Hoppers in Australian Trawl Fisheries

including Hoppers in Action CD video

A handbook for fishers

Australian Government
Fisheries Research and Development Corporation

OCEANWATCH
FOR THE FUTURE OF OUR MARINE ENVIRONMENT

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About Ocean Watch

Ocean Watch Australia Ltd is an environmental, non-profit organisation sponsored by the commercial seafood industry in New South Wales, Australia. Ocean Watch represents the environmental interests of industry and provides advice to the industry and government and educates the public on aspects of fisheries sustainability including environmental best practice as it relates to fishing, habitat protection/rehabilitation and water quality.

Postal address Ocean Watch Australia Ltd
Locked Bag 247
Pyrmont NSW 2009

Phone (02) 9660 2262

Internet address www.oceanwatch.org.au

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Prepared by Cassandra Rose and the Steering Committee (Anissa Lawrence and Christine Soul (Ocean Watch), Mervi Kangas (Department of Fisheries Western Australia), Neil Gribble (Department of Primary Industries Queensland), Denis Ballam (SeaNet Queensland), David Brewer (CSIRO Division of Marine Research Queensland) and Neil Carrick (South Australian Research and Development Institute).

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THE PURPOSE OF THIS HANDBOOK

This handbook aims to:

- detail the design, operation and use of hoppers (back deck water tanks/sorting devices) in trawl fisheries across Australia;
- enable the sharing of industry knowledge on hoppers among fishers from all Australian trawl fisheries;
- provide readily accessible information to fishers on the use and application of hoppers;
- facilitate the broader adoption among trawl fisheries of best practice use of hoppers. In fisheries where hoppers are not yet widely used but may be useful, help stimulate the development and uptake of new and suitable hopper designs; and
- provide a tool to inform and educate the general community, fisheries and environmental managers about the initiatives developed and adopted by Australian trawl fisheries to reduce the impacts of trawling on the aquatic environment, and to work towards achieving sustainable operating practices and improved economic efficiency.

This handbook is primarily a technical handbook for fishers. It is also however, a useful resource for others interested in the environmental management of Australian trawl fisheries.

The information presented in this handbook has been obtained through interviews and discussions with many trawl fishers across Australia, hopper manufacturers and through surveys conducted with fishers, researchers, fishing companies and other industry bodies.

INTRODUCTION

An industry driven initiative

Hoppers are a practical and efficient sorting device. Sorting the catch is easier and quicker and hoppers keep the target product and bycatch in better condition as they are held in sea water and not exposed to air on the back deck of the trawler.

The design, development and installation of hoppers on trawlers in Australia has been an initiative from industry. Large hoppers were first developed for trawlers in northern Australian waters in the early 1980's as a means of improving the quality of large catches of prawns that were exposed to the tropical heat during sorting and processing.

By dropping the trawl catch into a container of sea water on the back deck of the trawler rather than onto a dry sorting tray, prawns are not exposed to air and can "rest" in the sea water after the stress of capture. This allows the prawns to return to their normal colour and to hold their freshness while waiting for sorting, therefore providing a higher quality final product.

Along with improved product quality, hoppers have also improved processing efficiency. The use of a hopper therefore, provides strong economic benefits and as a result, have now been installed on a large number of prawn and scampi trawlers that operate in Australia's northern waters.

Hoppers are also used in other temperate and southern Australian prawn trawl fisheries, although their uptake has not been as widespread and to date, has mostly been limited by the size of vessel and cost of the hoppers. A number of vessels in the Scallop Fishery and Pilbara Finfish Fishery in Western Australia, Stout Whiting Fishery in Queensland, and the Finfish Trawl Fishery off northern Australia have also adopted large hoppers. Small hoppers are also used in NSW Estuary Trawl Fisheries.

Addressing environmental issues

In recent years with attention focused on the need to manage fisheries by the principles of Ecologically Sustainable Development (ESD), the value of hoppers, with the potential to increase bycatch survival has been recognised by the scientific and conservation community.

Awareness of environmental issues with respect to commercial fishing has increased markedly, both internationally and nationally. Under the international voluntary Food and Agriculture Organisation of the United Nations (FAO) *Code for Responsible Fisheries*, measures are required to conserve target and non-target species and their environment[1]. In Australia, under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the various pieces of State environmental legislation, fisheries must demonstrate that they are being managed in an ecologically sustainable manner, not just for the target species but for all species that interact with fishing gear.

Bycatch and byproduct

In recent times attention has focused on the level of bycatch associated with trawl fisheries, particularly prawn trawlers.

Bycatch refers to those animals and plants that are caught by trawling, but not kept by fishers because they have no commercial value or regulations prohibit them from being retained. Byproduct refers to any commercially valuable species inadvertently caught while targeting the primary species.

When a trawl net is emptied onto the back deck of the trawler, the crew will sort through and select the prawns and any other animals that can be retained as byproduct. Byproduct can vary between fisheries, but generally includes animals such as bugs, squid and scallops. Bycatch animals and plants will be returned to the water, often dead or in poor condition. Bycatch can vary between fisheries and range from small sharks and rays, through to non-commercial fish or invertebrates (animals without backbones such as crabs, starfish and sea urchins).

The diversity of the bycatch from Australian trawl fisheries is generally greater in the warm tropical northern waters than in the southern cool temperate waters. A small number of fish species account for the majority of bycatch in all Australian prawn trawl fisheries.

The EPBC Act and some State environmental legislation requires the investigation and adoption of measures that reduce bycatch. *The Queensland East Coast Trawl Management Plan 1999* specifies the need to reduce fish bycatch by 40% by 2005.

All Commonwealth and State fisheries with an export component must demonstrate that they are addressing bycatch issues.

Bycatch Reduction Devices

A great deal of research has been undertaken by fishers and scientists on the development and adoption of new gear technologies to reduce bycatch. Fishers are keen to reduce bycatch as much as possible as it can damage target catch and reduce fishing efficiency. Research has focussed on removing non-target animals from the trawl nets before being brought to the surface. This has led to the successful introduction of a range of Bycatch Reduction Devices (BRDs) in trawl nets such as Turtle Excluder Devices (TEDs) and the square mesh panel shown in Figure 1.

TEDs are a type of BRD that excludes turtles and other large animals such as sharks and rays.

BRDs are now mandatory in many trawl fisheries and are being continually improved by the collaborative efforts of fishers and researchers.

It is unlikely however, that bycatch from trawlers will be completely eliminated with present BRD designs. Although BRDs are effective for excluding turtles and some fish species, [2,3,4] many species groups are not well excluded and remain impacted.

Bycatch and hoppers

With a hopper the catch can be sorted in water rather than being exposed to air, as occurs with a conventional sorting tray. Hoppers also facilitate faster sorting of the catch and hence faster return of bycatch to the sea.

This could improve the chances of some types of bycatch surviving the fishing operation. Fishers believe that this is the case and preliminary research has shown that the use of hoppers does improve the survival of some bycatch species.

Hoppers, when used in conjunction with gear modifications such as BRDs and other operational procedures, can help to address bycatch issues through helping improve the survival of some bycatch species (Refer Figure 2).

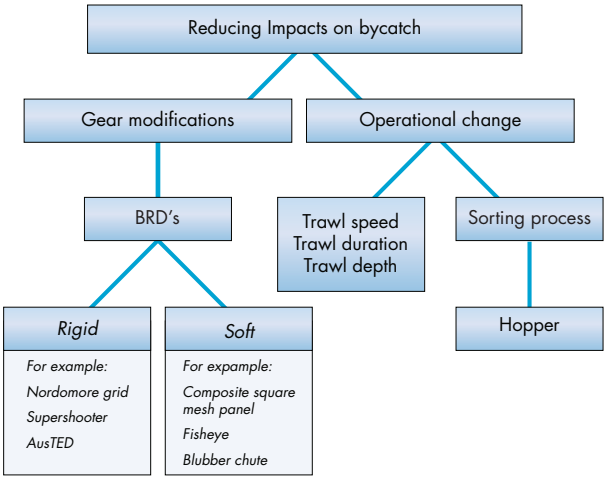


Figure 2 – A combination of gear modification and operational change can help reduce impacts on bycatch.

Any strategy that will potentially reduce the impacts to bycatch is good for the industry and all other stake holders. Not only does it improve the sustainability of the marine ecosystem on which the fishery depends, it helps maintain export permits and improves public perception of the trawling industry.

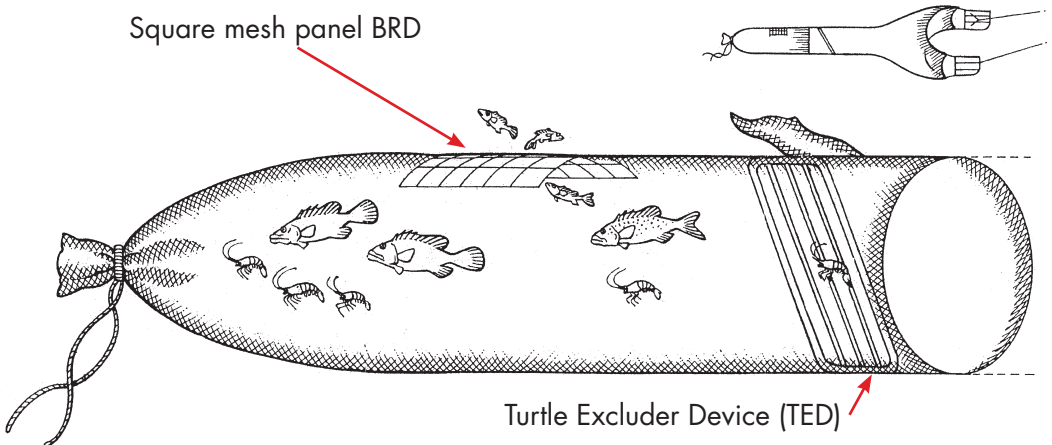


Figure 1 – BRDs are one way that trawl fisheries are reducing their impact on bycatch.
(Diagram provided by Queensland Fisheries Service.)

WHAT IS A HOPPER?

An Australian trawl hopper is a water container on the back deck of a trawl vessel that holds the catch prior to sorting in sea water. Rapid sorting methods are often applied with a hopper.

The sea water in the hopper:

- assists in keeping the catch "fresh" and allows bycatch species to recover from the trawl operation;
- improves the efficiency and speed of the sorting process; and
- assists in the effectiveness of separation of target species from bycatch using their different buoyancies and behaviours.

There are generally two major groups of hoppers: large and small. **Hoppers can be designed to suit any type and size of trawl vessel.** They can range from large, expensive steel apparatus with conveyors, to small, cheap and simple plastic tubs.

Large hoppers

The most commonly used type of hopper in Australia is the large hopper. These are defined as **water containers with a conveyor belt which carries the catch out of the hopper for sorting. They are mostly found on vessels greater than 18 metres in length.**

Large hoppers vary widely in size as dictated by the back deck area available and fishers' personal preferences. Generally speaking, they are 2-3 metres long x 2-2.5 metres wide x 1 metre high with a tapering hopper tank. The total hopper capacity is on average, 4.5 cubic metres, however the hopper is usually only filled with approximately 3 cubic metres of water.

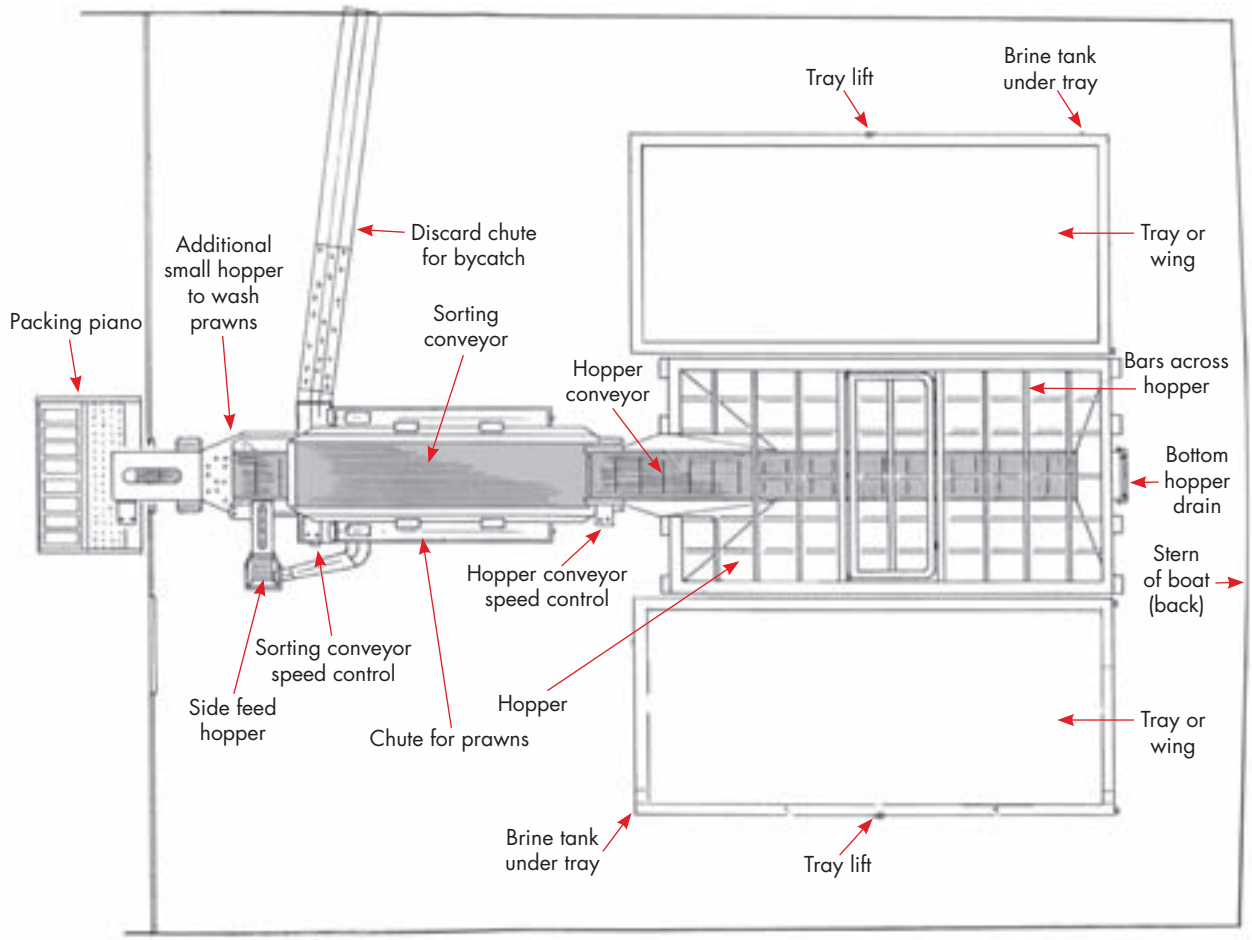


Figure 3 – Large hopper (plan view)

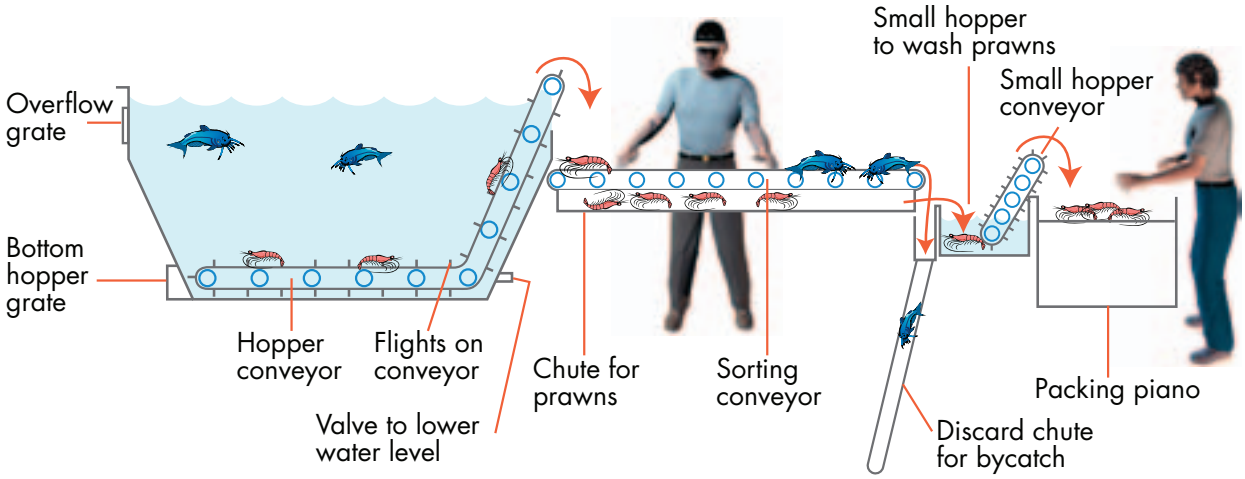


Figure 4 Large hopper (side view)

Large hoppers are made from steel, aluminium or fibreglass or from a combination of these materials. Most hoppers look like a large raised square box on the back deck of the trawler. The hopper is generally in the centre of the "box" with a tray on either side (Refer Figure 3). Grids or bars often cover the hopper to catch larger animals and objects, while allowing the remainder of the catch to fall through the bars and into the hopper.

Just before each trawl shot is hauled to the surface the hopper is filled with fresh sea water. Water does not generally flow continuously through these large hoppers although in some hoppers water jets and sprays are used to circulate and aerate the water.

Catch spilling from the nets into the hopper.

Generally, once the catch is spilled into the hopper, a ribbed conveyor belt that runs along the bottom of the hopper and up its side is used to remove the catch from the hopper (Refer Figure 4).

All catch held in hopper and sorting starts.

The ribs (called flights) assist with keeping the catch on the belt.

Catch held by flights on the belt of the hopper conveyor.

As the commercially valuable product (for example, prawns, scallops and bugs) tend to sink to the bottom of the hopper, they are removed by the conveyor early, thereby streamlining the sorting process.

The hopper conveyor belt is usually run at a slower speed initially, as the majority of prawns are removed from the hopper at the beginning of sorting.

Catch transferred from hopper conveyor to sorting conveyor.

The catch is automatically transferred from the hopper conveyor onto a second sorting conveyor, which runs horizontally along the deck at waist height. This sorting conveyor is often run at a moderately fast pace to keep an even spread of catch from which the crew rapidly pick out the prawns. Byproduct is sent down a chute with flowing sea water for further processing (washing, grading and packing).

Bycatch fish moving down discard chute, returning to the sea.

Many fish species swim or float and therefore tend to remain in the hopper until most of the commercial product has been removed. The crew can then drop the water level in the hopper and run both conveyor belts at maximum speed so that the remaining fish drop down onto the hopper conveyor, move rapidly along the sorting conveyor into a discard chute, returning these species in a sluice of sea water to the sea, usually within one minute of being removed from the hopper.

Picking out prawns and putting them into a sorting chute with flowing sea water.

The type of catch determines the required combination for the conveyor speed and rate at which to drop the water level in the hopper. With large hoppers, the two conveyor speeds and water level can easily be controlled. These can be co-ordinated to ensure a steady flow of catch out of the hopper and an even spread of catch along the sorting conveyor to suit the rate at which the crew can remove the prawns from the rest of the catch.

Grading and packing prawns.

The total time taken to sort all of the catch varies according to the catch size and composition and the crew. As a general rule, sorting times average at around 20-40 minutes per shot. **The hopper system greatly assists the sorting process and the whole operation can be completed smoothly and efficiently.**

Prawns ready for packing.

The following case study is an example of a standard large hopper and conveyor system used, although fishers do modify this system according to their deck space and amount of money they wish to spend. Modifications may include variations in the number and position of sprays (sprays help push the catch down into the hopper and aerate the water), width and depth of the hopper, size and spacing of bars on top of the hopper, relative position of the hopper and sorting conveyor and the type of belt used.

Northern Prawn Fishery

Many of the hoppers first built for the Northern Prawn Fishery (and still used today) are of similar design, with minor modifications to suit each vessel.

Hopper Materials: Stainless steel

Hopper Size: 3-4.5 m^3

Vessel Length: 19-24 metres

Hopper Cost: approx. $110,000 for hopper and conveyors, packing table, packing holding racks, power packs and installation.

FISHQUIP hoppers.

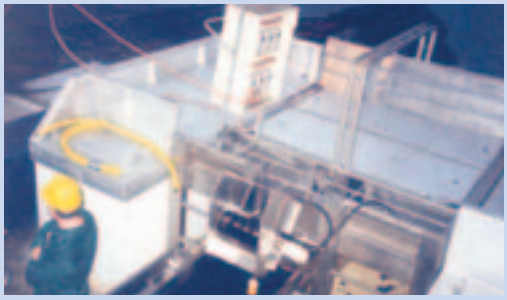
Benefits: This hopper was the first style of hopper to be developed and built in Australia. The hopper and conveyor system improved product quality, processing efficiency and Occupational Health and Safety for the crew.

Operation: The hopper is made from stainless steel suitable for the northern tropical waters. Initially, the hopper was constructed from aluminium, however when metabisulphate was introduced (to prevent black spot in prawns) the combination of the metabisulphate and the high water temperatures caused an increase in the corrosion rate of the aluminium. Consequently, the construction material was changed to high grade stainless steel.

The hopper size is fairly large to be able to hold the large amounts of catch and bycatch taken in this fishery. The hopper is wide which helps reduce the loading on the hopper conveyor (in a narrow hopper with large catches, the weight of the catch can be more concentrated on the conveyor belt, which places extra stress on the belt). There is a grated overflow at the back of the hopper to prevent water spilling out of the hopper in rough weather.

The bars help prevent large animals falling into the hopper (which were very useful prior to the introduction of TEDs, which now allow the majority of all turtles, sharks and rays to escape out of the nets whilst they are in the water). The bars also allow crew to move across the hopper from one side to the other if necessary. With large catch volumes, some of the catch spills over onto the trays and can either be easily hosed into the hopper or if necessary, the trays can be lifted with winches to tip it into the hopper.

Trays can be put across the top of the hopper to cover the whole or part of the hopper. These are useful if the trawl nets "mud up". The mud can be dumped onto the trays rather than into the hopper where it will clog and stop the conveyors. They are also useful to hold nets and equipment when the vessel is not fishing.

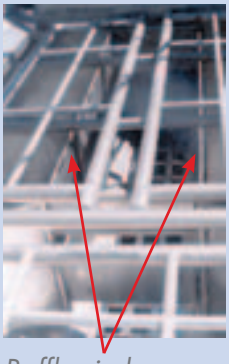


FISHQUIP hopper with trays across hopper.

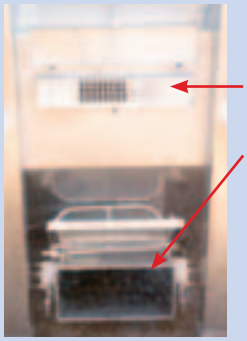
Most of these hoppers also use baffles. These are flat pieces of steel inserted into the hopper to divide it into sections. A gap of around 100mm is left between the baffles and the bottom of the hopper allowing water and the catch to move

underneath and be picked up by the conveyor and move out of the hopper. Baffles prevent the water from sloshing from one side of the hopper to the other and so reduce potential damage to animals in rough weather. In some hoppers they are permanently in place, while in others they are only inserted during rough weather.

Many hoppers also include a gate at the bottom rear of the hopper which can be opened to allow faster draining.



Baffles in hopper.



Overflow grate and bottom drain at the back of the hopper.

Sorting conveyors allow prawns to be picked out and bycatch returned via the discard chute to the sea. When there is a clean prawn catch with very little bycatch, the bycatch is picked out and released via the discard chute and the prawns sent via the conveyor to a washing container. There is usually a flap at the end of the conveyor and a slot at the end of the sorting chute that can be alternated to allow for the different types of sorting.

Any problems: Fishers commented that initially there were some problems with judging the size of the catch from each net however, it did not take long to adjust to the new system.

Slot and end of chute and sorting flap.

Small hoppers

Small hoppers are less common than the larger hoppers, being mostly used by smaller trawlers that work inshore and within estuarine waters. **Small hoppers are defined as simple water tanks without a conveyor. Instead, the fisher usually scoops out the catch with a sieve. They are found on vessels usually less than 18 metres in length (Refer Figure 5).**

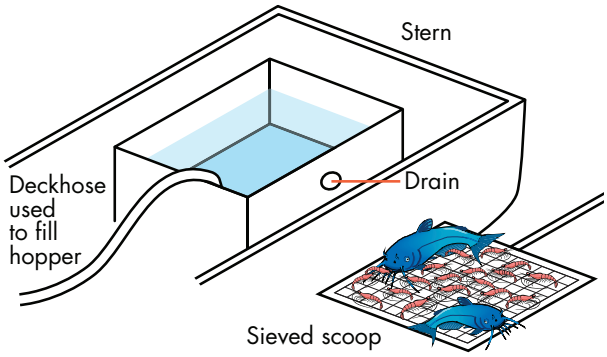


Figure 5 – Small hopper.

The small hopper is generally a small fibreglass, steel, plastic or aluminium box or tub (0.1-1m ^{3} volume) (basically any type of small container) on the back deck into which the catch is spilled. The designs of small hoppers can vary somewhat as they are tailored to suit each vessel.

Similar to the large hopper, the small hopper is filled with fresh sea water before each shot is hauled. After the catch is spilled into the hopper however, the crew usually stirs the water in the hopper and a sieved scoop is used to remove the catch. The prawns are then picked off and the bycatch tipped back into the sea. After sorting, the hopper is drained ready to be filled before the next shot is brought on board. This whole system runs entirely off the deck hose and is a very simple operation.

The following case study provides a good example of a how a small hopper is being used on a smaller vessel.

NSW Ocean Prawn trawler – Port Stephens

Vessel name: *Pops Last*

Hopper Materials: Aluminium

Hopper Size: approx. 1m^3

Vessel Length: 10 metres

Cost: approx. $1,000

Benefits: This vessel has used this style of hopper since 1950 to keep the prawns fresh. The aluminium box hopper takes up less room on the back deck than the conventional sorting tray. This fisher also catches lobsters and has indicated that the hopper is great for keeping them alive for the market.

Operation: The hopper is filled with fresh sea water from the deckhose before each shot. The three nets are all emptied into the hopper and as the prawns go to the bottom and the fish float, a sieve is used to scoop off the bycatch and return it to the sea. The prawns are hand graded off the scoop and cooked on board. The hopper is then drained through releasing the bung, which is attached to a deckhose at the bottom of the hopper.

Any problems: Small crabs in the catch can be annoying when using the hopper as they also sink to the bottom and can damage the prawns. They can be difficult to remove from the hopper as they are very active and will often fall off the sieve back into the hopper. If there are large numbers of these small crabs in the catch, the fisher may empty the nets into the hopper without water and try to quickly remove the crabs before filling it with water.

The history of hoppers

The first large hopper was built in 1982 in an attempt to prevent large catches of scampi and prawns "turning black" (black spot is caused by enzymatic oxidation) in the tropical heat before they could be sorted and processed. Fishers operating on the north west shelf of Australia were catching scampi in deep water (greater than 200 metres) off Port Hedland and sorting them on dry sorting trays in air temperatures greater than 30ºC. At the same time fishers catching large tonnages of banana prawns in the Northern Prawn Fishery (NPF) were having a similar problem with the prawns. In the NPF, fishers also wanted to easily discard the large numbers of small dollarfish (also known as ponyfish) that are sometimes caught with banana prawns.

Rod Tedman went to sea with Surfie Colless and Bluey Bedford on the Raptis trawler *Eylandt Pearl* in 1981 to find a solution to this problem. Rod suggested spilling the catch into a container of chilled sea water to keep the scampi cooler and then designed a conveyor system to lift the scampi out of the water container. He also noticed that the fish bycatch swam and saw this as a system that could also potentially help remove bycatch easily. A prototype hopper was subsequently built by Rod Tedman and installed on the Raptis trawler *Eylandt Pearl.* It was successful at not only reducing black spot, but also in decreasing processing time. As a result, A. Raptis & Sons had more hoppers built. Newfishing Australia also saw the advantages of the hopper system and commissioned Rod to build them hoppers. Within two decades hoppers were installed on the majority of NPF vessels.

A large catch of banana prawns in a hopper prior to the use of TEDs.

In 1994, Andy Haldane, a Spencer Gulf fisher in South Australia and engineer who had not yet heard of the NPF hoppers, designed and built his own hopper system. Andy believed that the use of a sorting conveyor would increase processing efficiency, and thereby designed a water container suitable for extracting prawns onto a sorting conveyor. Another 3-4 years followed before a fairly rapid uptake of hoppers by nearly all the fishers in the Spencer Gulf began. Since the mid to late 1990's, large hopper systems have been adopted in other trawl fisheries around Australia.

The first small hoppers were developed by a number of fishers in the NSW Ocean Prawn Trawl Fishery around 1950 to keep the prawns fresh rather than have them sitting on a sorting tray in the sun. The Hawkesbury Estuary Prawn Trawl fishers developed and installed their own design of hopper around 1970. They were built for this fishery primarily as a means of reducing the handling of catfish with venomous spines that were caught as bycatch. Fishers sorting the catch can easily be pricked by their spines, causing hours of pain. These hopper systems worked so well that virtually the same designs are still in use in these fisheries today.

Catch sorted on conventional dry sorting tray.

BENEFITS OF HOPPERS

Commercial benefits

Improved product quality

A survey was conducted with Australian trawl fishers that use hoppers. **All reported that hoppers have improved product quality and quality consistency.** Fishers estimated approximately 5-10% less damaged prawns (which are a lower value prawn) as a hopper reduces the amount of crushing to the product once it is on the vessel and also the level of handling.

A seafood marketing company receiving prawns from vessels using hoppers and conventional dry sorting trays commented that definite improvements in prawn quality are evident from those vessels using hoppers. Holding the target prawns or fish in sea water while sorting allows them to:

- rest after capture;
- return to normal colour;
- move around in the water;
- reduce the amount of fish scale loss;
- be washed (even muddy prawns come out of the hopper clean); and
- remain fresh and lively.

This increase in freshness is evident by the fact that at times the prawns are still lively when they are being packed into boxes, even after they have been removed from the hopper, picked off the sorting conveyor and then graded.

Prawn freshness is improved when they are held in water. Leader prawn (Peneaus monodon).

In a small number of cases where hoppers are used in vessels trawling deep waters in northern Australia, the hopper has refrigeration coils that chill the water. This provides improved product quality by simulating similar temperatures to the deep water in which the catch was taken. The effect of this chilled water on the survival of the bycatch is unknown.

Efficiencies in sorting and cost savings

Hoppers greatly increase the speed of catch sorting, allowing for continuity and efficiencies in the flow of processing operations. A reduction in sorting time and the one less crew member required for sorting allows more time for the crew to improve grading and quality control in packing. This not only improves product quality, but on some vessels this has meant that there is one less crew member, which may also sometimes reduce costs for the vessel owner.

Fishers have reported processing is 30-50% faster when using hoppers. Although improvements to sorting times are dependent on the type of catch and crew capabilities, they have been particularly evident with:

- large prawn and fish catches (greater than 1 tonne);
- clean catches (almost all prawns or fish with little bycatch); and
- experienced crew.

Scientific research undertaken for catch sorting using hoppers supports anecdotal reports provided by fishers. Sorting was found to be:

- twice as fast with a hopper in the Torres Strait Prawn Trawl Fishery, and highly efficient in the Queensland East Coast Trawl Fishery (Refer Figure 6);[5] and
- three times faster in the Spencer Gulf Prawn Fishery (where the catch is very clean).[6]

Research in Spencer Gulf Prawn Fishery has also found that as the size of the catch increases, beneficial gains in sorting time achieved with the use of a hopper are more noticeable. The difference in sorting times for small catches when using a hopper versus a sorting tray are noticeable but not as large.[6]

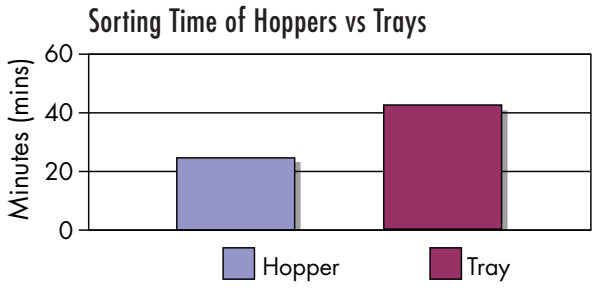


Figure 6 – Comparison of the average sorting times for a hopper vs a conventional tray [5]

Hoppers can maximise product quality and the efficiency of the processing operation as compared to when using a dry sorting tray. Product handling is reduced, there is less damage from other components of the catch, it is already washed, and processing is much faster with the product off the back deck and into the freezer or brine a lot quicker.

Improved market reputation and access to live prawn markets

A consistently high quality product is extremely beneficial for establishing a good reputation in the buyers market. The quality of prawn product on the global market is increasing with the continual improvements being made in fishing technology. Marketing of prawns is becoming harder in terms of differentiating product, so maximising quality and its consistency is fundamental.

The use of hoppers can help improve the reputation of a fishery's product in the market. As a higher and more consistent quality of product becomes known, the word spreads. For example, a seafood marketer surveyed commented that the modernisation of the Spencer Gulf Prawn Fishery, which has included the introduction of hopper based systems, has been a primary influence in establishing the reputation that the prawns caught in this fishery are one of the best quality prawns in the world.

A number of trawler operators have used hoppers to enable them to access the restaurant market. When surveyed, they commented that hoppers were ideal for maintaining premium prawn quality and that prawns could be kept alive onboard the vessel. Prawns sold live to local restaurants receive a higher price than that of frozen or wet (fresh on ice or in brine water) prawns.

Hoppers may also be useful for collection of live broodstock prawns for aquaculture hatcheries.

Occupational Health and Safety

Hoppers can improve Occupational Health and Safety conditions on the back deck of a trawler through reducing:

- safety risks to the crew associated with injuries received from venomous bycatch species by removing the majority of direct handling;
- repetitive tasks such as continually shovelling product onto a sorting conveyor or bending to pick up fish and scallops off the deck;
- time on deck, reducing fatigue, manual labour and the likelihood of injuries; and
- exposure of the crew to poor weather and associated safety risks through less time spent on deck.

Crew morale

The crew can sort and process the catch faster and be off the back deck a lot quicker. This is especially beneficial when catches are larger, the weather is unfavourable and the crew is required to work longer hours.

As fewer crew members are needed to process the catch, on vessels that remove a crew member a greater percentage of the value of the catch may then sometimes be available for distribution to the reduced crew.

More time to deal with gear/vessel operational problems

If there is a problem with the gear or vessel, with the catch in the hopper more time is available to address the problem, without having to be concerned about the catch being exposed to air.

Environmental benefits

Bycatch survival

Emptying the catch from a trawl into a container of sea water where it remains until it is removed by a conveyor and passes back into the sea (usually within a minute), may give some bycatch species a better chance of survival. This is compared to the catch being emptied onto a conventional sorting tray where the bycatch is exposed to the air while sorting is completed, before being returned to the sea (which on average can take up to 20 minutes for the last of the bycatch to be returned). In addition, as there is no need to shovel the catch from a sorting tray, the bycatch is not at risk from this type of physical damage.

Hoppers are good for returning bycatch to the water quickly. Anecdotal evidence from many fishers that use hoppers suggests a noticeable improvement in the amount of bycatch that is returned to the sea alive, although many fishers said this is difficult to quantify. There has also been little research on the long term survival rate of that bycatch returned to the sea.

Bycatch swimming in a hopper.

Those trawling operations that use a hopper with short shots in shallow water have a better chance of maximising bycatch survival. The earlier and quicker a species is returned to the sea, the greater its chance of survival.

Some fishers surveyed in the Northern Prawn Fishery reported that when trawling for banana prawns (short duration, shallow water shots with little bycatch), approximately 95% of bycatch fish were alive when returned to the water. When trawling for tiger prawns (longer shots, deeper water, more bycatch), approximately 30% of the bycatch was alive when returned to the sea.

Due to the high diversity of species caught as bycatch in trawl fisheries around Australia and the differing operational practices, a large scientific research project is required to quantitatively assess the level of bycatch survival provided by hoppers. To date, preliminary scientific assessments have shown that there is likely to be an improvement in bycatch survival through the use of hoppers for some species. However, the extent of the improvement is difficult to accurately quantify and varies for different species and operating conditions.

Preliminary scientific research[5] in the Torres Strait Prawn Trawl Fishery has indicated that the use of hoppers, in conjunction with the use of BRDs, potentially doubles the average numbers of fish bycatch alive when returned to the sea (Refer Figure 7):

- 16.1% of fish bycatch were alive when released from a hopper; while
- 8.5 % of fish bycatch were alive when released from a conventional sorting tray.

In addition, both the weight and diversity of bycatch species that were alive on release were all significantly higher from vessels using hoppers.[(5)]

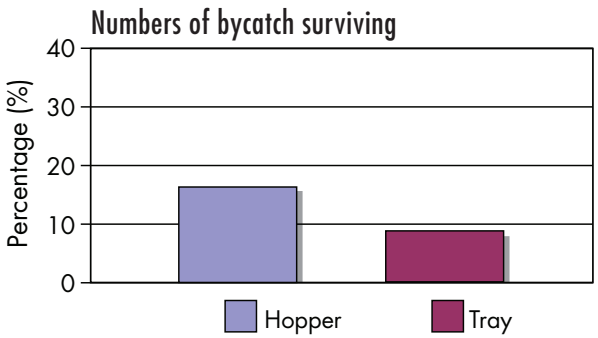


Figure 7 Comparison percentage of the number of bycatch animals surviving when returned to the sea using hoppers vs conventional trays, with the same average trawl depth and duration.[(5)]

Preliminary studies in South Australian trawl fisheries have also found that hoppers do improve bycatch survival for some species. Cuttlefish, trevally, rock flatheads, and 7-gilled sharks showed improved survival with the use of a hopper.[(6)]

The survival of bycatch from trawling is dependent on a range of fishery specific modes of operation [(7-14)]. These include:

- **Trawl duration:** The longer the trawl, the greater the weight of the catch and consequently the greater the degree of compression and potential physical damage to animals in the codend. The longer bycatch animals are in the codend, the greater their fatigue and stress. Research in Queensland [(5)] found that for each half hour increase in trawl time, the percentage of fish that survived decreased by 1.5%, regardless of whether the catch was processed using a hopper or tray.
- **Trawl depth and the rate at which a net is hauled at the end of a shot:** A reduction in pressure as the catch is brought to the surface can distend or rupture the swim-bladders of fish preventing them from sinking. These animals are vulnerable to predation by surface scavengers such as dolphins, seabirds and sharks. Research in Queensland [(5)] found that for every 10 metre increase in trawl depth, the percentage of fish that survived decreased by 3.8%, regardless of whether the catch was processed using a hopper or tray.

- **Time spent on a sorting tray exposed to the air:** The longer that marine animals are exposed on the sorting tray, the lower their chance of survival. This can be influenced by the amount of catch to be sorted, the number of crew sorting and sea conditions.
- **Size and composition of the catch:** The variety of species in the codend influences the potential damage to bycatch species from spines, teeth, venom, crushing and abrasion in the codend and on the tray or in the hopper.
- **Gear type:** Different net and codend mesh types and sizes can result in physical trauma and cause scale loss in fish. For example, in one study [14] larger size square mesh was found to damage fish less than same sized diamond mesh or smaller square mesh.
- **Trawl speed:** The speed at which a vessel travels while trawling can affect fatigue and the physiological stress of bycatch species.
- **Size of individual animals:** Smaller members of some species are less likely to survive than larger individuals.
- **Shot time:** Day versus night trawling and seasonal variations can affect bycatch species composition.
- **Ratio of catch size to hopper volume:** The ratio of catch size to water volume in the hopper can affect the availability of oxygen, with a high ratio resulting in rapid oxygen depletion. A small amount of catch to high volume of water improves oxygen concentrations and the environment for bycatch survival.

Community perceptions

A recent national survey undertaken of the public's perception of the fishing industry in Australia found that commercial fishing is generally viewed pessimistically by the community and bycatch issues are of concern.[15] The majority of the community however, did indicate a desire to increase their knowledge about the fishing industry **and the majority reported that environmentally friendly production was likely to influence them to buy more seafood. As such, it is good for the trawling industry when it can demonstrate to the public that it is addressing bycatch issues**.

The uptake of a device such as a hopper that may help improve bycatch survival is a benefit to trawling in the eyes of the community. This may work towards improved public perception of the fishery and better public relations.

WHO USES HOPPERS?

Hoppers are used mostly by trawlers targeting prawns, although they are also used in a few instances on scampi, fish and scallop trawlers. Figure 8 shows all trawl fisheries, highlighting those that use hoppers. Table 1 provides estimates of the percentage of vessels that use hoppers in each fishery and compares their operational procedures and annual catches.

In the Northern Prawn Fishery, Spencer Gulf Prawn Fishery, North West Slope Trawl Fishery, Queensland Stout Whiting Fishery and Hawkesbury and Hunter River Estuary Prawn Trawl Fisheries, more than 80% of vessels currently use hoppers. The Northern Prawn and Spencer Gulf Prawn Fisheries are high value fisheries that at times catch large volumes;. the North West Slope is where hoppers were first developed; large volumes of stout whiting are caught in warm Queensland waters; Hawkesbury hoppers were introduced many years ago to address safety issues associated with the large amounts of catfish caught; and the Hunter River hoppers have recently been introduced to improve bycatch survival and public perception of their fishery.

In general, prior to investing in capital equipment and modifying back deck layouts, fishers like to know how new equipment performs. As more fishers trial and use a new concept, the knowledge base and acceptance of the innovation often gains momentum. This has occurred with the use of hoppers in some fisheries.

The following limitations however, as described and prioritised in order of importance by the fishers surveyed, have delayed or prevented the uptake of hoppers in other fisheries:

- cost;
- a lack of space on the back deck to install a hopper;
- financial uncertainty associated with some fisheries to warrant investing in a hopper;
- concerns about vessel stability;
- a lack of information on the type of hoppers available to suit a particular vessel type;
- a preference by some fishers to keep back deck operations simple and non-mechanised; and
- fishing conditions do not warrant hopper use, for example warm water and higher air temperatures are not common in southern Australian fisheries.

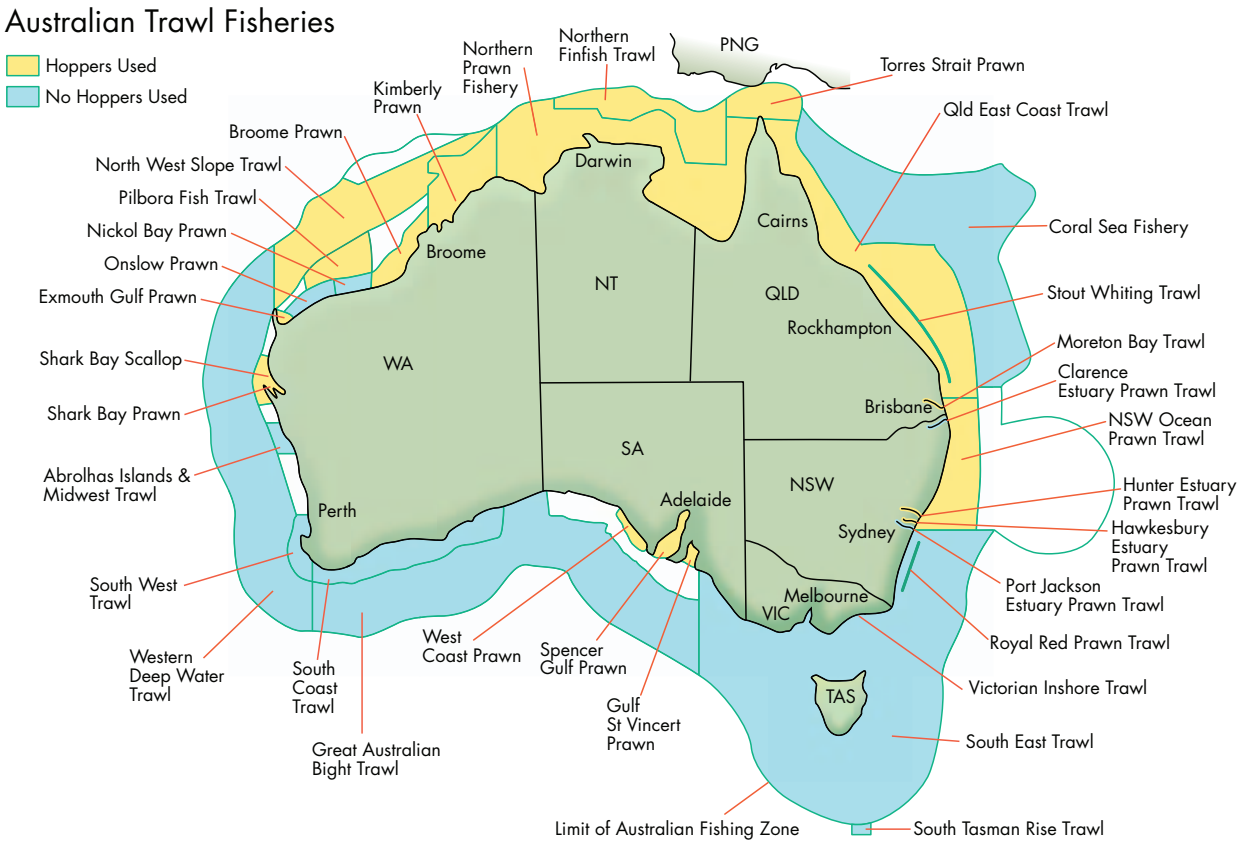


Figure 8 – The use of hoppers in Australian trawl fisheries.

Table 1 Summary of operational information for Australian trawl fisheries that use hoppers

Note: Only main target and main byproduct species are listed. Averages have been used for vessel size, crew number, trawl duration, depth and speed, annual catch and value.

Fishery	Number of active vessels	Percent that use hoppers (approx.)	Main target species and by-product	Vessel size (m) / number of crew	Number of nets / headrope length of each net (fathoms)	Day / night fishing	Trawl duration, depth (m), speed (kts)	Annual catch (tonnes)	Fishery value (million)	Mandatory BRDs
Commonwealth										
Northern Prawn	96	80%	Banana, tiger, endeavour prawns, squid, scallops, and bugs	17–2 m 4–6	2 nets 8–12 fathoms	Day Night	15 min–4 hrs 10–40 m 3–4 kts	8–10,000	$100–150m	TED BRD
Torres Strait Prawn	75	10–15%	Tiger, endeavour, red spot king prawns, squid, bugs and fish	14–20m 3–5	2–4 Nets 4–5 fathoms	Night	2–4 hrs 10–40 m 3–3.5 kts	1500–2000	$18–23m	TED BRD
North West Slope Trawl	3–10	80–100%	Scampi and deepwater prawn, squid, bugs, lobsters	20–25m 4–6	2–3 nets 8–20 fathoms	Day Night	3–5 hrs 350–600 m 2.5–3 kts	100	$1.2m	None
Northern Finfish Trawl	2	50%	Ref snapper, scarlet sea perch and fish	25–31m 5 crew	1 net 25 fathoms	Day	30 min–3 hrs 60m 3.6 kts	1,000	$4m	None
Queensland										
East Coast Otter Trawl	516	3 %	Tiger, endeavour, king prawns (red spot, eastern, western), scallops, bugs, squid. cuttlefish	12–18m 2–3 crew	2–4 nets 5 fathoms	Day Night	2–3 hrs 10–40 m 3–3.5 kts	9,000–12,000	$100–130m	TED BRD
Moreton Bay Otter Trawl	90	1%	Greasyback, eastern king, tiger, prawns and squid, blue swimmer crabs	5–12m 1–2 crew	2 nets 4 fathoms	Day Night	60 min 3–12 m 2.2–2.6 kts	1,000–1,500	$5–8m	TED BRD
Stout Whiting Trawl	5	100%	Stout whiting and fish	18–20m 4–6 crew	1 net 17 fathoms	Day Night	15 min–4 hrs 37–90m 3 kts	500–1,000	$2–3m	TED BRD
New South Wales										
Estuary Prawn Trawl – Hawkesbury River	38	80–90%	School, eastern king prawns, squid and finfish, blue swimmer crabs	7–10m 1 crew	1 net 6 fathoms	Day Night	30–45 min 3–20 m 2 kts	130	$1.2m	BRD
Estuary Prawn Trawl – Hunter River	28	100%	School, eastern king prawns and fish, squid	7–10m 1–2 crew	1 net 6 fathom	Day	15–60 min 1–18 m 2 kts	55	$0.5m	BRD
Ocean Prawn Trawl	330	2%	School, eastern king, royal red prawns and bugs, octopus, squid	12–18m 2–3 crew	3 nets 7–9 fathoms	Day Night	2.5–3.5 hrs 55–550 m 2.7 kts	3500	$32m	BRD

Fishery	Number of active vessels	Percent that use hoppers (approx.)	Main target species and by-product	Vessel size (m) / number of crew	Number of nets / headrope length of each net (fathoms)	Day / night fishing	Trawl duration, depth (m), speed (kts)	Annual catch (tonnes)	Fishery value (million)	Mandatory BRDs
South Australia										
Gulf St. Vincent	10	30%	Western king prawn and squid, slipper lobster	13–22m 3–4 crew	2–3 nets 5–7.5 fathoms	Night	60–80 min 18–40 m 3–3.5 kts	350	$6m	BRD
Spencer Gulf and West Coast	SG–39 WC–3	SG –97% WC–33%	Western king prawns and squid	17–22m 4 crew	2 nets 8 fathoms	Night	30–55 min 20–30 m 3–3.5 kts	SG– 2,100 WC –100	SG $40m WC $1.7m	Crab bags (Not mandatory)
Western Australia										
Shark Bay Prawn	27	4%	Western king, tiger, endeavour, coral prawns, scallops and blue swimmer crabs, squid, cuttlefish, fish	18–24m 4–6 crew	2 nets 8 fathoms	Night	30–60 min 12–35 m 3–4 kts	1,500–2,300	$25–30m	TED FED Crab bags (not mandatory)
Shark Bay Scallop	14	14%	Scallops and blue swimmer crabs, bugs	18–24m up to 13 crew	2 nets 7–8 fathoms	Day Night	20–150 min 16–40m 2.5–3 kts	1,200–3,000	$4–9m	TED
Exmouth Prawn	13	54%	Western King, tiger, endeavour, banana prawns and coral prawns, blue swimmer crab, squid, bugs, shark, fish	17–22m 3–4 crew	4 nets 4.5 fathoms	Night	1.5–3 hrs 5–20 m 2–3 kts	800–1300	$11–18m	TED
Broome Prawn	5	70–80%	Western king, coral prawns and cuttlefish, squid, bugs, fish	20–25m 4–6 crew	2–4 nets 7–16 fathoms	Night	1–1.5 hrs 30–100m 3–4 kts	50–150	$0.5–1.5m	TED
Kimberley Prawn	20–30	30–50%	Banana, tiger, endeavour prawns, squid, bug and fish	20–25m 4–6 crew	2 nets 8–16 fathoms	Day Night	1–1.5–hrs 15–45m 3–4 kts	250–500	$3 –6m	TED
Pilbara Demersal Finfish	7	14%	Bottom reef fish and shark, bugs, cuttlefish	25m 5 crew	1 net 36 fathom	Day Night	3 hours 100m 3 kts	1,900–2,200	$6–7m	TED

Key:

BRD – Bycatch reduction devices such as square mesh panels and fisheyes are used to eliminate undersized and small fish bycatch.

TED – Turtle Excluder Devices are used to prevent large animals such as turtles, sharks, rays etc being retained in nets.

FED – Fish Excluder Devices are used to exclude fish (similar to square mesh panel).

HOW ARE HOPPERS BEING USED?

Below are some examples of hoppers being used effectively by both large and small trawl vessels throughout Australian trawl fisheries.

Large hoppers

The Exmouth Gulf Prawn Fishery

Twelve of the thirteen active vessels in this fishery are owned by MG Kailis Pty Ltd. Seven of the Kailis vessels currently use hoppers of a similar design.

Hopper Materials: Stainless steel

Hopper Size: approx.2.5-3 m^3

Vessel Length: 17-22 metres

Hopper Cost: $100,000-$125,000 for hopper and conveyors, hydraulic lifts for trays and installation.

Benefits: MG Kailis first installed hoppers on their Exmouth trawlers in 1999-2000 to improve prawn product quality. The company subsequently received very positive feedback from the crews that hoppers were making processing easier, quicker and safer.

Operation: The hoppers in this fishery are fairly narrow with trays on each side that can be lifted hydraulically. Baffles are permanently fixed in place. The nets are initially spilled onto each side tray and any crabs are quickly picked out and returned to the sea. The trays are then tilted and the catch tipped into the hopper (so long as the catch is not too large, whereby some sorting may be done first). The prawns are sorted, placed into baskets and stored under the trays in modified brine tanks. At the end of the night's trawling, the vessels return to port and unload the baskets directly onto a shore conveyor from where they are transported to the factory.

The hydraulic lift on the trays makes processing easier as the trays can be lifted to tip catch into the hopper. At the end of each shot the trays are lifted again to put the prawn baskets into the brine tanks. Rather than using winches and ropes, the crew just presses a button to operate the hydraulic tray lift.

As interpreted under Western Australian Occupational Health and Safety legislation hopper trays can only be lifted if a prop is in place so as to prevent the trays from collapsing. With this set up, the hydraulic ram on these hoppers acts as a prop and so also meets Occupational Health and Safety requirements.

Any problems: Some catches will contain a few blue swimmer crabs. If these land on the trays when the bags are spilled, crews will try and quickly flick the crabs back into the sea. If they end up in the hopper they swim around, biting and damaging the prawns.

Some vessels require more modifications than others to install a hopper, depending on their size and back deck layout. MG Kailis aim to install hoppers on two of their Exmouth trawl vessels each year. However, installation is limited by cost and a good prawn season is needed to be able to invest in upgrading a trawler to include a hopper.

Spilling the bags.

Tipping the prawns into the hopper.

Catch coming out of the hopper.

Picking prawns off the sorting conveyor.

The end of sorting.

Putting the baskets of prawns into brine tanks.

Narrow hopper

Some vessels use a rather narrow hopper with wide trays. On this vessel, water is sprayed from the edge of the trays to keep the catch wet as it is tipped into the hopper. A curved slide with water running on it is used to deliver the catch from the hopper conveyor to the sorting conveyor.

Narrow hopper with large trays.

Curved slide delivers catch from hopper conveyor to sorting conveyor.

Sorting

A Shark Bay Prawn and Scallop vessel

Vessel name: *Matilda Bay*

Hopper Materials: Stainless steel

Hopper Size: approx.6 m^3

Vessel Length: 22 metres

Hopper Cost: $80,000-$90,000 for hopper and conveyor. Cost is extra for installation.

Benefits: A hopper was installed on the *Matilda Bay* in 1994-1995 primarily to improve Occupational Health and Safety conditions on the back deck of the trawler. The old fibreglass tray and tank was in need of replacement and the owner wanted to use a better processing system on the vessel and so upgraded to a hopper. Once installed and operating, large improvements to processing efficiency and some improvement to product quality were gained. This hopper is used for prawns and scallops. The hopper has greatly improved the processing of scallop catches by keeping the scallops alive and in good condition.

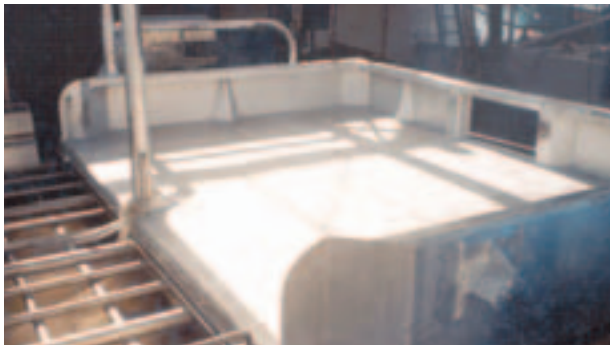
Operation: The hopper volume was maximised to be able to hold large catches of scallops. It has a tray on only one side of the hopper and baffles that are permanently fixed. The prawns/scallops are removed from the hopper and onto the sorting conveyor, which runs parallel to the width of the hopper. The tray on this vessel is lifted using hydraulics to make it easier for the crew.

Any problems: Installation was relatively simple, with only the existing sorting tray requiring removal. When wire weed is brought up with a catch, the catch is not dropped directly into the hopper, rather trays are placed across half of the hopper onto which the catch with weed is spilled. The crew then pitchfork the wire weed back over the side into the ocean.

Other comments: An increase in prawn quality is sometimes, but not always, evident with the use of a hopper. In 2003, a large amount of soft prawns were caught and although it was originally considered that the hopper may help improve the product quality of this type of prawn, it did not really make any noticeable difference. The company commented that this hopper is possibly a little too big-especially for the relatively short shots of 40-60 minutes, however as a prototype it was designed as large as possible to fit into the available deck space.

Hopper on back deck of trawler.

Large volume hopper.



The hopper has only one side tray.

Sorting conveyor parallel to width of hopper.

Sorting.

Pilbara Finfish trawlers

Vessel name: *Raconteur II and Torbay*

Hopper Materials: Stainless steel

Hopper Size: 9.5 m^3

Vessel Length: 25 metres

Hopper Cost: $80,000 -$90,000.

Benefits: Hopper and conveyor systems were installed on *Raconteur II* in 2000 and *Torbay* in 2002, both fish and scallop stern trawlers. For fish and scallops, the hopper allows improved quality as the fish are kept wet, scaling is reduced and processing is faster. Occupational Health and Safety is also improved as the crew are not required to bend down to handle the fish and scallops straight off the deck.

Operation: Hydraulic doors on the top deck open and the catch is spilled through a stainless steel grate into the hopper below. This grate catches any large objects such as sponges and large bycatch. A conveyor belt lifts the catch out of the hopper and onto a sorting table that was modified from an existing conventional sorting tray.

Any problems: None

From the top deck looking into the hopper below.

Fish moving onto the conveyor from the hopper.

Fish sorting table with bycatch chute in the centre.

Torbay, Point Sampson WA.

The Spencer Gulf Prawn Fishery

Thirty eight of the 39 vessels in this fishery use hoppers. Thirty seven of these are all of very similar design, built by one hopper builder.

Hopper Materials: Fibreglass or aluminium with stainless steel crab racks.

Hopper Size: approx.1.2 m^3

Vessel Length: 20-22 metres

Hopper Cost: $80,000-$90,000 for hopper and conveyors, prawn grader and installation

Benefits: A hopper was first designed and built for this fishery in 1994 by a Spencer Gulf fisher and engineer to increase processing efficiency. Three to four years later, other fishers in the Spencer Gulf began to commission this fisher to build and install similar hoppers on their vessels as they saw the benefits from this hopper system in reducing processing time, improving Occupational Health and Safety for the crew and increasing product quality. The hopper allowed the crew to focus more on grading the prawns and so provide a more consistent and better final product.

Fishers on these vessels commented that they installed a hopper that was designed and built by a local fisher who had knowledge and experience in this fishery and could design the hopper to suit local conditions.

Operation: This hopper has a smaller volume in comparison to other large hopper designs. The hopper is fairly steep and narrow. This design suits this fishery as the catches are mostly clean, with very little bycatch and the shots short (30-55 minutes) to maintain maximum product quality. Consequently, a large volume hopper is not required. The hopper is constructed from aluminium or fibreglass, as these materials are cheaper and easier to use than stainless steel. In the cold South Australian waters there is little corrosion of aluminium and so it lasts well. With fibreglass, once the mould is constructed, it makes manufacturing easier.

The hopper is divided into two compartments and nets are spilled into each. There are marks up the centreboard to provide a clear indication to the fisher of how much catch is in each net. Sprays are not required with these hoppers to push the catch or aerate the water, given their small size.

Crab racks have also been incorporated into these hoppers. Blue swimmer crabs are the largest part of the bycatch in this fishery and cannot be retained because of the commercial crab fishery in the Spencer Gulf. Crab bags are also included in the nets to separate the crabs from the prawns in the codend. The addition of crab racks ensures crab survival is maximised and damage to the prawns minimised. The racks are made of stainless steel so as to absorb the impact of other objects, such as rocks falling from the nets. The nets are spilled onto the crab racks which retain the crabs (and any other large bycatch such as the occasional shark or ray) and allow the prawns to fall through into the hopper below. The racks are then immediately tilted and the blue crabs and other larger bycatch returned directly to the sea.

The processing efficiency of this hopper system is further enhanced by the incorporation of a prawn grader into the processing line. Graders have been used in this fishery since the 1980's as they increase the efficiency of sorting and grading, particularly given only one species, the western king prawn is caught. Graders can also work effectively with two species of prawns in the catch. However, with more species, fishers believe it is just as quick to sort and grade by hand.

Any problems: The only problem indicated by fishers is that initially it took a little time to get used to assessing how well each net was fishing. However, fishers soon adapted to using the marks on the centreboard in the hopper to judge the catch size from each net.

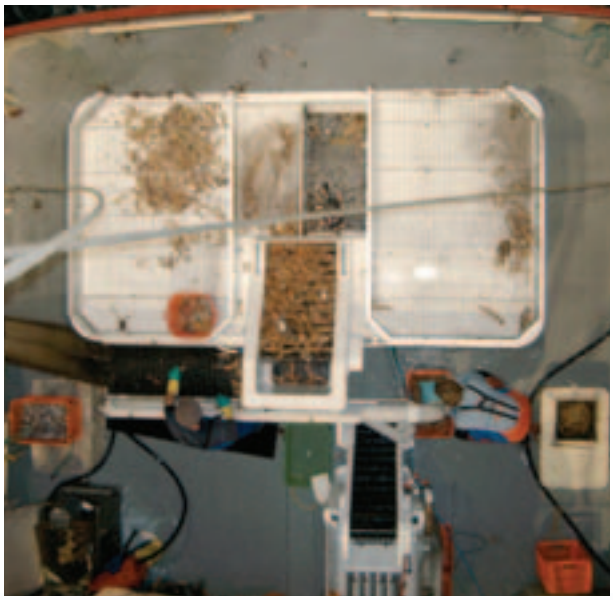
Spencer Gulf hopper.

Emptying crab bags onto crab racks.

Prawns are removed from the hopper via a conveyor.

Lifting crab racks returns crabs and large bycatch to the sea.

Haldane grader.



Hopper system with catch in hopper, crab racks, conveyors, discard chute and grader.

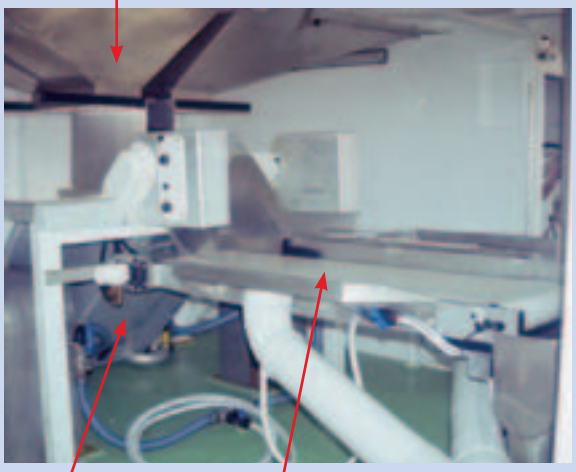
Discard chute.

New trawler design in the Spencer Gulf Prawn Fishery

There is a new trawler design in the Spencer Gulf Prawn Fishery whereby the bags are raised over the stern via a crane on the back deck that then swivels and spills the bags through an opening in the top deck into a hopper on the deck below. Crab racks are built into the top deck so that any bycatch crabs can easily be returned to the sea. The hopper is the same design as described above for this Spencer Gulf fishery. All processing occurs inside in an enclosed processing area, so the crew are not exposed to the elements on the back deck.

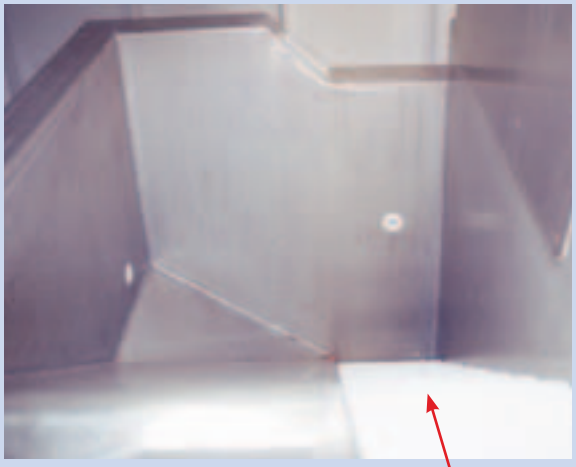
Trawler with crane.

Funnel from top deck to direct catch into hopper.



Hopper and sorting conveyor.

Grates (crab racks) on top deck. Catch is spilled onto grates and into the hopper below.



Looking into the hopper. *Hopper conveyor*

Northern Prawn Fishery vessel

Vessel name: *Ocean Thief*

Hopper Materials: Stainless steel

Hopper Size: approx. 2-3 m^3

Vessel Length: 22 metres

Hopper Cost: approx. $100,000 for hopper and conveyors, power packs and installation.

Benefits: This hopper was installed in 2002, mainly for processing large catches of banana prawns in the Northern Prawn Fishery. The increased speed of processing improves product quality and benefits the crew through more time to catch up on sleep. The cost of installing the hopper was taken into consideration as part of upgrading the vessel, which was more than 20 years old and due for a major refit.

Operation: The hopper has trays that can be lifted from either side. This is handy for the large catches of banana prawns that sometimes need to be stored in brine tanks located under the hopper while the crew processes prawns in the hopper. There are hinges on both sides of the tray so that they can be lifted to spill the remaining catch into the hopper (like most other hoppers). The trays can also be lifted to near vertical so that when the hopper is full, the codend can be spilled directly into the brine tanks, with the tray forming a barrier to prevent the catch going in the hopper. When all banana prawns from the hopper have been sorted, the tray can be lifted in the other direction to allow easy transfer of prawns from the brine tanks into the hopper (Refer Figure 9).

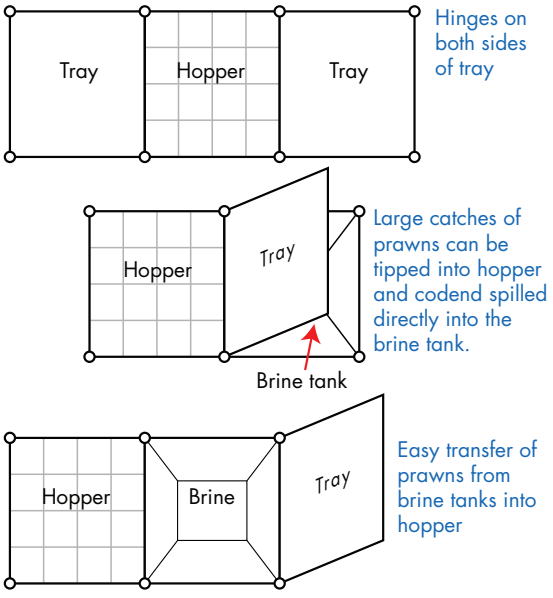
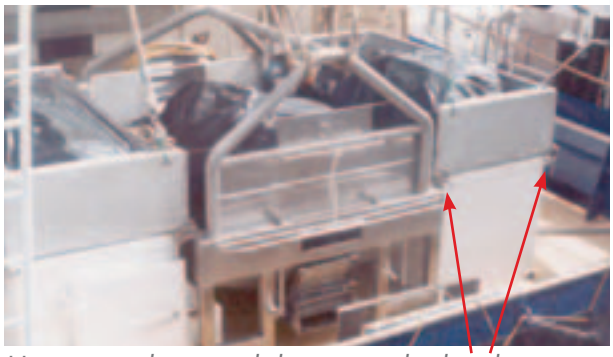


Figure 9 – Hopper hinges.

There is just enough gap between the baffles and the bottom of the hopper to allow water flow to carry catch through. If this gap is too large, a reverse current can be created and catch may start circling and the prawns may not sink to the bottom. Water sprays are situated at the conveyor end of the hopper, along each side to help push the catch into the hopper and keep the banana prawns cool.

A "wafer butterfly" valve is used on the water outlet of this hopper which allows easy control over the amount of water drained from the hopper.

Any problems: It was a fairly major and costly job to modify the back deck to install the hopper, as new brine tanks were required to accommodate a fairly wide hopper, while retaining their capacity. The owners did not want a narrow hopper, as it was considered that the large catches may place too much stress on the hopper conveyor belt. They also wanted to have a large volume hopper to maintain a good ratio of water to catch to maintain product quality.



Hopper and tray with hinges on both sides.

Slots for baffles.

Wafer butterfly valve.

Reducing the cost

To reduce the cost of a hopper on a 23 metre Northern Prawn Fishery vessel the hopper builder designed and built a narrow, steep sided hopper without a sorting conveyor, but allowing for the owner to install one himself at a later date. This pre-built hopper came with a pre-made conveyor (up the side of the hopper) to lift the product out of the hopper and potentially onto a sorting conveyor with bolt-on attachments (a hydraulic drive and stainless steel frame). This reduced the cost of the hopper to approximately $20,000.

A different sorting conveyor

For the 22 metre Northern Prawn Fishery vessel *Brianna-Rene-Adele*, cost savings were made on the hopper system installed by using the existing water slide as the sorting conveyor. The total cost was $65,000, including the hopper, hopper conveyor, tray lids, a power pack, the cutting of the existing sorting bins, installation and wiring.

Once the catch leaves the hopper, it falls onto an angled slide with flowing water to move the catch along, rather than onto a sorting conveyor. The product is then picked off the water slide and dropped into a chute which goes to a small prawn washer on the deck.

Chute to small prawn washer.

Slide used for sorting.

Small prawn washer.

A Stout Whiting vessel

Vessel name: *Amanda Jane*

Hopper Materials: Stainless steel

Hopper Volume: 4 m^3

Vessel Length: 19.5 metres

Hopper Cost: approx. $25,000 for hopper and conveyors.

Benefits: This hopper was installed in 1993 to process large catches (greater than 1 tonne) of stout whiting. When using a conventional sorting tray, with the time required to process the large volumes of fish, quality can start to deteriorate in the heat. In a hopper, the stout whiting remain cool and are washed. Consequently, the hopper improves product quality, greatly improves processing efficiency and reduces handling of the product.

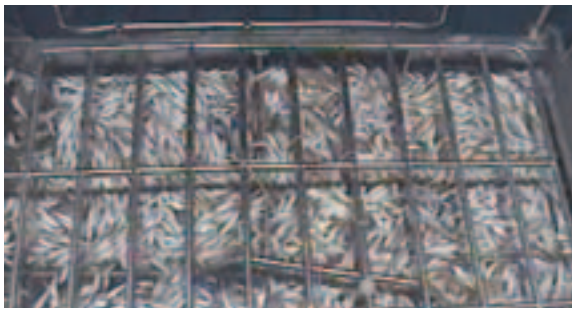
Operation: The volume of this hopper is larger than a standard sized hopper so as to hold the large catches of fish. Baffles are in place to reduce fish damage from water sloshing around the hopper. After the net is emptied into the hopper, a conveyor is used to bring the fish out and onto a small water slide that then directs them onto a sorting conveyor. The fish are then picked out and sent down a chute into another small water tank. From there, another conveyor spills them onto a grading piano for packing.

When the vessel is being used for prawning, the hopper is removed from the back deck and replaced with a sorting tray. This hopper is designed specifically to process stout whiting and is not suitable for prawn catches. With prawns, the company found that the large volume of water sloshed around too much and damaged the prawns (the baffles are designed for the fish and a different combination and placement of baffles would be needed for the prawns). In addition the crab bycatch swims around in the hopper, biting and further damaging the prawns.

Any problems: None with stout whiting, but for prawns this hopper is not suitable.

Hauling the net in over the stern.

Slide with flowing water to carry fish from hopper to sorting conveyor.



Hopper full of fish.

Sorting.

Hopper conveyor lifting fish from the hopper.

Bycatch drops into discard chute. Fish moved via another chute to small water tank for processing.

The smallest vessel using a large hopper system

Vessel name: *Vansittart*

Hopper Materials: Stainless steel and aluminium

Hopper Volume: 1-2 m^3

Vessel Length: 13.95 metres

Hopper Cost: $10,000-$12,000 for hopper, conveyors and motors

Benefits: This vessel operates year round with just two crew. The hopper was designed, built and installed by the owner/operators in 2000 to improve processing efficiency and speed for one person on the back deck. The hopper also improves product quality, as the prawns are cleaner and fresher than those previously sorted off a conventional tray. With the combination of TEDs and a hopper, the number of damaged prawns found prior to the use of either of these devices has reduced. All processing can now be done under cover protected from the often rough weather of the Torres Strait.

Operation: The steep sided, narrow hopper sits in the middle of the back deck with a tray above and to the rear on top of the snap freezers. Most of the year the catch from all four nets can be spilled directly into the hopper. If the catch is too large, however, some nets will be spilled onto the tray and the catch then hosed into the hopper via a hatch.

The catch is lifted out of hopper via a conveyor that spills it onto a sorting conveyor. A mirror positioned above the top of the hopper conveyor allows the crew standing at the sorting conveyor to easily keep an eye on the amount of catch coming out of the hopper. The two speed controls for both hoppers are next to one another on the sorting conveyor so a crew member can control both conveyor speeds easily without moving from their position. The whole system is compact and easily operated by one person.

After the remaining catch has been sorted from the hopper the prawns are put back in the hopper to give them another wash, then graded on the sorting conveyor.

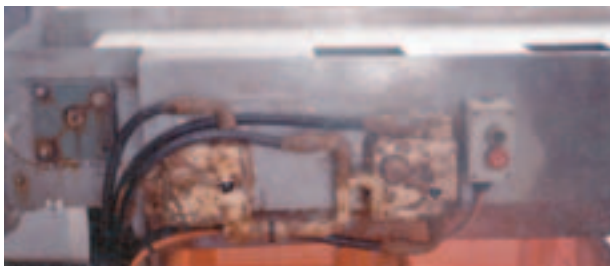
Although aluminium was used in some of the hopper during construction to minimise costs, it was important that the aluminium did not come into contact with metabisulphite so as to prevent corrosion.

Any problems: None.

Other comments: As this vessel works in the rough waters of the Torres Strait, to make it a more stable and comfortable vessel on which to work, the owner/operators widened it to 5.6 metres and built flotation tanks in the hull (just less than 50% of the hull space is void). With this increase in vessel stability, they decided that it could accommodate a hopper. As a suitable hopper was not readily available, they designed their own and are very happy with the way the whole system operates.

Steep narrow small hopper.

Tray, snap freezers, hopper and sorting conveyor on the back deck.



Switches to control both conveyor belt speeds.

Mirrors above conveyor.

Top view of hopper and tray.

Small hoppers

NSW Estuary Prawn Trawl Fishery- Hawkesbury River

Vessel name: *Sandralyn 3*

Hopper Materials: Plastic box

Hopper Size: 0.5m x 0.5m x 1m (approx. 0.25m^3)

Vessel Length: 10 metres

Hopper Cost: approx. $70

Benefits: These hoppers have been in use in this fishery for 30-35 years and were initially designed and installed by the Hawkesbury River trawl fishers as an Occupational Health and Safety measure to reduce handling and direct contact with venomous catfish and bullrouts. In some areas of the river there are large catches of these fish that can cause great discomfort and create blood poisoning if their spines prick the skin. The hoppers are also beneficial in terms of potentially improving bycatch and prawn survival in large catches. Most fishers in this fishery use hoppers.

Operation: The hopper is filled with the deckhose (and is drained via a plug at the bottom of the hopper). The metal prawn basket in the hopper enables the transfer of prawns onto the sorting tray if necessary. The single net is spilled into the hopper and the prawns settle to the bottom. The fishers use a fish sieve to remove unwanted bycatch which swim to the surface and return them back over the side into the sea. The prawns are then scooped out, hand graded and either retained on ice, put into a tank of water to keep them alive and/or cooked on board.

The hopper is not always emptied after each shot. It depends on the time available for sorting and the water quality in the hopper.

When harvesting schools of prawns with a running tide, there is no time with only one crew to grade or sort after each shot. The catch is therefore dropped into the hopper after each shot until the tide turns and the fisher then has time to start sorting.

During the day there may be some occasions where birds such as black shags and pelicans are present and will eat the fish bycatch as they are returned directly to the water. To prevent this, some fishers put the fish bycatch into another container of water until they shoot their nets away again. When they shoot away, the birds leave the area around the boat and the small fish can then be released.

When fishing at night, the hopper may not always be used as catfish are not generally encountered as frequently as during the day, there are no bird predators and the bycatch has a better chance of remaining alive on coming to the surface as the shots are of short duration (30-45 minutes) and there is less heat.

These fishers also sometimes target squid and when doing so do not use the hopper as the squid release ink in the water making sorting difficult.

Some other fishers in this fishery use plastic "butchers" tubs as hoppers. These are a round tub about 1 metre in diameter and 0.5 metre high.

Any problems: No problems have been encountered with this system. The original basic design first used is still in use today.

Hawkesbury River trawler.

Hopper with metal baskets.

Hopper and conventional tray.

Emptying catch into the hopper.

NSW Estuary Prawn Trawl – Hunter River

As of December 2003 fishers in the Hunter River have voluntarily made it mandatory for all Hunter River prawn trawl vessels to use a hopper. This is mainly to improve the survival of the bycatch and small prawns which were previously released back into the water at the end of the sorting from a dry tray, in poor condition. The use of hoppers also reduces the handling of venomous bycatch species as they can be scooped out, rather than hand picked.

The type of hopper tank installed is at the discretion of the fisher. For example, the fisher interviewed uses a 44 gallon drum cut down to a suitable height for him to work. Some other fishers use plastic butchers drums. The hopper is usually filled with fresh sea water, the catch emptied into it and a fish sieve used to scoop off the bycatch and tip it down a conduit pipe, reaching into the sea approximately 150 mm below the waterline. The release of bycatch below the waterline prevents the birds eating it and may further enhance bycatch survival.

It is expected that product quality will improve with the use of hoppers, as previously some fishers used a tool like a screwdriver to pick up the prawns off the tray by their antenna and put them into the cooker. This method however, sometimes resulted in small prawns being mixed in with the larger prawns. With the hopper, fishers can hand-grade off the scoop, providing more accurate grading.

In addition, the Hunter River fishers also understand the need for good public opinion and see the introduction of hoppers as a way for improving public perceptions of the fishery. Fishers see the introduction of hoppers as a win for their fishery by potentially reducing impacts to bycatch, while improving product quality. By using BRDs in their nets, in conjunction with a hopper and a discard pipe below the waterline, the fishers expect that bycatch survival should improve.

NSW Ocean Prawn Trawl – Port Stephens

Vessel name: *Fairwind*

Hopper Materials: Plastic fishbin

Hopper Size: approx. 1m^3

Vessel Length: 16 metres

Cost: approx. $960

Benefits: This vessel has used this type of hopper for over 30 years when fishing for royal red prawns during the day off the continental shelf in approximately 600 metres of water. The hopper allows the prawns to swim around, remain cool and prevents black spot, which may occur on a conventional sorting tray when exposed to the air and heat. For the same reason, this fisher also uses the hopper when fishing for king prawns on hot days.

Operation: As this is a multi-species fishing vessel, a permanently installed hopper can take up too much room on the back deck. This fisher often goes lobster fishing and needs room for the lobster traps. Consequently, he finds it useful to have a hopper that he can move out of the way when fishing for lobsters. When not needed, the Fishbin hopper is stored behind the wheelhouse. When it is needed, it is simply moved onto the back deck and filled with fresh sea water via the deckhose. A bung is located at the bottom of the hopper acting as a drain. Many of the small fish float or swim to the top of the hopper and are scooped out easily using a sieve before being returned to the sea. The prawns are then sorted off the sieve.

Any problems: If fishing muddy grounds, soft mud settles in the bottom of the hopper making sorting and cleaning difficult. Small crabs in the hopper are also annoying as they swim around the bottom and bite and damage the prawns. In rough seas, the water in the hopper sloshes around, spilling over the side and wetting the crew. This sloshing can also impact on the survival of fish bycatch.

NSW Ocean Prawn trawler.

Fishbin hopper.

Live restaurant prawns – Moreton Bay

Vessel name: *Carefree*

Hopper Materials: Fibreglass

Hopper Size: 0.6 m x 0.4 m x 0.5 m (approx. 0.12 m^3, approx. 400 litres)

Vessel Length: 12 metres

Cost: approx. $1,000

Benefits: This hopper system was designed and installed by the owner in 2000 to maximise the production of live prawns for the live restaurant market. The primary benefit seen was the improved product quality from the catch remaining submerged in water during the sorting process to keep the prawns alive.

The owners have found that this system provides a 90% survival rate for prawns caught. At the same time, they believe that it has markedly increased the survival rate of the bycatch when the average length of a trawl shot is 45-60 minutes. Another advantage is space efficiency. Space on the back deck is a problem for the smaller boats in Moreton Bay.

Operation: This systems consists of three layers – the hopper, a sorting tray, and a drain. All catch from the codend is placed into the water in the hopper immediately upon winching up. A grid in the hopper separates the larger and smaller animals, thereby allowing larger bycatch to be returned to the sea very quickly, thereby reducing sorting time. To further enhance the survival rate, pumps are used in the hopper to circulate and aerate the water.

Comment from trawler owner: "We strongly believe that the hopper system that we have designed has much to offer to the sustainability of the environment and thus the fishing industry".[16]

Any problems: There is a restriction on the capacity of the hopper (under 60 kg of prawns per shot).

Live restaurant prawns – Newcastle

Vessel name: *Fear Not*

Hopper Materials: Fibreglass

Hopper Size: Two hoppers, each holding around 700 litres of sea water.

Vessel Length: 18 metres

Cost: approx. $1,000

Benefits: This fisher designed, built and installed his own hopper in 2001 so as to keep prawns alive for the live restaurant market. The spilling of catch into water greatly improves prawn quality and the more efficient processing allows additional time for grading to ensure top quality. In addition, the fisher believes more bycatch is returned alive to the sea. Using this hopper also provides more time to make decisions on the vessel operations, as the prawns are held in water and not exposed to the air like on a conventional sorting tray. It also is beneficial for Occupational Health and Safety, as it reduces the handling of venomous fish bycatch such as catfish.

Operation: The hopper system consists of two hoppers with a movable sorting tray on top. The hoppers are filled using the deckhose. The first two codends are spilled into one hopper, and the sorting tray put on top. The third net is then spilled into the other hopper. There are no conveyors, rather the prawns are scooped out of the hopper with nets. The prawns are sorted and graded and put into baskets in containers of sea water. Bycatch is returned to the sea by hand. Baffles are used in the hoppers to prevent the water sloshing. The hopper is emptied after each shot via a valve on the bottom of the tank.

For the live prawn market, the hopper is used in conjunction with short shots of 45-60 minutes to maintain premium quality prawns. It was not a major job to fit the hopper onto the trawler.

Any problems: None

Small boat hopper prototype

This is a prototype of a small vessel hopper, not yet in commercial use.

Hopper Materials: Originally fibreglass, however a new hopper is being constructed from ¾ inch construction ply for pressure moulding to allow plastic models to be produced at low cost.

Hopper Size: approx. 1m^3 volume

Vessel Length: The prototype is designed for small inshore trawlers and beam trawl vessels (less than 12-14 metres). However, it can easily be modified for a larger inshore trawler by doubling the capacity. Alternatively, two small hoppers could be installed, one on each side of the dry sorting tray.

Hopper Cost: minimal (price of fibreglass/plastic tank and PVC pipe).

Benefits: The use of a hopper in inshore and river trawl fisheries close to urban development can reduce the incidence of dead bycatch washing up on beaches and riverbanks, which is a major concern for the community. The prototype is designed for fisheries that operate in shallow waters (less than 20 metres), with short daylight shots (less than 60 minutes) (such as the Cairns Inshore Region Banana Prawn and Tiger Prawn Broodstock Fishery, Moreton Bay Otter and Beam Trawl fisheries, and the smaller end of the Queensland East Coast Otter Trawl Fishery fleet).

With short daylight shots, bycatch species are mainly small fish. Initial trials with this hopper have showed an enhancing of the survival of these small fish.

Hopper full of water.

Spilling catch into hopper.

Bycatch fish swimming in hopper.

Bycatch leaving hopper and onto discard chute.

In addition, the hopper improves prawn quality and could be used by broodstock collectors (for tiger prawn aquaculture) and those who wish to access the live prawn market.

The hopper also operates entirely off the deckhose with no need for hydraulics.

Operation: The hopper is a small tank on a stand into which the net is emptied. A black lid is then placed on the hopper to reduce light levels in the hopper. At the top of the hopper at one end is a water inlet and at the other, a small covered outlet. Water flows continually into the hopper via a deckhose. A PVC pipe inside the hopper directs the water flow so that the current flows away from the outlet hole. Once the catch is in the hopper and the lid on, the outlet hole is uncovered and becomes a source of light. The fish swim against the current, towards the light and from the outlet into a discard chute that has a strong flow of sea water that flushes the fish back into the sea.

The hopper floor can also be raised, which encourages fish crowding and the fish to swim out faster. After all the fish have swum out, the water flow rate can be reduced and the hopper floor containing all the prawns raised and used as a tray covered with water from which to sort the prawns.

The hopper operates on the assumption that fish are attracted to light, that they will turn against a current and swim into it and that crowding of the fish in the hopper helps the fish aggregate and swim more quickly out of the hopper.

Any Problems: None. A small trawler using a dry sorting tray usually does not require any modification for this hopper to be installed, as the small hopper tank can usually fit on the back deck next to the tray.

WHAT DOES THE SCIENCE SAY?

There is scant published literature on hoppers, both within Australia and overseas. This is not surprising given that the development and uptake of hoppers has been a relatively recent industry initiative, driven by economics.

Within the Australian literature there are only two published papers that refer to hoppers.[17,18] These studies found that sub-sampling from the hopper caused a bias in catch composition estimates, as the distribution of species exiting the hopper and onto the sorting conveyor was uneven. This was due to the differing buoyancies of the individual species and variations in catch size.

When the catch was spilled into the hopper most of the prawns, other crustaceans and shells (bivalves) sank and were removed near the beginning of sorting. For example, all scallops (*Amusium pleuronectes*) had been removed from the hopper by the time approximately 50% of the catch was sorted. Many fish species floated and tended to remain in the hopper until the majority of the prawns had been removed. The removal of ponyfish/dollarfish (*Leiognathus moretonensis)* and silver biddy (*Gerres subfasciatus)*, both small fish that live in the water column, did not start until after 60-70% of the catch was sorted. Some fish species did come out of the hopper near the beginning of sorting, such as lizard fish (*Saurida undosquamis)* and rusty flathead (*Inegocia japonica)*, both of which are long, shallow bodied fish that live on the sea bed.[19]

Other limited information relating to hoppers includes:

- A CD Rom on best practice hopper operation.[20] This shows footage of a hopper in operation and is a practical demonstration that highlights the best practices for hopper use to maximise bycatch survival and enhance product quality. It also includes a video of the operation of a small boat hopper prototype developed in Queensland. This CD Rom is included at the back of this handbook.

- A report which describes two small boat hoppers used in NSW [21] and a report on the preliminary assessment of bycatch survival from hoppers compared with conventional sorting trays.[5]

- References to hoppers made by conservation groups when commenting on a number of trawl management plans. The Great Barrier Reef Marine Park Authority recommends that the development and adoption of hopper technology be encouraged.[22] The Australian Coral Reef Society recommends that research and assessment of hoppers continues.[23] The World Wide Fund for Nature (WWF) position statement on trawling in the Great Barrier Reef area states that "to reduce the extent of bycatch mortality there should be rapid industry wide adoption of wet hoppers".[24]

Hoppers and bycatch survival

The use of hoppers on trawlers, when used in conjunction with other bycatch reduction gear technologies and operational procedures, has the potential to increase the survival of bycatch. Very little scientific research has however, been conducted to test this theory.

Hoppers have been evaluated for their potential to improve bycatch survival in the Queensland East Coast Prawn Trawl Fishery.[5] Comparative potential survival was examined between boats, with and without hoppers. The survival for bycatch from hoppers was assessed over two and four hours using short survival trials. As such, this was considered a preliminary study that suggested indications of potential survival. Longer duration survival trials (greater than 4 days [8]) would be necessary to fully assess bycatch survival rates.

This preliminary work indicated that hoppers increase short term bycatch survival. The use of hoppers almost doubled the average numbers of bycatch surviving the catch and sorting process, improving from 8.5% with a conventional sorting tray to 16.1% when using a hopper. The range of numbers of species surviving varied. For a conventional sorting tray it was 1.2%-17.1%, while for a hopper was 4.6%-37.4%. However, overall the numbers of species that survived were all significantly higher from vessels using hoppers.

A total of 151 species were sampled for the bycatch survival studies, where 88 species survived hopper processing, 53 species survived processing from a conventional sorting tray and 58 species did not survive either hopper or tray processing.

The set up and operation of the hopper was also observed to have an affect on bycatch survival. The more efficiently the hopper operated, the better the survival.

The information available suggests that hoppers do improve short term bycatch survival for some species, although the response by different taxonomic groups and species may be highly variable and bycatch survival improvement may only occur if hoppers are used in conjunction with other bycatch reduction gear technologies and operational practices.

Fate of bycatch on trawlers

Extensive work has been undertaken to examine the fate of bycatch from trawlers. This research however, has not been undertaken on trawlers using hoppers.

The majority of fish bycatch (80-90%) died when discarded from trawlers using conventional sorting trays. Care should be taken not to generalise though, as there can be large differences in fish survival, even within the same family, genera and with size.[7,8,25]

Invertebrates generally have higher survival rates than fish, although this also varies with species and between studies. Crustaceans were found to generally survive trawling and exposure on the sorting tray. Nearly all cephalopods (cuttlefish and squid) were dead when discarded from the sorting tray.[7] Bivalve molluscs (shells) were found to be the most resistant to trawling. Most gastropods (snails) and robust echinoderms, such as some holothurians (sea cucumbers) and asteroids (starfish) also survived capture in trawl nets.[8,9]

International fisheries that use hoppers

The use of large hoppers in international fisheries appears to be limited to some Australian vessels fishing in Indonesian waters that use the same type of large hopper as used in Australian waters.

Internationally, the term "hopper" on a trawler generally refers to a large empty metal container into which the catch is emptied and then the target species (often fish) are removed by a conveyor. **These containers are not however filled with sea water as with hoppers in Australia.**

In 2001, a USA "shrimp" fisher designed and tested his own version of a small water filled hopper with a conveyor to lift out the catch.[26] Similarly to that found in Australia, this fisher found that with his prototype hopper sorting time was faster, bycatch mortality appeared to be reduced and profitability increased with the removal of a crew member.

Water filled hoppers have been developed in Australia in relatively recent times. In Australia, the main uptake of large hoppers is in high value prawn fisheries, especially in the tropics. There appears to be few other industrialised countries that have high value prawn trawl fisheries in the tropics where money has been invested on upgrading processing equipment.

Gaps in the research

The major gap that currently exists is the lack of thorough scientific research on the effects of hoppers on bycatch survival and the fate of discards from a hopper. Preliminary scientific research in the Queensland East Coast Prawn Trawl Fishery [5] indicated the survival of species for up to four hours after release from a hopper back into sea water. The longer term effects of trawling on survival rates is unknown.

This area needs to be investigated more rigorously, particularly as conservation groups have begun calling for the mandatory use of hoppers, based on the idea that they improve bycatch survival, yet with little supportive scientific evidence.

Conclusion

Hoppers may be considered as part of a suite of tools to improve the survival of bycatch. To maximise bycatch survival, hoppers need to be used in conjunction with other techniques (for example, bycatch reduction devices) and with best practice operational methods (for example, low catch to water volume ratios).

Fisheries managers, industry and scientific and conservation groups have called for more research into the effectiveness of hoppers in improving bycatch survival. The Northern Prawn Fishery and Torres Strait Prawn Fishery also support this call for more quantitative hopper bycatch research in their Bycatch Action Plans.

A full literature review is available on the Ocean Watch website at www.oceanwatch.org.au and included on the CD Rom at the back of this handbook.

12 TIPS FOR LARGE HOPPER PRACTICE

Over the years a number of fishers have learned some valuable lessons and tips on enhancing the survival of prawns and bycatch when using large hoppers. Below is a collection of some of those lessons.

1. **Shorter trawl duration** shots of less than 2.5 hours enhance bycatch survival in general and increase the value of commercial catch.

2. **Ensure the hopper is filled with clean, non-refrigerated sea water** until it overflows out the rear grill grate. In rough weather, the hopper should be filled with sea water to a level that suits the conditions.

3. **Place baffles in position** to stop sloshing water in rough seas.

4. **Spill the contents of the cod-ends into the hopper** rather than onto the sorting trays.

5. **Do not overload the hopper with catch** as overloading can affect product quality, bycatch survival and can place stress on the conveyor belt.

6. **Do not put gravel, mud, sand, coral etc into the hopper** as it can clog and jam the hopper conveyor. Consider spilling the catch onto the trays and hosing the catch into hopper, unless as happens in some areas occasionally, there is a very large amount of fine gritty mud that turns "cement like" with water. In these cases you cannot hose this into the hopper and have to sort through it on the trays.

7. **When sorting commences** and the sorting system provides for either prawns or bycatch to be picked out, **make sure the flap at the end of the conveyor and the slot at the end of the sorting chute are in their correct positions before starting conveyors!**

8. **Start with a slow sorting conveyor speed** so the crew can sort through the large, initial load of catch moving past them. Most of the prawns and heavier materials will be removed by the hopper conveyor first.

9. It is essential to **co-ordinate the speeds of the two conveyors so that the flow of product is steady and regulated** to the sorting ability of the crew. Continuous sorting is more efficient than stopping and starting.

10. As the number of prawns remaining in the hopper reduces, **lower the water level in the hopper** to increase the rate at which the last prawns can be removed via the conveyor from the hopper.

11. **When there are no more prawns, drain out all the remaining water and run the two conveyors at maximum speed** to bring the rest of the bycatch quickly out of the hopper, rapidly along the sorting conveyor and into the discard chute, using a strong fresh sea water flow (to prevent any blockages) and return the bycatch to the sea.

12. **Keep conveyor belts running and hose out hopper thoroughly** until the water running out of the drains is clear. Hose down the sorting conveyor and blast it with water from underneath to clean it properly.

FREQUENTLY ASKED QUESTIONS

Q How much do hoppers cost?

A The average cost of purchasing and installing a hopper is dependent on the type and size of boat and style required. To give an indication of price, it is likely that you would need to invest:

- $80,000-$125,000 for large hopper systems which includes the hopper (approximately $20,000-$45,000) and sorting conveyors (approximately $10,000-$28,000), grading piano (or grading machine), packing table, packing holding racks, power packs and installation;
- $45,000-$60,000 for the large hopper, conveyors and installation;
- $30,000 for a smaller version of the large hopper, conveyors and installation; or
- as little as $70 for a simple small plastic container and a sieve to scoop the catch out.

These costs are influenced by:

- the materials used to make the hopper (for example, stainless steel, alloy steel, aluminium or fibreglass) and the quality of the materials used on other parts such as conveyors and rollers;
- the size of the hopper and complexity of the system installed; and
- the level of modification required to the back deck of the vessel to install the hopper.

For example, in the Northern Prawn Fishery where vessels are large (greater than 18 metres), hopper systems need to be able to take the weight of large tonnages of banana prawns and will usually incorporate grading pianos and packing tables. In other fisheries where the vessels are smaller and catches are not so large, the system can be a much simpler, smaller scale design without extras such as piano graders. This makes it cheaper to build.

The quality of materials also influences the overall cost. For example, a high quality conveyor belt is expensive. However, better quality belts are more durable, respond better to heat and cold, have a better gearing system with more grips for the belt on the cogs and use high wearing resistant nylon slips under the conveyor rather than butchers nylon.

Another factor that can affect the cost is the fluctuating price of material such as stainless steel.

Q Is it a major job to modify a vessel to install a hopper?

A Usually not. In many cases it is simply a matter of cutting off the existing box and tray, or on smaller vessels possibly even turning the tray and box into a hopper.

Examples of other modifications discussed by fishers who have installed hoppers include:

- building new deck brines to maintain brine capacity; and
- moving engine room fans to the back of the boat so as to create more deck space for the hopper, while maintaining enough room for crew to move around.

Q Where can I purchase a hopper?

A Although any engineering company can design and build a hopper, knowledge of the operational practices of a trawl vessel and the handling of its target species assists in tailoring a design of hopper that suits the vessel. Three main hopper manufacturers are responsible for the majority of large hoppers currently in use within Australia, namely:

- FISHQUIP operating out of St Helens, Tasmania;
- Haldane Enterprises operating out of Port Lincoln, South Australia; and
- Tropic Engineering operating out of Cairns, Queensland.

Q Can the installation of a hopper affect vessel stability?

A Stability issues have not been encountered by fishers using hoppers on larger vessels. Trawlers greater than approximately 18 metres in length are designed to take the weight of large amounts of product on the back deck. Many fishers indicated that the additional weight of the hopper and its water made no difference to the stability of their vessel.

On smaller vessels there are conflicting opinions. Those fishers using small hoppers on inshore and estuarine trawlers indicated that they have not experienced any problems related to stability. Other fishers on smaller trawlers of approximately

12-18 metres without hoppers commented that they believed that a hopper would detrimentally affect stability due to the extra weight of the water above deck, particularly with this water sloshing around in rough weather.

An engineer that designs and builds hoppers disagrees and has indicated that for small trawlers that can have, for example, 500 pounds (approximately 230kg) of product on a dry sorting tray, the installation of a hopper transfers the weight of this product to a lower position in the boat, thereby lowering the centre of gravity (refer Figure 10). As such, the stability of the vessel would not be affected by the installation of a hopper. In addition, the water in the hopper is displaced by the product (flowing out the overflow grate), reducing some of the water's weight.

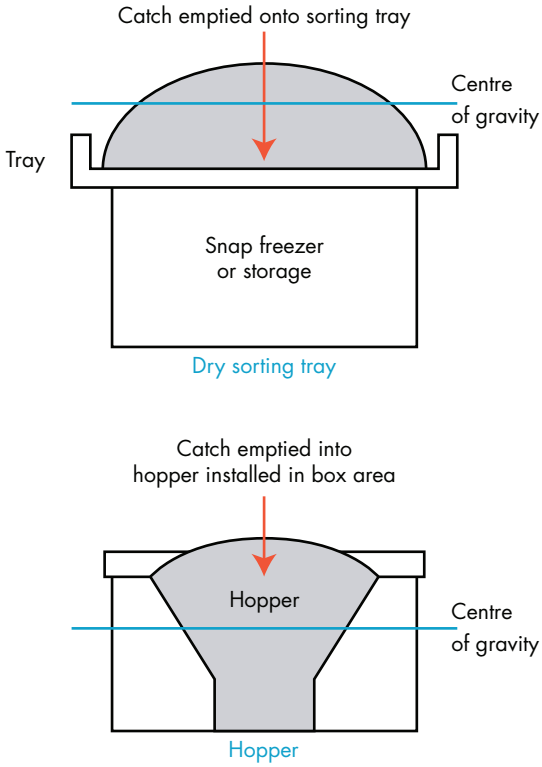


Figure 10 – Comparison of the centre of gravity using a conventional sorting tray and hopper.

Hoppers designed to suit small vessels have a reduced volume, are generally narrow and use baffles to prevent sloshing water. Currently, the smallest vessel using a hopper system with a conveyor is 13.9 metres long and 5.6 metres wide. This vessel was widened to make it more stable and comfortable, as it works the Torres Strait where the sea is often rough. After widening the vessel, a narrow, small hopper was installed. No problems have been encountered with stability.

Q Do hoppers provide value for money? How long will it take to recoup the costs of purchasing and installing a hopper?

A It is difficult to define any increases to product value per kilogram attributable from the use of a hopper due to external factors such as market price fluctuations, the value of the Australian dollar and unexpected events such as SARS.

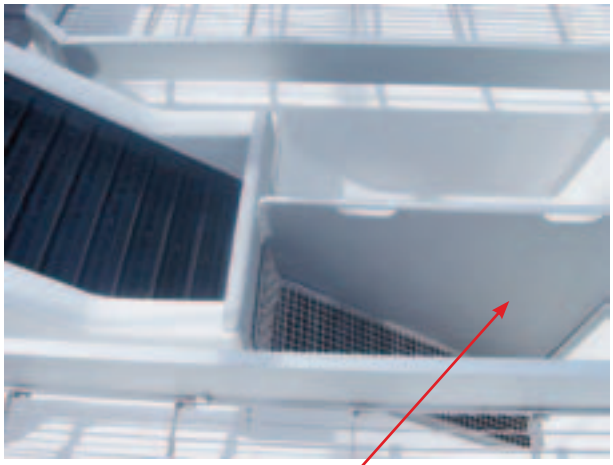
However, although the hopper cannot be directly translated into a price per kilogram product improvement, **all fishers surveyed stated that product quality had improved and that the hopper was worth installing**. This is because it improves processing efficiency, product quality and crew Occupational Health and Safety- all of which are cost benefits.

A fisher surveyed from the Spencer Gulf Prawn Fishery commented that with a good crew and strong product prices, a fisher could probably recoup the money spent on the hopper system in a couple of good seasons.

Q How can you tell how well each net is fishing when the catch is spilled into a hopper?

A Fishers surveyed commented that initially it was more difficult to assess how much catch was in each net when using a hopper, given that the catch was spilled directly into the hopper**.** However, these fishers commented that they now do not have any trouble judging the size of the catch in each net.

For some hopper designs, measurement marks are placed along a centreboard in the hopper to estimate the amount of catch.



Centre board with marks to show the level of catch in the hopper.

With large catches, the catch is often spilled over onto trays on either side of the hopper, so as not to overload the hopper. Water sprays are often used on the trays to keep this catch cooler. The catch on the tray is tipped into the hopper as sorting progresses. The skipper can then easily see what is in each net.

Q How reliable are hoppers?

A Hoppers can break down, however, as with any mechanical equipment, regular maintenance greatly reduces the likelihood of breakdowns.

For example, a fisher commented that a conveyor belt snapped. This may have been due to the belt being worn, overloaded with catch, or both. To avoid this, conveyor belts should be maintained in good condition and the hopper not overloaded with catch as this may place excessive weight on the belt.

A new hopper modification is currently under construction for the Spencer Gulf Prawn Fishery to provide a contingency if there is a hopper breakdown at sea. The hopper that is currently used by nearly all the Spencer Gulf vessels has a centreboard which divides the hopper into two. This system is being modified to include dual conveyor belts, one from each side of the hopper. If one conveyor breaks down, the crew can still continue processing by operating the hopper from the other side.

Q How many types of hoppers are there?

A Large hopper systems use a standard design, but with a wide range of modifications. For each vessel, the hopper system is designed and modified to suit the needs of that vessel.

For small to medium vessels (12-18 metres), off the shelf hopper systems that use conveyors (except those mentioned earlier in the comments on stability) are not readily available. These vessels often need more than a simple tank with scoop, and yet a hopper with a conveyor is often considered too costly to justify for the vessel.

The benefits of improved product quality and increased sorting time are more marginal with smaller catches. However, with the addition of a hopper, one less crew member is needed, which saves costs. The 13.9 metre vessel with a hopper and conveyor, operates year round using just two crew. Some fishers on these sized vessels when surveyed indicated that they would be willing to use a hopper, but did not wish to spend the money designing, installing and trialling one.

Q Is there enough room on the back deck of small trawlers to put a hopper?

A A hopper can be designed to suit any size trawler including the smallest estuarine trawlers. For very small vessels (less than 10-12 metres) the hopper is simply a small water container, while for approximately 12-18 metre vessels, it is possible to design a small hopper system, with a hopper and sorting conveyors or simply just a hopper conveyor. Once the product is out of the hopper, sorting conveyors are not necessary. One vessel uses a water slide for sorting. Many modifications are possible.

A hopper needs to be economical on space as there is very little room on the back deck of smaller vessels. Fishers surveyed indicated that a lack of space was a key constraint to installing a hopper. The new prototype small hopper system is suitable for such vessels with limited deck space, no hydraulics and little money to spare on installing a larger type hopper.

GENERAL CONTACTS AND INFORMATION

The contact details for relevant organisations, hopper manufacturers and individuals in the following categories can be obtained from Ocean Watch Australia Ltd:

- hopper designers and manufacturers;
- industry bodies;
- fisheries management agencies;
- environmental management agencies;
- research providers;
- market development;
- Fisheries Research and Development Corporation; and
- Master Fish Merchants Association of Australia.

This handbook is available via the Ocean Watch website www.oceanwatch.org.au

Spencer Gulf trawlers.

References

1. FAO (1995) Code of Conduct for responsible fisheries. FAO 1995, 41pp

2. Brewer, D.T., Rawlinson, N., Eayrs, S. and Burridge, C.Y. (1998) An assessment of Bycatch Reduction Devices in a tropical Australian Prawn Trawl Fishery. *Fisheries Research*. 36, 195-215

3. Broadhurst, M.K. and Kennelly, S.J. (1996) Rigid and flexible separator trawls that reduce the by-catch of small fish in the Clarence River Prawn-Trawl Fishery. *Australian Marine and Freshwater Research* 47, 991-998

4. Robins-Troeger, J.B., Buckworth, R.C. and Dredge, M.C.L (1995) Development of a trawl efficiency device (TED) for Australian prawn fisheries. II. Field evaluations of the AusTED. *Fisheries Research* 22, 107-117

5. Dell, Q., Gribble, N., Foster, S. and Ballam, D. (2003) Evaluation of Hoppers for reduction of bycatch mortality in the Queensland East Coast Prawn Trawl Fishery. FRDC Project 2001/098. 68 pp

6. Personal communication with Carrick N. SARDI, SA, 2003.

7. Wassenberg, T.J. and Hill, B.J. (1989) The effect of trawling and subsequent handling on the survival rates of the bycatch of prawn trawlers in Moreton Bay Australia. *Fisheries Research.* 7, 99-110

8. Wassenberg, T.J. and Hill, B.J. (1993) Selection of the appropriate duration of experiments to measure the survival of animals discarded from trawlers. *Fisheries Research.* 17, 343-352

9. Hill, B.J. and Wassenberg, T.J. (1992) The fate of materials discarded from shrimp trawlers. International conference on shrimp bycatch Lake Buena Vista, Florida. 115-123

10. Harris, A.N. and Poiner, I.R. (1990) By-catch of the prawn fishery of Torres Strait: composition and partitioning of the discards into components that float or sink *Australian Journal of Marine and Freshwater Res*earch. 41, 37-52

11. Andrew, N.L. and Pepperell, J.G. (1992) The by-catch of shrimp trawl fisheries. *Oceanography and Marine Biology Annual Review.* 30, 527-565

12. Kennelly. S.J. (1995) The issue of bycatch in Australia's demersal trawl fisheries. *Reviews in Fish Biology and Fisheries.* 5, 213-234.

13. Blaber, S., Brewer, D., Buckworth, R., Burridge C., Farmer, M., Milton, D., Salini, J., Wang, Y., Wassenberg, T., Buxton, C., Cartwright, I., Eayrs, S., Rawlinson, N., Gill, N., Mounsey, R., Ramm, D. and MacCartie, J. (1997) Effects of trawl design on bycatch and benthos in prawn and finfish fisheries. FRDC Project 93/179. 199pp

14. Farmer, M.J., Brewer, D.T. and Blaber, S.J.M. (1998) Damage to selected fish species escaping from prawn trawl codends: a comparison between square mesh and diamond mesh. *Fisheries Research*. 38, 73-81

15. Aslin, H.J and Byron I.G. (2003) Community perceptions of fishing: implications for industry image, marketing and sustainability. Bureau of Rural Sciences and Fisheries Research and Development Corporation. 20pp

16. Personal communication with Yang, J, trawl vessel owner in the Moreton Bay Trawl Fishery, Queensland. 2003.

17. Heales, D.S., Brewer, D.T. and Wang, Y.G. (2000) Subsampling multi-species trawl catches from tropical northern Australia: does it matter which part of the catch is sampled? *Fisheries Research*. 48, 117-126

18. Heales D.S., Brewer D.T. and Jones, P.N. (2003) Subsampling trawl catches from vessels using sea water hoppers: are catch composition estimates biased? *Fisheries Research*. 63, 113-120

19. Personal communication with Heales D.S. CSIRO Cleveland, Queensland. 2003.

20. SeaNet Fisheries Extension Program (2002) Recommended Practices for Hopper Operation. CDRom. Ocean Watch Australia Ltd. FRDC Project 2001/098

21. Broadhurst M.K. (1999) Separating prawns and bycatch using on board sorting containers filled with water: examples from New South Wales, Australia. Report for GEF/UNEP/FAO Project on reduction of the impact of shrimp fisheries; Regional workshop for Africa, Lagos, Nigeria 13-15th December 1999. 9pp

22. GBRMPA (2003) The Great Barrier Reef Marine Park Authority Audit of the Queensland East Coast Trawl Fishery.

23. ACRS (2003) The Australian Coral Reef Society comments on the Ecological Assessment of the Queensland. East Coast Trawl Fishery.

24. WWF (2000) and (2001) World Wildlife Fund Position statements on Demersal Otter Trawling in the Great Barrier Reef World Heritage Area., Worldwide Fund for Nature, Australia

25. Hill, B.J. and Wassenberg, T.J. (1990) Fate of discards from Prawn Trawlers in Torres Strait. *Australian Journal of Marine and Freshwater Res*earch. 41, 53-64

26. Lewis J.K. (2001) Bycatch mortality reduction in a shrimping operation. North Carolina Sea Grant Program. Final Report. Project No. 00-FEG-18. http://www.ncseagrant.org/.

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