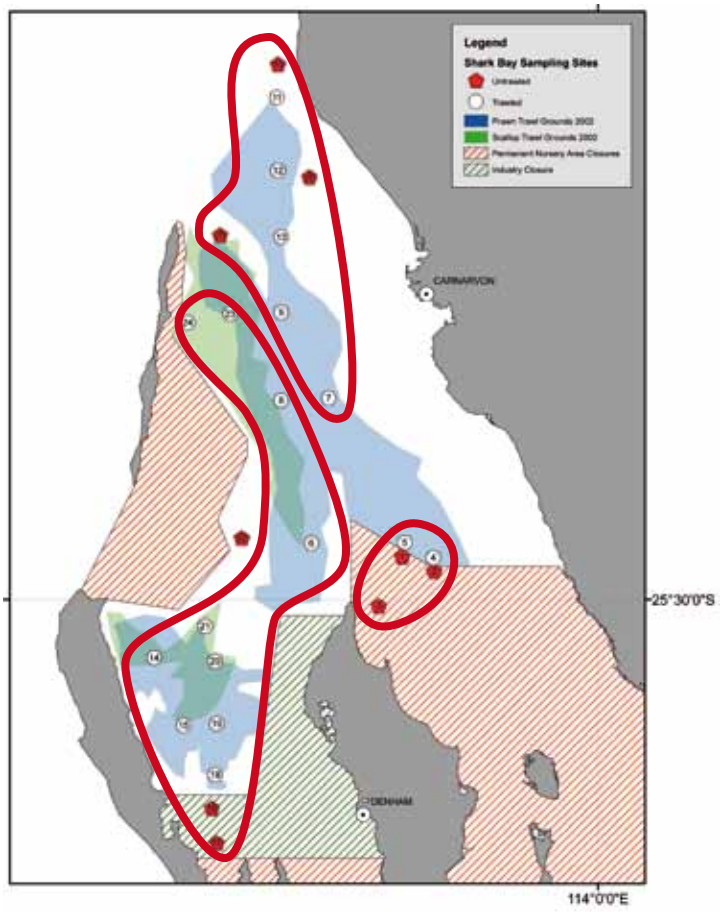


Figure 5 Similarities in invertebrate assemblages in Shark Bay (main areas where invertebrate species assemblages are similar: the eastern gulf, Denham Sound and the central and northern parts of Shark Bay)