ESTUARY PRAWN TRAWL SHARE LINKAGE WORKING GROUP

Agenda Item 7: Providing for the use of more efficient trawl systems in the EPT Fishery

November 2013

Agenda item:

Preliminary outcomes of the FRDC-funded research project 'Reducing the environmental impacts and improving the profitability of prawn trawling through a structured framework of anterior gear modifications' and potential reforms to provide for the use of more efficient trawl systems in the NSW Estuary Prawn Trawl Fishery.

Background:

The project objectives are:

1. To identify anterior gear modifications that reduce the bycatch, drag/fuel consumption and habitat impacts of prawn trawls, while maintaining target catches and isolate their mechanisms of action.
2. Using (i) above, provide a framework and direction for the future refinement of Australian prawn trawls.
3. Investigate the practicality of simple, but appropriate changes identified above under commercial conditions in NSW, and assist local commercial fishers and managers in their implementation, adoption and where appropriate, legislation.

Several papers have been completed and published (or are in the process of being published). A list of the papers and lay summaries for each are attached.

Current situation:

The industry-wide reform program presents an ideal opportunity to review the regulations that govern the use of fishing gear in the Estuary Prawn Trawl Fishery. The reasons for this include:

- The reform program is all about improving industry viability – and the research above demonstrates that much can be done to improve the efficiency of existing gears.
- Some of the linkage options short-listed by the Working Group to date relate to trawl gear (i.e. linking shares to headline lengths etc.). It would be inappropriate to progress those concepts in isolation of potential changes as a result of the above research.
- Implementing the outcomes of the reform program will require amendments to the regulations – and if changes are to be made to the gears that may be used ideally, these should be concurrent.
- Improving the efficiency of fishing gears is one way to minimise the risk of reduced school prawn (and squid) production as a result of the reform program (e.g. if a larger number of active and productive fishers take the opportunity to exit); both initially and into the foreseeable future.

Advice from the Science and Research Division indicates that based on the results of the research above, consideration should be given to the following, in the order suggested.

1. Choose the most appropriate mesh size the size of the targeted prawns.
2. Shorten the trawl body length as much as possible.
3. Reduce wing height/area as much as possible.
4. Closely match the otter-board size to the trawl twine area.
5. Choose the most hydrodynamic otter board.

6. Triple and quad rigs are more fuel efficient than double or single rigs.

Further advice from the Science and Research Division indicates that combinations of the modifications tested appear as effective as BRDs (like the Nordmore-grid) in reducing bycatch and would have obvious cumulative benefits and importantly, some of the modifications will reduce fuel consumption by up to 18-20%.

Draft recommendations (for discussion):

The following draft recommendations have been developed to stimulate and guide discussions.

Recommendation 1 (voluntary v compulsory)

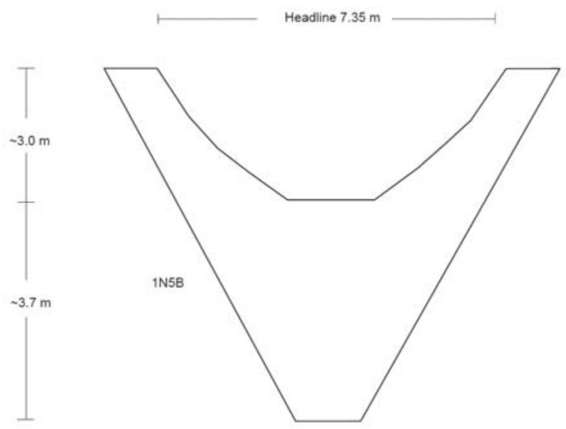
The regulations are amended in such a way that shareholders may voluntarily adopt the full range of modifications proposed – to improve their profitability and reduce bycatch – rather than forcing all shareholders to modify all of their nets.

Recommendation 2 (agreement on new minimum mesh sizes)

New minimum mesh sizes are agreed and adopted as soon as the results of the research on mesh sizes are available – early to mid 2014. The agreed minimum mesh sizes may be estuary-specific or fishery-wide.

Recommendation 3 (new mesh sizes only allowed if shorter nets with steeper tapers used)

The new minimum mesh size(s) – which are likely to be relevant to the body of the net only – may only be exercised when using a 'shorter net with a steeper side taper (i.e. 1P5B)', which might be defined as a net with a body length (from mid headline)-to-headline length ratio not exceeding ~0.5. For example, a Clarence-River trawl with a headline length of 7.35 m would need to be less than 3.7 m long from the mid headline to the end of the body (see Figure).



Recommendation 4 (wing heights and boards)

No changes are made to the regulations with respect to wing heights and otter boards, noting that these are not currently regulated. Under this approach, shareholders may voluntarily pursue reduced wing heights and smaller or more hydrodynamic boards to reduce drag and fuel use. Note that lower wing heights will further reduce the length of the trawl, and therefore should help to reduce bycatch.

Recommendation 5 (multiple nets)

The regulations are amended in such a way that shareholders may use any number of nets in any configuration including: single, dual, double, triple or quad gear.

Recommendation 6 (headline lengths for multiple nets: standardising 'swept area')

The regulations are amended in such a way that the 'swept area' remains the same regardless of whether single, dual, double, triple and quad gear are used. This would be achieved by adopting the following.

Table 1. Likely spread ratios expressed as a % of the maximum headline length for a single net.

Single	Dual	Double	Triple	Quad
~67	~75	~70	~77	~75

The Working Group's views are sought on whether swept area should be standardised, noting the following pros and cons identified to date:

Cons:

- Additional cost and complexity. That is, additional regulation, policy and advisory material and the need for fishers to calculate the total allowable headline length based on the number of nets proposed to be used.
- Removes some incentive for fishers to convert to multiple nets – because there would be no immediate increase in swept area – potentially resulting in fewer fishers voluntarily converting and the economic and environmental benefits not being realised to the extent possible.

Pros:

- May stimulate the trading and consolidation of shares (and adjustment) by those converting to multiple nets and seeking to offset any reduction in swept area. This is only relevant if share are linked to net length or net length days.

Recommendation 6 (regulating the length of each headline if multiple nets are used)

The regulations are amended in such a way that if multiple nets are used, they need not have the same headline lengths. For example: a shareholder intending to use triple gear and entitled to use 15 metres of headline should be allowed to use two nets with 5.5 metres of headline and one net with 4 meters of headline – rather than being forced to use three nets of equal size. Also see the next issue.

Recommendation 7 (new maximum headline lengths)

The maximum headline lengths applying to each estuary are increased for improved profitability and rationalised/simplified. Providing for increased headline lengths is justified given the objectives of the reform program and the fact that linking shares to resource access will establish a mechanism to reduce catch or effort if needed for sustainability, resource sharing or other such reasons.

The Working Groups help would be needed to establish new maximum headline-length restrictions – refer to Table 3 below. When determining the new maximum headline lengths, consideration will need to be given to the following:

- If shares are linked to a catch quota, there is no need to worry about catches increasing because total catches in the relevant sector(s) will be capped.
- If shares are linked to net length (i.e. headline length) or net length days (i.e. headline-length days), there is no need to worry about catches increasing significantly. This is because the total 'headline length' or 'headline-length days' available to the fleet will be restricted to historical/sustainable levels.
- If shares are linked to days or endorsement numbers (i.e. minimum shareholdings), consideration will need to be given to the likelihood of fishers increasing their headline lengths, the risk of catches increasing significantly (over and above 'historical levels' or any pseudo ITCAL that may apply) and whether that risk needs to be:
  - Offset by adopting conservative ITCALs (if a days regime is to be pursued);
  - Offset by adopting conservative adjustment targets (if minimum shareholdings is to be pursued);
  - Monitored (i.e. total catches) and the ITCALs or adjustment targets kept under review.

Table 2. Current maximum headline lengths

Sector	Maximum headline lengths
Hunter River	11 metres
Hawkesbury River	11 metres or two nets of 11 metres headline if working Broken Bay
Clarence River	11 metres or two nets of 7.5 metres each

Table 3. Potential maximum headline lengths if shares are linked to various forms of catch or effort

Sector	Catch quota or net length	Days or endorsement numbers
Hunter River	? metres (for discussion)	? metres (for discussion)
Hawkesbury River	? metres (for discussion)	? metres (for discussion)
Clarence River	? metres (for discussion)	? metres (for discussion)

More information

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Research papers completed and published (or in the process of being published)

Broadhurst, M.K., Sterling, D.J., and Cullis, B.R. 2012. Effects of otter boards on catches of an Australian penaeid. Fish. Res. 131-133: 67-75.

Broadhurst, M.K., Sterling, D.J., and Millar, R.B. 2012. Short vs long penaeid trawls: effects of side taper on engineering and catching performances. Fish. Res. 134-136: 73-81.

Broadhurst, M.K., Sterling, D.J., and Millar, R.B. 2012. Relative engineering and catching performances of paired penaeid-trawling systems. Fish. Res. 143: 143–152.

Broadhurst, M.K., Sterling, D.J., and Millar, R.B. 2012. Progressing more environmentally benign penaeid-trawling systems by comparing Australian single- and multi-trawl configurations. Fish. Res. 146: 7–17.

Broadhurst, M.K., Sterling, D.J. and Millar, R.B. 2013. Engineering and catch implications of variable wing-end spread on a penaeid trawl. Sub. To Fish. Res.

Broadhurst, M.K., Sterling, D.J. and Millar, R.B. 2013. Configuring the mesh size, side taper and wing twine area of penaeid trawls to reduce environmental impacts. Sub to ICES J. Mar. Sci.

Promoting refinements to trawl-spreading mechanisms: effects of otter boards on catches of an Australian penaeid

Bottom trawling is an old, but very common, commercial fishing method used throughout the world to target various species of benthic fish and crustaceans, and especially penaeid prawns. Prawn-trawl configurations typically involve multiple nets (i.e. double-, triple- or quad-rigs) that are attached to hydro vanes, or 'otter boards' and towed behind a vessel. The otter boards comprise a substantial weight (up to 40%) of the entire trawl configuration and are orientated at an angle to the tow, so that their drag horizontally spreads the nets.

While so-called 'otter trawls' are quite effective at catching prawns (and other benthic organisms), in some countries there are concerns over their perceived habitat impacts, and they are not particularly fuel efficient. In recent years, rising fuel costs have prompted efforts at improving the efficiency of otter trawling, and because otter boards contribute towards much of the total drag, their modification is a logical starting point. There are several options for reducing otter-board drag, ranging from simply lower angles of attack and greater aspect ratios of traditional configurations, to completely new, more hydrodynamic designs. Alternatively, in some small-scale fisheries, simply replacing otter boards with a horizontal beam and sleds (which are towed parallel to the vessel) should also reduce drag.

However, one important consideration associated with modifying or removing otter boards is that they represent a considerable percentage of the trawl bottom contact and are angled to direct water towards the trawl. These are two factors that could affect the catches of prawns. Understanding the contribution of otter boards to prawn catches is important, since to encourage the adoption of more hydrodynamic, fuel efficient, and environmentally benign trawling systems, there may be some requirement for compensatory adjustments to other trawl parameters to maintain catches.

This study aimed to contribute towards the limited available scientific data in this field, by determining the importance of otter boards on catches of school prawns in Lake Wooloweyah, NSW. Two identical trawls were separately and alternately attached behind either conventional otter boards or a beam assembly (6-m in length) and simultaneously towed (in a double rig) by a local trawler for fifty-one 40-min hauls. Information was collected on the horizontal trawl openings (and associated area trawled), the drag of each configuration and the catches of school prawns and unwanted fish.

The two spreading systems caused similar trawl openings (~ 4.4 m between the wing ends). But, compared to the otter trawl, the beam trawl had significantly less drag (by ~10%) and also caught ~33% fewer school prawns per hectare trawled. The difference in prawn catches was attributed to the efficiency of the otter boards for disturbing school prawns out of the substrate and directing them towards the trawl mouth. The beam trawl also caught ~80% fewer individuals of the most abundant fish (southern herring), which was at least partially attributed to the beam directing some individuals away from the trawl mouth.

While the large reduction in prawn catches by the beam trawl tested here would preclude its use in Lake Wooloweyah, simple modifications, like increasing the foot-rope length to compensate for the loss of the otter boards and making the beam more hydrodynamic, might increase the catches of prawns, and lower drag (while still catching few fish). Alternatively, if otter boards remain but modifications to improve their hydrodynamics concomitantly reduce bottom contact, then adjustments to other trawl parameters might also be required to offset any loss of the targeted school prawns.

Main messages:

- Otter boards result in increased fuel use, but appear to contribute towards catching school prawns.
- Beam trawls had less drag (10%) and reduced bycatch (80% reduction in the numbers of southern herring), but caught significantly fewer prawns (33%).
- Reduced catch, whether the result of using a beam or more hydrodynamic boards, could be offset by allowing longer headline lengths, while still maintaining drag benefits.

Potential way forward:

- Otter boards are not regulated. As such, shareholders may adopt more hydrodynamic boards without DPI intervention.
- Management arrangements that provide for shareholders to increase headline lengths to offset any decrease in catches would be beneficial.
- Beam trawls are unlawful. DPI has not yet considered the introduction of beam trawling, but would be interested in the working group's preliminary thoughts.

Short vs long penaeid trawls: effects of side taper on engineering and catching performances

Prawns form the basis of important fisheries throughout estuaries and coastal areas in many tropical and temperate countries. More than 100 species are targeted using various fishing gears, although much of the total catch comes from 'otter trawls', which comprise a funnel-shaped net made from small mesh that is towed along the sea bed and horizontally spread using hydro vanes (called 'otter boards'). Historically, this type of fishing gear has raised environmental concerns throughout most areas of its operation.

The main concern is that, because of their small meshes and use in areas characterised by large abundances of small organisms, prawn trawls often catch non-target individuals (especially fish).Over the past two decades, this issue has been partially addressed via the installation of bycatch reduction devices (BRDs) into the posterior section (termed the 'codend') of trawls. Such modifications have dramatically improved selectivity, but none are 100% effective, and in some fisheries large numbers of unwanted organisms are still caught and discarded.

A second, more recent growing concern associated with prawn trawls is their relatively poor efficiency. Trawling produces a lot of drag, which requires substantial energy. Rising fuel costs, combined with concerns over carbon emissions, have led to an increasing impetus to reduce the inherent engineering deficits of this fishing method.

Conceivably, both of the above environmental concerns associated with prawn trawling could be addressed via modifications to the anterior sections of trawls; primarily because this area ultimately (1) is responsible for much of the drag, and (2) regulates what is directed into the codend. However, very little relevant research has been done. The aim of this study was to help address this shortfall, by assessing the importance of simply varying the side taper (and therefore the total length and the amount of netting) in a common design of trawl body made with either two or four panels. The work was done in the Clarence River, but the results have implications for other local and international prawn-trawl fisheries.

Four trawls (called the '1N2B two-seam', '1N2B four-seam', '1N5B two-seam' and '1N5B four-seam trawls') were constructed. All trawls were identical except two were made with shallow tapers (25^{o} to the direction of towing and total lengths of 10.4 m), while the other two were steeper and shorter (35^{o} and 6.8 m). For each taper design, one of the trawls was made using four panels, and the other using two (to encompass variability in conventional construction). The trawls were tested against each other during several days fishing, and data collected on their associated horizontal spread, drag and catches.

Irrespective of the number of panels, compared to the long, shallow-tapered 1N2B trawls, the shorter, steeper-tapered 1N5B designs achieved significantly greater predicted horizontal spreads (4.7–5.6%), while reducing drag (up to 4.3%) and also the numbers (per hectare trawled) of one abundant fish species (southern herring) by up to 66%. However, catches of the targeted school prawns (per hectare trawled) were also significantly lower in both of the 1N5B trawls (by up to 50%; and biased towards smaller individuals).

The catch reductions were attributed to the shorter, steeper-tapered trawl bodies increasing the probability of both fish and prawns encountering open meshes and/or allowing southern herring to swim forward and escape through the mouth of the trawl. Although the loss of school prawns was economically unacceptable for the Clarence River fishery, catches could be improved simply by reducing the mesh (42 mm) to a more appropriate size while potentially still maintaining the inherent engineering and selectivity benefits of using short trawls. The utility of this and other simple modifications to anterior trawl design will be tested as part of ongoing research.

Main messages:

- Shorter nets with steeper tapers delivered greater spread, reduced drag (fuel use) and reduced bycatch (66% reduction of southern herring) but, owing to the relatively large mesh size used, caught significantly fewer prawns (up to 50%). Many of the prawns escaping were of smaller size classes.
- Reduced prawn catches could be offset by allowing the use of a more appropriate (smaller) mesh size.

Potential way forward:

- Net lengths (e.g. mid headline to codend) and side taper are not regulated. As such, shareholders may adopt shorter nets with steeper side tapers without DPI intervention.
- To encourage using shorter nets with steeper tapers, consideration should however be given to reducing current mesh sizes and allowing for the use of multiple smaller nets:

    - Refer to the paper titled ‘Progressing more environmentally benign penaeid-trawling systems by comparing Australian single- and multi-trawl configurations’ concerning single, double, dual, triple and quad rigs.
    - Researching appropriate mesh sizes for prawn-trawl nets used to target school prawns is proposed for early-to-mid 2014. Preliminary advice indicates that using smaller mesh sizes goes hand-in-hand with shorter nets and steep side tapers. The easiest way to regulate shorter nets with steep side tapers might be to establish a maximum ratio of headline length to body length.
- Allowing shareholders to increase headline length on an ‘as needs’ basis may also help to offset the decrease in catches of prawns when using shorter nets with steep side tapers.

Relative engineering and catching performances of paired penaeid-trawling systems

Penaeid prawns are very important to the commercial fisheries of many countries. More than 100 species are targeted using various stationary and mobile fishing gears, although most of the global catch is harvested by otter trawling, which involves one or more funnel-shaped nets that are towed and held open by hydro vanes (called ‘otter boards’).

All prawn-trawl fisheries have specific management issues and challenges, but at a broad level, the key environmental concerns of most can be simplified as: poor (1) species and size selectivity (i.e. discarded bycatch) and (2) fossil-fuel efficiencies, and (3) unwanted benthic habitat impacts. Over the past 30 years, various attempts have been made to independently address these three issues, although by far the greatest efforts have focused on modifying trawls to include physical bycatch reduction devices (BRDs), designed to exclude unwanted fish (i.e. 1 above).

While BRDs have mitigated what is perhaps the most important environmental concern associated with prawn trawling, none are 100% effective and few, if any, also address either the poor fuel efficiencies or the potential habitat impacts of trawls (2 and 3 above). Also, in many prawn-trawl fisheries, including those in Australia, there has been reluctance by industries to adopt BRDs that have had few perceived practical benefits.

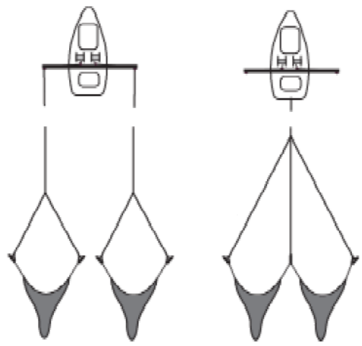
An alternative resolution approach might involve attempts at broadly addressing aspects of all three environmental issues (especially that of most concern to fishers – poor efficiencies) by firstly comparing existing categories of trawling configurations to gauge the limits of what is possible within the current technology, before complicating additions or adjustments are made. Such a framework makes sense, not only in terms of practicality, but also legislation, because simply choosing a conventional configuration that is inherently more environmentally benign fits more easily within existing policy than completely new gear.

The aim of this study was to investigate the utility of such an approach by comparing the relative engineering and catching performances of two mechanisms for spreading paired trawls in the Clarence River. Identical, twin trawls (7.35-m headline) were alternately towed in a “double rig” (comprising four otter boards; two for each trawl) with either 18- or 36-m bridles (“short-” and “long-” double rigs) and in a “dual rig” (36-m bridles with the trawls separated by an otter board, sled and then another otter board).

Across similar towing speeds, the average horizontal trawl openings were greatest in the long-double (4.51 m each), followed by the short-double (4.28 m) and dual (3.85 m) rigs. But, compared to both double rigs, the dual rig required 24 and 20% less towing force and fuel and caught significantly fewer (by ~60%) small mulloway per hectare of trawl-mouth contact.

The dual rig also caught proportionally larger school prawns, but fewer by number than the double rigs. These two effects on prawn catches were attributed to the m otter boards and their efficiency for disturbing small school prawns out of the substratum and directing them towards the trawl mouth.

The results suggest that while removing two otter boards reduces benthic contact, towing force, fuel consumption and bycatch, there is some cost to the catches of school prawns. However, simple adjustments to the dual rig, including possibly longer otter boards, and/or slightly wider trawls might improve prawn catches, while still maintaining the other associated environmental benefits. The data also support a framework of progressing simple, applied solutions to holistically address all of the key perceived environmental concerns associated with prawn trawling.



Double rig (left) and dual rig (right)

Main messages:

- Double rig delivered greater spread and more school prawns (by number). The increased number of prawns was attributed to the additional otter boards.
- Dual rig had relatively less benthic contact, drag, fuel consumption and bycatch (60% of small mulloway).
- The reduced prawn catch in the dual rig could be offset by using longer otter boards and/or increasing headline lengths, while still maintaining inherent environmental benefits.

Potential way forward:

- Allow for the use of double and dual rigs in the Hunter River and the Hawkesbury River upstream of Juno Point. Double and dual rigs can already be used in the Clarence River and the Hawkesbury River downstream of Juno Point.
- Otter boards are not regulated. As such, shareholders may adopt longer otter boards to potentially offset the reduced catch in dual rigs without DPI intervention.
- Allowing shareholders to increase headline lengths on an as needs basis may also help to offset the decrease in catches of prawns when using a dual rig.

Progressing more environmentally benign penaeid-trawling systems by comparing Australian single- and multi-trawl configurations

Prawns are important to commercial fisheries throughout Australia, with 13 key species targeted by some 1300 vessels (~8–25 m) in 13 separately managed fisheries; towing either a single trawl, or two, three or four trawls in parallel. All trawls are fished on the seabed, and opened horizontally using complex systems of hydrovanes (termed ‘otter boards’) and sleds.

Australian prawn-trawl fisheries are quite diverse in terms of the targeted species and legislated gear configurations (including minimum and maximum mesh sizes and headline lengths), but like in many overseas fisheries, they all have two common environmental issues, including poor (1) species and size selectivity and (2) high energy intensities. Further, in some fisheries there is an additional concern regarding (3) perceived habitat impacts.

Over the past 30 years, attempts have been made to independently address these three issues, although by far the greatest effort has focused on modifying trawls to include physical bycatch reduction devices (BRDs), designed to exclude unwanted fish (i.e. 1 above). While BRDs have mitigated what is perhaps the most important environmental concern associated with prawn trawling, none are 100% effective, nor do they address the high energy intensities or the potential habitat impacts of trawls (2 and 3 above). Also, in many prawn-trawl fisheries, there has been reluctance by industries to adopt BRDs that have had few practical benefits.

An alternative resolution approach might involve attempts at broadly addressing aspects of all three environmental issues (especially that of most concern to fishers – high fuel costs) by firstly comparing existing categories of trawling configurations to gauge the limits of what is possible within the current technology, before complicating additions or adjustments are made. Such a framework makes sense, not only in terms of practicality, but also legislation, because simply choosing a conventional configuration that has fewer environmental impacts fits more easily within existing policy than completely new gear.

As part of an ongoing four-year project, this study aimed to further investigate the potential for the above benefits by comparing single-, double-, triple- and quad-rigged prawn trawls (all with the same cumulative headline length of 14.63 m) at one location (the Clarence River) in NSW. The chosen trawl configurations were representative of those used throughout Australia, and all were optimised to fit the same vessel. Over six weeks, each configuration was tested a total of 36 times (in 35-min tows), with various relevant technical (e.g. drag, fuel used, horizontal-net spread and towing speed) and biological (numbers, weights and sizes of catches) data recorded.

The relative performances of the four trawling configurations reflected a complex array of interacting factors, but broadly the incremental magnitudes of differences decreased with an increasing number of nets. The single trawl had the least total bottom contact, but the greatest drag, lowest horizontal spread ratio (SR – i.e. horizontal opening to headline length of 63.50%) and required the most fuel to tow (an average of 2.82 L per ha trawled). Further, this system caught significantly more yellowfin bream, and fewer (but larger) school prawns than the multi-trawl configurations. Compared to single rig, the double rig had a greater SR (68.76%) and was easier to tow (2.53 L per ha trawled). However, triple- and quad-rigs similarly achieved the greatest SRs (75.46 and 74.37%) and at lower drag and fuel consumptions (2.08 and 2.22 L per ha trawled, respectively).

Providing effort is regulated, the latter two configurations, but especially triple rig (which, owing to smaller and two fewer otter boards had relatively less total bottom contact), could represent the most suitable configuration from which to progress modifications to reduce the environmental impacts of prawn trawling. Such modifications could include more hydrodynamic otter boards and netting materials, different ground gear configurations and net designs. These, and other, changes will be assessed as part of ongoing work.

Main messages:

- The single rig had the least total bottom contact, greatest drag, lowest spread ratio, and required the most fuel to tow. This configuration also caught significantly more bycatch and fewer (but larger) school prawns.
- The double rig had a greater spread ratio than the single rig, and was easier to tow (i.e. used less fuel).
- The triple- and quad-rigs had the greatest spread ratios, lowest drag and least fuel consumption.

- The triple rig could represent the most suitable configuration from an environmental perspective, given smaller and fewer otter boards, and relatively less total bottom contact.

Potential way forward:

- Remove all current restrictions on the number of nets that may be used.
- Allowing shareholders to increase headline lengths on an as needs basis may help to offset the small decrease in catches of [smaller] school prawns if using multiple nets.

Engineering and catch implications of variable wing-end spread on a penaeid trawl

Prawn trawling forms the basis of important artisanal and industrial fisheries in many tropical and temperate countries. While these fisheries use different designs and configurations of trawls, nearly all are characterised by the same environmental problems of (1) poor size and species selectivity, and (2) high fuel intensities.

The main concern is that, because of their small meshes and use in areas characterised by large abundances of small organisms, prawn trawls often catch non-target individuals (especially fish). Over the past two decades, this issue has been partially addressed via the installation of bycatch reduction devices (BRDs) into the posterior section (termed the codend‘) of trawls. Such modifications have improved selectivity, but none are 100% effective, and in some fisheries large numbers of unwanted organisms are still caught and discarded.

A second, more recent growing concern associated with prawn trawls is their relatively poor efficiency. Trawling produces a lot of drag, which requires substantial energy. Rising fuel costs, combined with concerns over carbon emissions, have led to an increasing impetus to reduce the inherent engineering deficits of this fishing method.

Both of the above environmental concerns associated with prawn trawling can be addressed via modifications to the anterior sections of trawls; primarily because this area ultimately (1) is responsible for much of the drag, and (2) regulates what is directed into the codend. However, one issue associated with testing often quite different anterior trawl sections is the potential for a confounding effect of relative horizontal trawl opening (termed — spread ratio and defined as the headline length ÷ wing-end spread) on efficiency. No scientific work has been done to determine the importance of spread ratio on prawn-trawl performance.

We sought to address this shortfall here using a novel experimental approach. Two identical beam and-sled assemblies were configured to allow two identical trawls (7.35 m headlines) to be adjusted to spread ratios of 0.5, 0.6, 0.7 and 0.8; which were deployed behind a twin-rigged trawler in Lake Wooloweyah and towed across the same depth, current, towing speed and duration. Each spread ratio was tested during 30 tows.

The results showed that increasing spread ratio significantly increased drag (by up to 16%), without affecting absolute catches. However, when standardized to per ha trawled, significantly fewer of the targeted school prawns (biased towards larger individuals) and total bycatch by weight were retained in the wider-spread trawls. The catch reductions with increasing spread ratio were thought to reflect either: (1) slightly reduced ground-gear contact and headline heights offsetting the greater swept areas; or perhaps more likely (2) steeper wing angles which increased the probability of mesh encounters for school prawns and were less efficient for herding fish. Based on this study, we conclude that future research comparing modified trawls should focus on maintaining similar spread ratios to minimise confounding effects.

Main messages:

- Future research comparing modified trawls should focus on maintaining similar spread ratios to minimise confounding effects.

Potential way forward:

- Relevant to future research, rather than current mangement arrangements.

Configuring the mesh size, side taper and wing twine area of penaeid trawls to reduce environmental impacts

Prawn trawling occurs throughout inshore waters of many tropical and temperate countries, and is an important source of income for coastal communities. More than 100 species are targeted using a variety of trawl designs and methods of operation. While there are fishery-specific management concerns, virtually all prawn fisheries are characterized by the same two broad environmental issues.

The main concern is that, because of their small meshes and use in areas characterised by large abundances of small organisms, prawn trawls often catch non-target individuals (especially fish), termed bycatch‘. Over the past two decades, this issue has been partially addressed via the installation of bycatch reduction devices (BRDs) into the posterior section (termed the codend‘) of trawls. Such modifications have improved selectivity, but in some fisheries, large numbers of unwanted organisms are still caught and discarded.

The second, more recent growing concern associated with prawn trawls is their relatively poor efficiency. Trawling produces a lot of drag, which requires substantial energy. Rising fuel costs have led to an increasing impetus to reduce the inherent engineering deficits of this fishing method.

Conceivably, the above environmental concerns associated with prawn trawling could be concurrently addressed via modifications to the anterior sections of trawls; primarily because this area ultimately (1) is responsible for much of the drag, and (2) regulates what is directed into the codend. However, very little relevant research has been done. The aim of this study was to help address this shortfall, by assessing the importance of mesh size, trawl side taper (and therefore the total length) and wing depth (and therefore the amount of wing netting) in a common design of trawl body. The work was done in Lake Wooloweyah and the Clarence River, but the results have implications for other local and international prawn-trawl fisheries.

Five trawls were tested. The first trawl was made from 41-mm mesh (18 ply twine) and represented conventional designs (termed the 41 1N3B deep-wing‘), while the remaining four trawls were all made from 32-mm mesh (12 ply) and differed only in their side tapers (1N3B−~28^{o} to the tow direction vs 1N5B−~35^{o}), and wing depths (deep‘–97 T vs shallow‘–60 T). All trawls had Nordmøre-grids installed, and were each deployed 38 times.

There were incremental drag reductions (and therefore fuel savings – by up to 18 and 12% per hour and hectare trawled) associated with reducing twine area (via either of the assessed modifications), and subsequently reducing otter-board area. Side taper and wing depth had interactive and varied effects on bycatch reduction, but compared to the conventional 41 1N3B deep-wing trawl, the 32 1N5B shallow-wing trawl (i.e. the design with the least amount of twine) caught significantly fewer unwanted fish (by up to 57%); which was explained by the shorter trawl allowing more individuals to swim forward and escape, either from the mouth of the trawl or via the Nordmøre-grid. In most cases, all small-meshed trawls also caught more school prawns (including both small and commercial-sized individuals) than the conventional 41-mm trawl.

The results observed here have implications for on-going research. Clearly, determining the most appropriate mesh size and ideally ensuring consistent openings throughout the trawl is an important precursor to other modifications. We showed that it is possible to reduce mesh size, but still reduce bycatch via other changes; presumably because mesh openings mostly determined the selectivity of the targeted school prawns, whereas fish were more affected by changes in trawl geometry. Based on the mean sizes of school prawns retained, the 32-mm mesh we examined is too small. However, it should be possible to increase mesh size slightly to somewhere less than 41-mm, while still using a steep side taper to reduce fish bycatch, and with the least amount of twine area to minimise otter-board area and drag. These results support a philosophy of first optimising mesh size as a precursor to other anterior changes in other prawn-trawl fisheries.

Main messages:

- First and foremost, determine the appropriate mesh size for the target species. Appropriate mesh sizes for prawn trawl nets used to target school prawns are proposed to be researched during early-to-mid 2014. The study above indicates that the appropriate mesh size for the Clarence River Prawn Trawl fishery will lie somewhere between 32 and 41 mm.
- Then consider reducing twine area (i.e. short nets with steeper tapers and shallow wings) noting reduced drag and fuel savings by up to 18 and 12% per hour and hectare trawled.

- Then consider minimising the size/area/style of the otter boards to further reduce drag.
- The small mesh [32 mm] steep side taper [1N5B] shallow-wing trawl (i.e. the design with the lowest twine area) caught significantly fewer unwanted fish (by up to 57%), but the small mesh did result in increased catches of smaller size class prawns.

Potential way forward:

- Commit to adopting appropriate mesh sizes for each of the three estuaries (when the results of research are available; mid to late 2014) to facilitate industry adoption of multiple short nets with steeper tapers and shallow wings and appropriate boards for optimum economic efficiency.