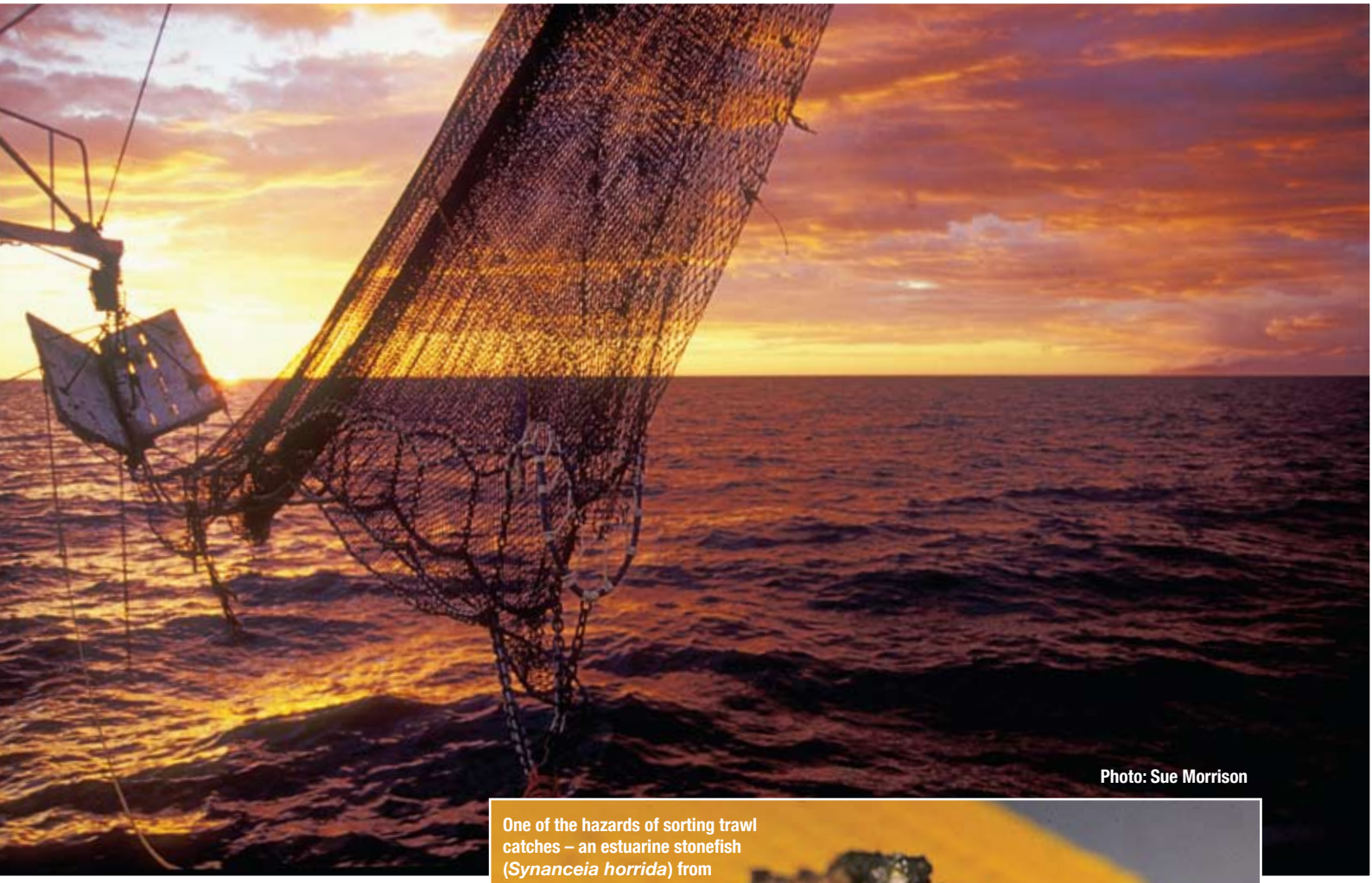


Photo: Sue Morrison

Checking the bottom of the bays

by Cathy Anderson

One of the most hotly debated fishing practices is trawling – sweeping nets across the seafloor to catch crustaceans, molluscs and bottom-dwelling fish such as flounder and flathead.

In Western Australia, the most valuable trawl fisheries (worth $30-40 million per annum) catch mainly tiger, king and endeavour prawns in both Shark Bay and Exmouth Gulf, and saucer scallops in Shark Bay. The fishing grounds are vast areas where, since the early 1960s, trawlers have fished the open sandy habitats preferred by these species.

With management came controls on the areas open to fishing and the amount of fishing allowed, but these controls have become more conservative in recent years.

One of the hazards of sorting trawl catches – an estuarine stonefish (*Synanceia horrida*) from Shark Bay. Photo: Phil Unsworth

Gradually, concern over habitat damage and protection of marine species has combined with improved industry economics and enlightened self-interest; new measures have minimised the effects of trawling on non-target species.

The national *Environment Protection and Biodiversity Conservation Act (1999)* requires Australia's export fisheries to be sustainable or risk losing their export licences and suffer consumer backlash – WA's trawl fisheries have to meet Ecologically Sustainable Development (ESD) targets, and the Shark Bay prawn and scallop fisheries exist within a World Heritage Area.

Researchers have built a strong relationship with the trawl industry to collect valuable research data. Funds collected from the fishers through the cost recovery system go towards scientific study and management, including the development of effective bycatch reduction devices (BRDs) that can drop bycatch rates between 20-75 per cent, with catches of some individual species being reduced by over 90 per cent.

The sheer size of these trawling grounds makes it logistically difficult to really find out what effects trawling has on its inhabitants. The high costs of this kind of research have limited earlier work, and the first comprehensive study of Shark Bay and Exmouth Gulf trawling was only funded in 2002. After three years of collecting data, the findings have just been published. The study was overseen by a committee with representatives from the prawn and scallop industry, and the Conservation Council of Western Australia.

Principal researchers Dr Mervi Kangas (Department of Fisheries) and Sue Morrison (WA Museum) assembled a team to amass and analyse the required data, to develop biodiversity and habitat monitoring measures for the trawl fisheries in Shark Bay, Exmouth Gulf and Onslow.

The study found that trawling does not represent such a serious threat to many of the species found on the trawl grounds, as previously thought. This is partly because many species also live in adjacent untrawled areas, and may repopulate trawl grounds after fishing. However, it is acknowledged that the marine communities were likely to have been different before trawling began in the early 1960s.

Trawling practices are now well-managed, but they do maintain an altered marine community. The study is of great significance because the huge quantity of information collected means scientists can compare and track future changes to improve their understanding of the dynamics of marine ecosystems in these regions.

"Industry and managers needed to have information to base any arguments on trawl impact on these habitats," Dr Kangas explained. "The Department's aim is to look at whole ecosystems when managing fisheries.

"The study provides a baseline for future research, but we're not trying to draw inferences about whole ecosystems and the way they work, rather, some selected species were examined in more detail.

"When people see 'biodiversity' in the report's title, they think it means biodiversity of everything in the area, but we were only examining what could be caught on sandy trawlable habitat with prawn trawl gear (that only catches certain types of animals). Our experiments simulated commercial fishing, so we used the same gear (without BRDs), went to the same locations, at the same seasons and times of night that they normally fish.

Costing over $1 million, provided by the industry and the Fisheries Research and Development Corporation, the report is a mighty collection (over 300 pages) of analysed data, with extensive lists of hundreds of species identified; maps and graphs showing seasonal abundance of various species at selected sites; and details of the trawling and sampling methods used.

Researchers maintained a tight focus – trying to allow for the complexity and natural changes, seasonal or otherwise, in the environment – but the study still produced data that took years to process. Museum taxonomist Dr Jane Fromont and her team are still working on the sponge collection from Exmouth Gulf, expected to raise the count of sponge species identified in the sampled areas to over 400.

Marking the spots

Researchers visited Shark Bay four times: at the trawling season's end in October/ November 2002, and then during 2003 at

Researchers quickly sort the catch into separate baskets for later study.

the beginning (Feb/Mar), middle (June/July) and end (Oct/Nov) of the season. They trawled at 26 sites on each visit, a mix of normally fished sites and adjacent untrawled areas. Only one year's sampling was completed in Exmouth Gulf and Onslow, at 25 mixed sites, following the same seasonal fishing pattern.

This data enabled them to look for effects of trawling across seasons in Shark Bay, and to compare fished and unfished areas; as well as comparing low, medium and high levels of trawling within trawled areas in Shark Bay, Exmouth Gulf and Onslow.

Years of logbook and catch returns kept by commercial prawn and scallop fishers, and data from regular Departmental stock surveys and satellite Vessel Monitoring System records were also available. This influenced their choice of sites, as they could identify where and when commercial trawling was done, and which key species appeared in the bycatch at various places.

Researchers wanted to see whether nearby similar habitats where trawling was not permitted could act as refuges, and allow animal and plant species to re-populate trawled areas.

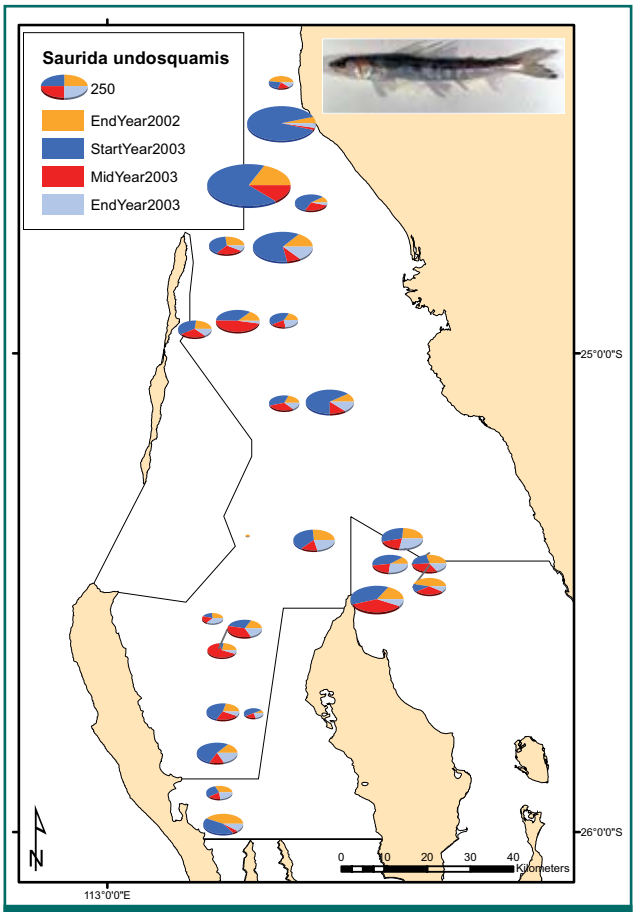
Sounds simple? Nothing in the constantly changing marine world is that easy; they couldn't do a balanced comparison between adjacent trawled and untrawled areas because in parts of Shark Bay, trawl grounds extend to the very edges of these trawlable areas.

"In Shark Bay, many untrawled areas contain seagrass meadows, and we didn't want to sample those because the assemblage is very different," Dr Kangas explained.

In recent years, only 20-40 per cent of the available fishery area has been regularly trawled, enabling some formerly trawled areas to be recolonised by benthic invertebrate organisms such as soft corals, gorgonian fans, sponges and ascidians.

"There are likely to have been changes over the years in the trawled areas due to the trawling, but we can't measure them in this study because the original habitats and fauna in some areas may be gone," Dr Kangas said.

Sue Morrison related anecdotal evidence from long-serving Museum staff of sponge and soft coral colonies which once existed on parts of the trawl grounds, but it is thought that some of these species may still be found in now-closed areas.



The lizardfish is a good candidate for an indicator species for Shark Bay as it is widespread and fairly abundant.

The sea beasties

Once a spectrum of sites was selected, the Department of Fisheries' research ship, the *RV Naturaliste*, began trawling. It was difficult work, mostly done at night, and – without BRDs on their nets – some large and potentially dangerous animals such as sharks, stingrays and sea snakes came thrashing out of the nets and had to be guided gently back into the sea.

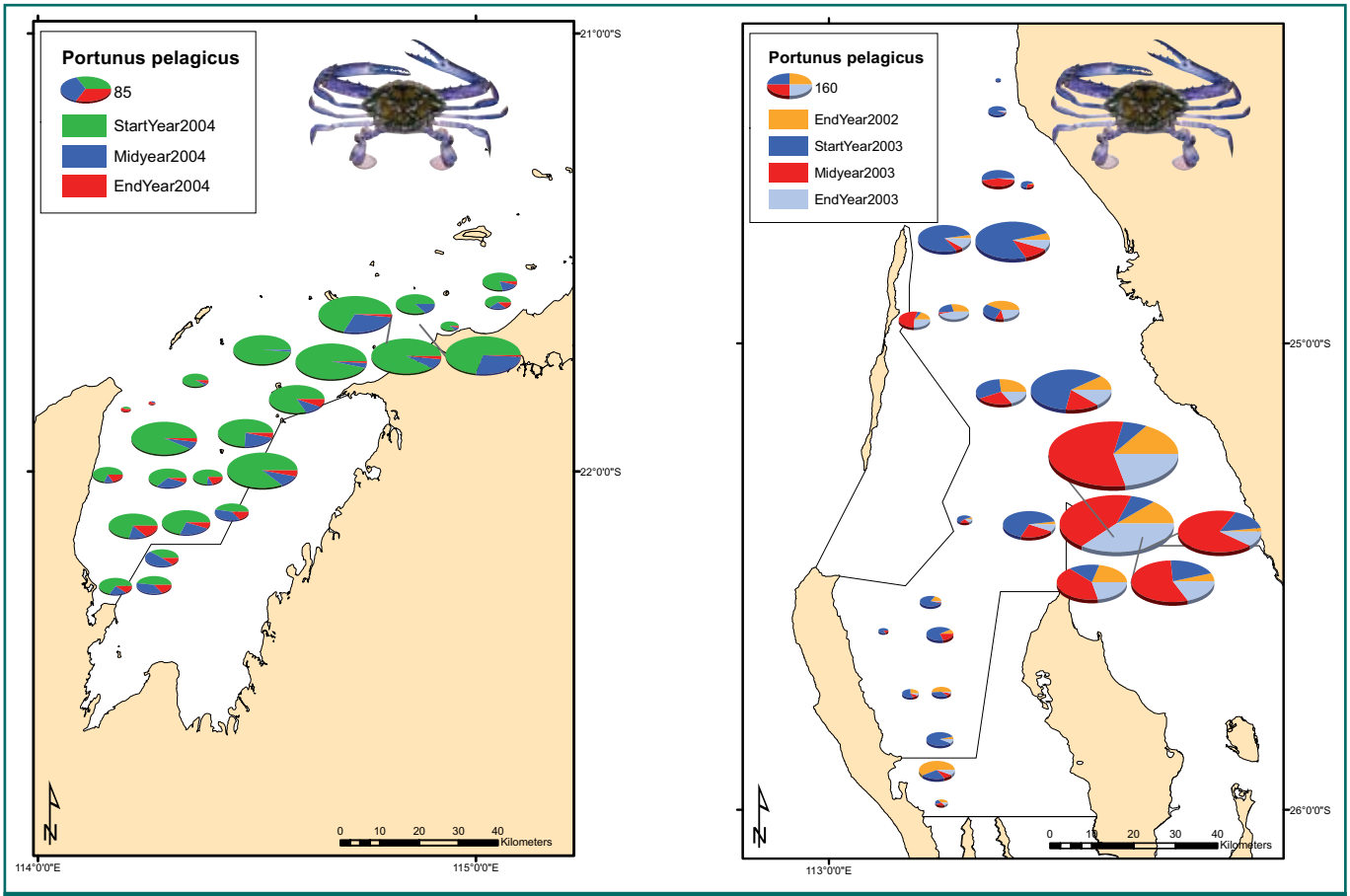
The catch had to be sorted, identified and counted; some fish, molluscs and crustaceans were sexed and measured; and voucher specimens retained for verifying identifications and lodging in the permanent WA Museum collections.

A major benefit of the study was gaining approximately 2,700 specimens for the Aquatic Zoology reference collection at the WA Museum. Staff identified species where possible while they sorted catches, but some species were new, some were almost identical and some could only be identified after microscopic examination.

"The sponges were especially difficult to identify; you can't tell just by looking at them, so samples had to be excised, bagged, labelled and frozen for examination later in the Museum laboratory," Sue Morrison said.

"During the survey, one of our biologists discovered that if you looked closely you could see a very faint yellow line

The feeding tentacles of this holothurian (*Cholochirus crassus*), common to Shark Bay, are visible on the left. Photo: Sue Morrison



These graphs show blue swimmer crabs are most abundant in Exmouth Gulf at the start of the fishing season, while those in Shark Bay (where they are much more numerous) vary in seasonal abundance at different locations.

that distinguished between two species of ponyfish, but it was barely visible while alive and disappeared once it was dead. Once dead, the species can only be separated by using a microscope and scientific key."

Photography played a crucial part in the recording; staff took pictures of species too large to collect and creatures that change in appearance once dead or preserved. Fish can change dramatically after death, losing most colours, and capturing this live appearance is a major benefit for taxonomists and scientific artists.

Each trawled site was rated for *richness* (the number of species found in the area trawled); *even-ness* (how many of each species, are the species in equal numbers, or are 10 or 20 quite abundant and the rest sparse, do they occur in clusters or are they widespread?); *abundance* (this can be expressed as a formula, the number of animals per species per distance trawled); and *diversity* (the combination of abundance and even-ness).

To their surprise, researchers found the biggest differences in species caught were between sites within each embayment, rather than between adjacent trawled and untrawled areas.

"I thought the difference between trawled and untrawled sites would be like chalk and cheese," Sue Morrison said, "but it wasn't like that at all. Differences were more subtle.

"You could pick out one or two species in every case where you could see a difference, but examination of all species together masked many of the subtle effects at the species level."

The biodiversity measures also responded differently, for example, in Exmouth Gulf, abundance was higher on trawl grounds whereas species richness was higher in untrawled areas.

"The fauna that are sessile (fixed to the substrate on the seabed), such as sponges, and of limited mobility, such as urchins, showed more impact from trawling because they are more easily caught and are slow to recolonise."

The scientists found a lot of species were in fairly low numbers everywhere because of the nature of the trawl habitat – open sandy areas with little shelter for plants and animals to hide in or attach to – and this is likely to be one of the reasons why the differences were subtle.

Indicators

One of the aims of the study was to survey the species at each site then select suitable indicator species – creatures whose populations might change in response to various stresses such as fishing or environmental variation. Knowing which species are vulnerable to trawling is essential for future monitoring of the fisheries; changes can prompt fisheries managers to adapt measures to protect the fishery and the environment.

The report notes that between 10 and 20 of the most abundant species at each site (and the catches varied considerably between sites) could be used as indicator species.

"The main target species – prawns and scallops – are the obvious ones but you need species that aren't too mobile and those that are widespread. You can't use aggregating or schooling species, as their numbers can vary hugely naturally," Dr Kangas said.

Key indicator species are divided into fishes and invertebrates. For example, the suggested fish list for Shark Bay is hair-finned leatherjacket, asymmetrical goatfish, large-scale lizardfish, bullrout, trumpeter, WA butterfish, threadfin emperor, purple tuskfish and yellow-striped goatfish. The invertebrates list is western king and brown tiger prawns, blue swimmer crab, saucer scallop, sea slugs, squid, two species of sea cucumber and a species of sea star.

However, the researchers agree that some indicator species should be less abundant creatures.

"A good example is the elasmobranchs, (sharks and rays) – big predators that are particularly susceptible to disturbances and fishing pressures because they are naturally in lower numbers and have a slow reproductive rate," Sue Morrison said.

Complicating the picture are the very mobile species, such as schools of fish and crabs, which benefit from trawling disturbance of the seabed because it exposes the organisms they eat. Dolphins and sharks also often follow trawlers to snap up the bycatch returned to the sea.

Stott's goatfish (*Upeneichthys stotti*) loses its brilliant colours after death and preservation so a photo is an essential record. Photo: Sue Morrison

The study included repeated trawling over the same trawl tracks over four nights to try to measure short-term trawl effects. Some species, such as prawns, scallops and sea urchins, declined (they were being efficiently caught by the gear) while others, such as crabs and some fishes, increased (coming into the area to feed).

"Some of the animals that love disturbed soft bottom are thriving" Sue Morrison said, "and some fish species actually increase in abundance on the trawl grounds by the end of the season."

"We did catch one unlucky stingray three nights in a row in Denham Sound during the repeated trawl study" Dr Kangas related, "so obviously some species have a preferred territory on the trawl grounds. For this ray, the area had scallops it likes to eat, but by the fourth night it must have decided it had had enough and moved on!"

The brevity of the study meant researchers couldn't make firm conclusions about annual variations in species (apart from prawns and scallops, which are well understood). However, they could make some general observations about the variation they found.

"There is a seasonal decline in abundance that picks up again by the start of the following year," Dr Kangas said. "We couldn't demonstrate this in Exmouth because we only studied over one year there, but anecdotal evidence from annual

Aboard the *RV Naturaliste*, skipper Theo Berden lent his net-repairing skills, and Dr Mervi Kangas sorted and labelled species at the identification station. Photos: Sue Morrison and Mark Maddern

prawn surveys indicates that it occurs there as well.

"Many of the animals we sampled were very productive because they are short-lived and can have high variability in abundance from year to year.

"Fish abundance in Shark Bay and invertebrate abundance in Exmouth Gulf was higher at the start of the fishing season with a decline during the year. Evidently, there is some effect with trawling depleting numbers of some species, and some species are likely to move around reducing numbers at a site, but there are likely to be other factors influencing the annual decline."

At the controls

Effective control of trawling with a range of measures (such as limiting the number of licences in the fishery, seasonal and spatial closures, and gear restrictions) protects the stocks of both target species and other species identified as at risk. For example, there is a closure in southern Denham Sound to protect pink snapper. It can also reduce the amount of monitoring needed, which is enormously expensive, because the fishing effort allowed is calculated to leave healthy breeding stocks.

Mandatory BRDs in nets (including grids to keep out large animals and mesh hatches that smaller fish can escape through) were introduced from 2003 onwards. Most trawlers now carry hoppers of seawater so unwanted animals can be kept alive and released with less handling to improve their survival.

Most of WA's waters are closed to trawling. There are closures of sensitive areas (often by consensus between Department of Fisheries managers and fishers) and areas where it is not economically viable for trawlers to work because the animals caught there are too small and of low value, weeds choke the nets, or the bottom is too rugged and damages gear. These closures give researchers some environmental contrast to work with.

"Most of the trawling is now in the middle of both Shark Bay and Exmouth Gulf embayments because fishers aim for larger, more valuable prawns," Dr Kangas said. "The original closures came in because we wanted to protect juvenile prawns but in later years much of the area has become a habitat-protection closure, because it is important to leave areas untrawled for other reasons than just protecting target species.

Sue Morrison showing the features of a herring to Maryann Evetts. Photo: Mark Maddern

"The trawling industry doesn't need to go into sensitive areas because the trawl grounds that have been established are productive enough. The fishery is managed in such a way that they get the full available catch (primarily an annual crop) from the existing trawl grounds.

"Over the years, the fishing effort has declined (by approximately 30 per cent in trawl hours since the mid-1980s) and the area trawled in these fisheries has contracted. Although fishers may have more impact on the areas they do trawl, they are leaving a lot more alone so there is more potential for recovery."

The course ahead

"When people ask me what the general results of the study are, I find it hard to summarise in a few sentences because it is so complex," Dr Kangas said.

The study concludes that it 'demonstrated variability in faunal abundance and diversity measures within and between sites but these could not be attributed to trawling.'

"We can say that trawling is not the key factor in differences between sites today," Dr Kangas confirmed. "It's extremely difficult to prove strong trawl impacts from our data."

Dr Kangas said having more sampling sites would have improved their ability to detect differences but there were time and dollar constraints. However, from here researchers can target their research more (perhaps concentrating on a particular area or species) and it gives good baseline information for future work.

The next step is to continue monitoring the overall extent of trawling in the regions, with future consideration of monitoring of selected sampling sites if appropriate.

Meanwhile, there are benefits to the community, industry and science from the study. Researchers conclude it will allow the Department to provide information to other government agencies; respond to queries from conservation and community groups; provide an inventory of current species caught by prawn trawlers in Shark Bay, Exmouth Gulf and Onslow; and give a 'useful insight into the high diversity of both fish and invertebrate species and the highly variable nature of faunal assemblages in these regions.' ■

You can view or download *Fisheries Research Report No. 160 Development of biodiversity and habitat monitoring systems for key trawl fisheries in Western Australia* at **www.fish.wa.gov.au**