Tactical Research Fund: Empowering Industry R&D – Refinement of fyke net modifications to improve uptake by industry

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Western Victoria Eel Growers Group

Australian Government

Fisheries Research and Development Corporation

Project No. 2009/064

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Date: March 2012

Published by: Aquaprime Consulting, 2012

ISBN 978-0-646-57496-7

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1 NON TECHNICAL SUMMARY

2009/064 Tactical Research Fund: Empowering Industry R&D – Refinement of fyke net modifications to improve uptake by industry

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OBJECTIVES:

1 To identify with industry, potential user-friendly fyke net modifications

2 To trial agreed fyke net modifications in the effective reduction of protected fauna bycatch

3 To demonstrate to industry the benefits of modified gear options

NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED TO DATE

The key outcomes from the project are the introduction and uptake by the commercial eel fishery of low cost, practical and user-friendly modified fyke nets which reduce the bycatch of, and interaction with, protected wildlife, e.g., tortoises and platypuses. These modified nets will have particular application in waters where protected species are likely to occur, such as wildlife reserves, wetlands and dams.

The refined modifications to fyke nets were found to improve user-friendliness of modified gear by increasing the portability and management of the gear. The refined modified gear minimised retention, or at least maximised survival of protected wildlife species, while continuing to effectively catch eels. Tortoises were the only protected wildlife species recorded as bycatch in this project. All tortoises caught in the modified gear were released alive.

The modified fyke nets can be used in locations where the incidental bycatch of protected wildlife may occur to improve the management of bycatch without significantly impacting the commercial eel catch.

Refinements to modified gear developed in this project included the development of a collapsible frame for the open mesh box modification and the addition of a

codend to the mesh box to improve catch harvesting, a flexible escape tube and a removable codend, both of which can be attached to existing fyke nets.

Eel fishers are now better equipped to operate in areas where a likelihood of interaction with protected wildlife species may exist. The potential impact of fishery-wildlife interactions and community perceptions relating to bycatch in the fishery are now able to be improved by informing the public that fishers are addressing the issue through the use of modified nets.

The Victorian eel fishing industry has historically been proactive in the reduction of bycatch in the fishery, developing and utilised a range of bycatch reduction devices and practices over many years. However, detailed knowledge of bycatch issues associated with the Victorian Eel Fishery has been identified in the Victorian Eel Fishery Bycatch Action Plan (BAP) and Eel Fishery Management Plan (EFMP) as being deficient (McKinnon 2002; Leporati and McKinnon 2006), and recommendations were made to commence fishery dependent and independent monitoring of bycatch in the fishery.

Formal assessment of the ecological risks to bycatch species in the Victorian Eel Fishery, as recommended in the BAP, has found the ecological risks associated with the eel fishery are low, and that current management is adequate to manage the level of risk posed by the industry (Anon. 2007). Furthermore, the fishery has been granted the maximum (5 year) exemption from export controls following evaluation of the ecological sustainability of the fishery by the Department of Environment, Water, Heritage and the Arts (DEWHA) under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*. However, the industry recognises that a degree of social unacceptability exists in relation to the bycatch of some species, notably protected fauna such as platypuses and water birds. Consequently, industry has developed and trialled a number of modified fyke net prototypes for commercial application specifically to reduce the risk of interaction with protected wildlife and other fauna in the fishery (FRDC Project 2008/017). The current project further identified and refined a shortlist of designs which were seen by industry to be effective in improving bycatch management and are, importantly, practical to use, thereby improving the rate of uptake by industry.

The gear trialled in this project included a box net design which was effectively a combination of the two designs trialled in Project 2008/017, including a PVC and steel frame supporting the nylon mesh cage and easily dismantled for storage and transport. A further modification included the addition of a standard codend to the mesh box component to improve ease of harvesting the catch. Other gear modifications included a flexible escape tube for the escape of bycatch and a removable codend, both of which can be attached to existing fyke nets.

The results show that there was no significant difference in the catch of eels or bycatch between collapsible box type nets and those with removable codends, nor between collapsible box type nets and those with escape tubes. The difference between eel catch between nets with removable codends and those

with escape tubes however, was significant, suggesting that the use of nets with escape tubes may reduce the commercial eel catch by up to 20%.

Clearing the catch from the modified nets was considerably easier than from the net designs trialled in Project 2008/017, thereby improving the likelihood of uptake by industry; the refined modifications are more flexible and can be folded and stacked flat on the floor of a small boat, allowing a larger number of modified nets to be carried at once.

Feedback from industry indicated that all gear types developed in this project would have application in the differing circumstances applying to individual operators. All industry participants who took part in the industry workshop indicated they would use the gear.

The gear modifications trialled in this project may provide opportunities for the use of modified fyke nets in waters which may otherwise be closed to eel fishing, such as wildlife reserves not presently fished commercially for eels, or in eel fisheries where fyke nets are not presently used to catch adult eels (e.g. Queensland and New South Wales).

KEYWORDS: **Eel fishery, fyke nets, gear modifications, bycatch, protected wildlife**

2 ACKNOWLEDGEMENTS

This project is supported by funding from the FRDC on behalf of the Australian Government and was initiated under FRDC Project 2007/304 “Empowering Stakeholders to Initiate and Advance R&D Projects in the Seafood Industry”. The authors acknowledge Dr Carolyn Stewardson for comments on an earlier draft and Graham Quarrell for contributions to the design and construction of prototype nets for the project.

3 BACKGROUND

The Victorian Eel Fishing Industry has historically been proactive in the reduction of bycatch in the fishery, developing and utilising a range of bycatch reduction devices and practices over many years. However, detailed knowledge of bycatch issues associated with the Victorian Eel Fishery has been identified in the Victorian Eel Fishery Bycatch Action Plan (BAP) and Eel Fishery Management Plan (EFMP) as being deficient (McKinnon 2002; Leporati and McKinnon 2006), and recommendations were made to commence fishery dependent and independent monitoring of bycatch in the fishery.

Formal assessment of the ecological risks to bycatch species in the Victorian Eel Fishery, as recommended in the BAP, has found the ecological risks associated with the Victorian Eel Fishery are low, and that current management is adequate to manage the level of risk posed by the industry (Anon. 2007). Furthermore, the fishery has been granted the maximum (5 year) exemption from export controls following evaluation of the ecological sustainability of the fishery by the Department of Environment, Water, Heritage and the Arts (DEWHA) under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*. However, the industry recognises that a degree of social unacceptability exists in relation to the bycatch of some species, notably protected fauna such as platypuses and water birds. Consequently, industry has further designed and developed fishing equipment and modifications to existing fishing gear, specifically to reduce the risk of interaction with protected wildlife and other fauna in the fishery. To this end, McKinnon and Milner (2009) developed and trialled a number of modified fyke net prototypes for commercial application.

Successful modifications to gear have been made in the NSW commercial eel trap fishery specifically to reduce platypus mortality in the fishery (Grant et al. 2004). Such modifications do not allow the escape of platypuses from the nets, but provide airspace for platypuses to move into for subsequent release. Such a method provides a similar result to raising fyke net cod ends, which is often practised in the Victorian Eel Fishery. The modifications trialled in Project 2008/17 (McKinnon and Milner 2009), provided a distinct advantage by permitting platypuses to escape from the nets in a timely manner, thereby reducing stress and the risk of injury or mortality.

The current project further identified and refined a shortlist of designs which were seen by industry to be effective in improving bycatch management and are, importantly, practical to use, thereby improving the rate of uptake by industry.

This project addresses the FRDC's Research, Development and Extension priorities by focusing on the maintenance and improvement of the management and use of aquatic natural resources to ensure their sustainability.

The project has been discussed formally among industry and management representatives through bimonthly meetings of the Victorian Eel Fishers' Association (VEFA) and prepared in consultation with the VEFA and with Fisheries Victoria, both of whom support the project in principle.

3.1 Consultation

This proposal extends the recently completed project “Empowering Industry R&D: Trials of gear modifications to reduce bycatch in freshwater fyke nets” (FRDC Project 2008/017), which was supported by the Victorian Eel Fishermen’s Association and the Victorian Department of Primary Industries — Fisheries Victoria.

The findings of project 2008/017, including recommendations for further development of modified gear to improve the likelihood of uptake by industry as detailed in this proposal, have been presented to DPI, the EFA and a number of other relevant groups including Catchment Management Authorities and Landcare groups. All groups expressed in-principle support for the further development of gear modifications to fyke nets. The Victorian Eel Fishermen’s Association committed to providing in-kind support and cash contributions from its members in the further development of gear modifications to fyke nets to improve the likelihood of uptake of modified gear by its members.

Both the Eel Fishermen’s Association and the Victorian DPI provided written support for the continuation of this work as identified in the project proposal.

4 NEED

Gear modifications trialled in Project 2008/017 (McKinnon and Milner 2009) included: (1) a rigid-frame, steel mesh cod end and (2) a collapsible, nylon mesh cod end. These reduced bycatch of platypuses in fyke nets, and increased the likelihood of survival of other non-target species, without impacting the commercial eel catch.

However, the project identified some limitations with these gear modifications:

1. Clearing the catch from the rigid-framed nets was considerably easier than from the collapsible nets. However, the bulky construction of the rigid-framed nets restricted the numbers which could be safely transported on board a commercial 4–5m eel punt to a maximum of 2–3 nets. Feedback from industry has identified that operators would need to be able to transport and work at least 5–10 modified nets at once to justify the use of such nets from a commercial perspective.

2. The nylon mesh nets were more flexible and could be folded and stacked flat on the floor of a boat, allowing a larger number to be carried at once. However, the main disadvantage with this design is the difficulty in clearing the catch, as these nets are cumbersome to handle.

Industry has recognised that the gear modifications improved bycatch management in the fishery. However, the Victorian Eel Fishermen's Association has highlighted that the weaknesses described above are major impediments to the adoption by industry of the modified gear.

A key recommendation of project 2008/017 therefore was the further refinement of gear modifications to maximise the likelihood of uptake of the modified gear by industry. The Project Investigators and the Victorian Eel Fishermen's Association identified a number of opportunities for the further development of the gear to improve its efficiency, and therefore increase the likelihood of uptake by industry. Such developments were needed to be made for industry to take full advantage of the findings of Project 2008/017.

5 OBJECTIVES

1 To identify with industry, potential user-friendly fyke net modifications

2 To trial agreed fyke net modifications in the effective reduction of protected fauna bycatch

3 To demonstrate to industry the benefits of modified gear options

6 METHODS

6.1 For Objective 1

An industry workshop was conducted on 23 March 2010 to identify potential modification designs, recognising the needs and requirements for the practical use of commercial fishing gear by industry. The workshop included presentation and discussion of the results and findings of project 2008/017, including the limitations of the gear trialled in that project. The aim of the workshop was to build on these to identify a shortlist of potential fyke net designs which would be expected to achieve the required bycatch reduction outcomes while maintaining and improving likely acceptance for use by industry.

6.2 For Objective 2

Gear Description and Construction

Two units of each of three prototype modified fyke net designs, based on a shortlist of designs determined from the industry workshop, were constructed during 2010.

The gear trialled in this project included gear which was further refined from the two box-type nets trialled in Project 2008/017 (McKinnon and Milner 2009), plus two further designs identified in the industry workshop held in 2010. All modified nets were designed to allow the escape or simple release of bycatch, particularly protected wildlife, from commercial fyke nets while retaining the target eel catch. Similar gear modifications have been successfully applied in other net fisheries to reduce incidental capture of protected or unwanted species.

The results of Project 2008/017 (McKinnon and Milner 2009) identified that clearing the catch from the rigid-framed nets was considerably easier than from the collapsible nets but that the bulky construction of the rigid-framed nets restricted the numbers which could be practicably used. The nylon mesh nets were more flexible and compact during transport; however the nets were found to be cumbersome to handle and made clearing the catch difficult. Furthermore, in both gear types, clearing the catch required the physical lifting of the box codend which was cumbersome and time consuming, even with two operators.

The box net design was effectively a combination of the two designs trialled in Project 2008/017 (McKinnon and Milner 2009). A PVC and steel frame was constructed to support the nylon mesh cage when in use and was easily dismantled for storage and transport (Figure 1). A further modification included the addition of a standard codend to the mesh box component (Figure 2). This was designed to facilitate the easy removal of the commercial eel catch without the need to manually lift the collapsible box compartment.

Commercial fyke nets typically comprise a single wing (although up to 3 wings may be used in the commercial eel fishery) which may be up to 46 m in length, but a wing of less than 10 m is more commonly used. The wing leads into a 4–6 m long collapsible conical net constructed of nylon mesh between 1.5 and 3.9 cm, and which contains at least 2 internal funnels (Figure 3).

The modified gear trialled in this project included:

1. A collapsible nylon mesh box supported with a PVC frame attached to an otherwise standard fyke net.
2. A standard fyke net fitted with a flexible mesh escape tube in the cod-end.
3. A standard fyke net fitted with a removable cod-end.

The nylon mesh cod end was 700 mm wide x 1,300 mm long x 1,200 mm high (Figure 2); The escape tube fitted to a standard fyke net was 1,200 mm long x 250 mm wide (Figure 4); The removable cod-end fitted to the standard fyke net was 2.0 m long x 250 mm wide (Figure 5). In each case the fyke net component of each net was 2.0 m length with a single wing of 6.0 m length.

Field Trials

Timing

The first round of trials was to be completed by late November 2010 and the second round by mid February 2011. Some of the modified nets were not completed by November when field surveys were scheduled to commence, so fieldwork was delayed to allow for the completion of the nets. It was then intended for the two rounds of surveys to be completed consecutively in January and February 2011, however major flooding in western Victoria in January 2011 severely damaged or destroyed much of the equipment belonging to the Western Victoria Eel Growers' Group, including much of the gear to be used in the trials. The modified gear was subsequently repaired or replaced as appropriate and trials were conducted during July and August 2011 over two 10 day sampling events.

Although the timing of the trials did not allow for an examination of the effect of seasonality in the trials as intended in the project proposal, the project investigators felt that the trials should proceed at the first available opportunity as the major flood event described above had delayed the project substantially. The project investigators felt that undertaking trials during the winter period only would not compromise the project results, as the efficacy in the management of bycatch using net modifications had been demonstrated in Project 2008/017 where trials were conducted over a broad temporal scale. Based on the commercial catch history of the study site, and industry experience, it was expected that the catch rates of eels and other species would still be high enough during winter for any significant differences between gear types to be observed.

In order to expedite the project's progress, trials were conducted at one site only. This site was a large wetland on private property which is commercially fished for eels and had been sampled during Project 2008/017 (McKinnon and Milner 2009). This wetland was known to contain populations of eels, platypuses, waterbirds and tortoises and was considered to be representative of the type of habitat for which all modified gear designs would be suited for use.

The efficacy of net modifications in improving bycatch management in the Victorian Eel Fishery had been largely demonstrated in Project 2008/017 (McKinnon and Milner 2009). The Project Investigators therefore felt that the "user-friendliness" of the refinement of gear modifications could be justifiably examined with the concentration of the field component of the project at one site as described above.

Experimental Design

Field based trials comprised paired comparisons between different gear types as follows:

- Modified fyke net 1 vs Modified fyke net 2
- Modified fyke net 3 vs Modified fyke net 2
- Modified fyke net 1 vs Modified fyke net 3

Animal ethics approval and fisheries research permits were current for the project investigators, however Fisheries Victoria permit conditions required the clearance of nets every 12 hours, rather than every 24 hours, which significantly increased the time commitment and cost of the fieldwork component of the project over the budgeted amount.

Data analysis

Analysis of variance (ANOVA) with repeated measures was used to identify gear that showed significant difference at $\alpha=0.05$ between catches of each species. The ANOVA was performed on pairs of nets as follows: nets with a collapsible nylon mesh box and standard fyke net fitted with a flexible mesh escape tube; nets with a collapsible nylon mesh box and standard fyke net fitted with a removable cod-end; standard fyke net fitted with a flexible mesh escape tube and standard fyke net fitted with a removable cod-end. The catch rate was transformed (double square root) to satisfy the homogeneity of variance assumption.

6.3 For Objective 3

Industry members were invited to attend at least one field day to demonstrate the use of the three modified nets and to provide feedback on the practicality and likelihood of uptake of the gear. Although a great deal of interest was stimulated it was felt by industry that most feedback could be adequately generated through the demonstration of the gear at a one-day workshop which was subsequently held at Werribee on 22 November 2011. The reduction of this component of the project to a one-day workshop substantially reduced the cost of this component of the project which assisted in offsetting the increased cost of fieldwork due to additional gear clearance conditions of the research permit as described above.

During the gear demonstration workshop industry participants were invited to trial the prototype modified gear in their own allocated waters. A standard set of questions in the form of a survey was provided to industry participants to document feedback (Appendix 3).

6.4 Site description

Trials were undertaken at one key site in Victoria which had been used to trial modified gear during Project 2008/017 (Figure 6). This site, a billabong on private land in Gippsland (38.0092ºS; 146.918 ºE) was known to contain populations of protected wildlife, including many water bird species, tortoises, water rats, and/or abundant small fish species (Figure 7). Platypuses are also abundant in the area, thus it was expected that this species may also be encountered during the trials. Sampling was undertaken from 18 July to 11 August 2011.

6.5 Experimental design

The number of paired comparisons undertaken was reduced from six to three as the gear type with removable codend was considered to be identical to a standard fyke net in terms of fishing efficiency. Thus including a standard fyke net in the analysis was considered unnecessary. Minimum paired comparisons between nets were therefore made as follows:

- Removable codend versus collapsible mesh box net
- Removable codend versus escape tube net
- Escape tube net versus collapsible mesh box net

The latter section of the removable codend nets were always set above the water surface to ensure that potential entrapments of wildlife did not result in any mortality or unacceptable harm.

Analysis of variance (ANOVA) with repeated measures was used to identify gear that showed significant difference at $\alpha=0.05$ between catches of each species. The catch rate was transformed (double square root) to satisfy the homogeneity of variance assumption.

Monitoring of fyke nets included visual observation where possible, to observe interactions between protected fauna and different gear types and to ensure that potential entrapments of wildlife do not result in any mortality or unacceptable harm.

Figure 1. Collapsible mesh box net in collapsed position

Figure 2. Collapsible box net erected with codend attached

Figure 3. Standard commercial fyke net

Figure 4. Modified fyke net with escape tube

Figure 5. Standard fyke net with removable cod end

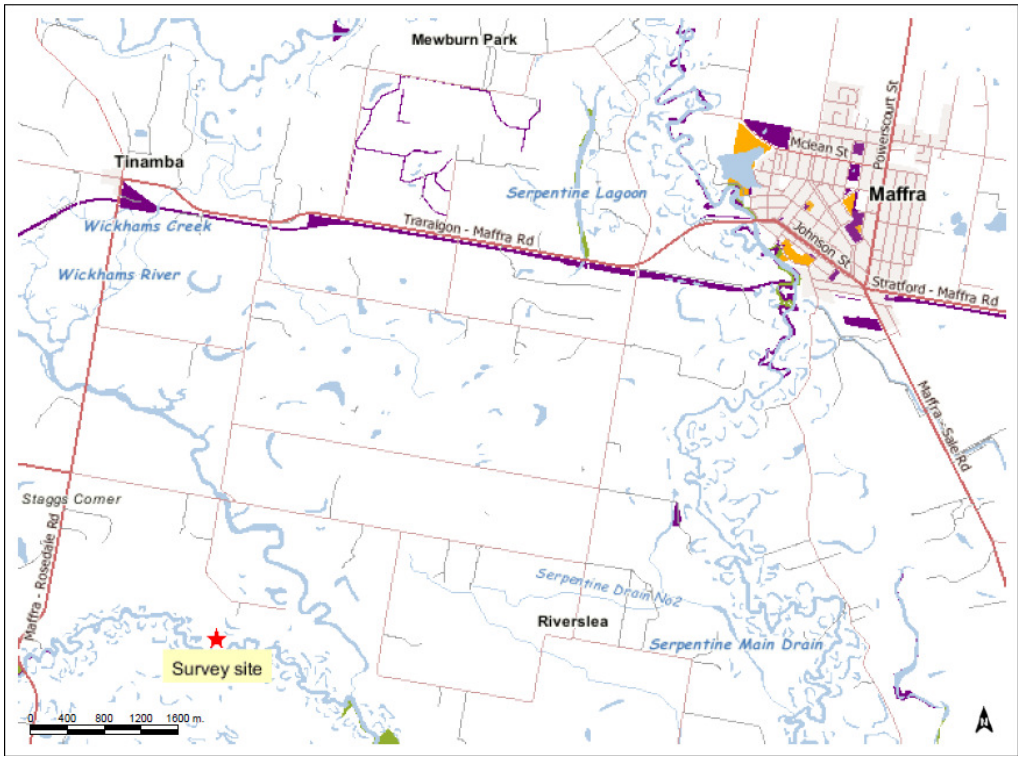

Figure 6. Location of survey site

Figure 7. Refined modified fyke net at survey site

7 RESULTS/DISCUSSION

This project followed on from project 2008/017 which investigated fyke net modifications, specifically: (1) a rigid-frame, steel mesh cod end and (2) a collapsible, nylon mesh cod end. These reduced bycatch of platypuses in fyke nets, and increased the likelihood of survival of other non-target species, without impacting the commercial eel catch. However, the project identified some limitations with the gear modifications. Therefore, Project 2009/064 was funded to address these limitations to increase the likelihood of uptake by industry. The major limitations identified in Project 2008/017 were as follows:

(a) Clearing the catch from the rigid-framed nets was considerably easier than from the collapsible nets. However, the bulky construction of the rigid-framed nets restricted the numbers which could be safely transported on board a commercial 4m eel punt to a maximum of 2–3 nets. Feedback from industry has identified that operators would need to be able to transport and work at least 5–10 modified nets at once to justify the use of such nets from a commercial perspective.

(b) The nylon mesh nets were more flexible and could be folded and stacked flat on the floor of a boat, allowing a larger number to be carried at once. However, the main disadvantage with this design is the difficulty in clearing the catch, as these nets are cumbersome to handle.

Project 2009/064 aimed to produce a modified fyke net that was:

(a) Effective at reducing bycatch of protected species

(b) Maintain target catch

(c) Low cost

(d) Practical/user-friendly

7.1 Field surveys

It was initially proposed that sampling would be conducted over two discrete periods during summer and autumn when activity of fish and potential wildlife bycatch species would be at a maximum. However, for the reasons described above, sampling was undertaken over two consecutive 10-day periods during winter 2011 and data from both sampling events were analysed collectively.

The results show that there was no significant difference in the catch of eels between collapsible box type nets and those with removable codends (Figure 8), nor between collapsible box type nets and those with escape tubes (Figure 9). The difference between eel catch between nets with removable codends and those with escape tubes however, was significant ($P<0.05$), suggesting that the use of nets with escape tubes may reduce the commercial eel catch by up to 20% (Figure 10).

The species recorded during the surveys were shortfinned eel (*Anguilla australis*), longfinned eel (*A. reinhardtii*), carp (*Cyprinus carpio*), goldfish (*Carassius auratus*) and eastern snake-necked tortoise (*Chelodina longicollis*).

A summary of survey results is presented in Table 1. Goldfish (*Carassius auratus*) dominated the catch for all gear types, followed by carp (*Cyprinus carpio*) then both species of eels (*Anguilla australis, A. reinhardtii*) (Table 1). Eastern snake-necked tortoise (*Chelodina longicollis*) was the only protected wildlife bycatch caught during the surveys and these were caught in comparatively high numbers (Table 1). This species is widespread and commonly encountered and is not listed as threatened in Victoria (Victorian Department of Sustainability and Environment 2007). It is not unusual for such high abundance of this species to occur in freshwater habitats such as farm dams and wetlands.

There was no significant difference in the eel catch between nets with removable codends and nets with a collapsible box (Figure 8), or between nets with a collapsible box and nets with escape tubes (Figure 9), however the eel catch in nets with extended codends was significantly greater than in gear with escape tubes ($F_{1,2}$=6.67; P=0.01) (Figure 10). There was no significant difference in the catch of bycatch fish species (carp and goldfish combined) or of eastern snake-necked tortoises between any of the gear types (Figures 8–10).

There is no clear reason why the nets containing escape tubes would catch fewer eels than nets with extended codends, although on several occasions large carp were observed blocking the internal funnels of the nets with escape tubes, as well as the escape tubes themselves. This may have impacted the ability of these nets to catch and retain eels, and may also reduce the opportunity for protected wildlife species to escape through the escape tube. It may also be possible that eels themselves escaped the net through the escape tube. If this was indeed the case however, it would be expected that a layer of slime (mucus) would have present on the exposed mesh of the escape tube. To reduce the risk of the escape of eels from nets with escape tubes, the nets could be set with the escape tube on a steeper angle while still providing opportunity for any protected wildlife to escape.

Table 1. Total catch (number) by species and gear type.

Species Caught	Removable codend	Collapsible Box	Escape tube
Shortfinned eel	23	21	30
Longfinned eel	37	24	25
Carp	42	32	33
Goldfish	60	51	40
Eastern snake-necked tortoise	68	49	58

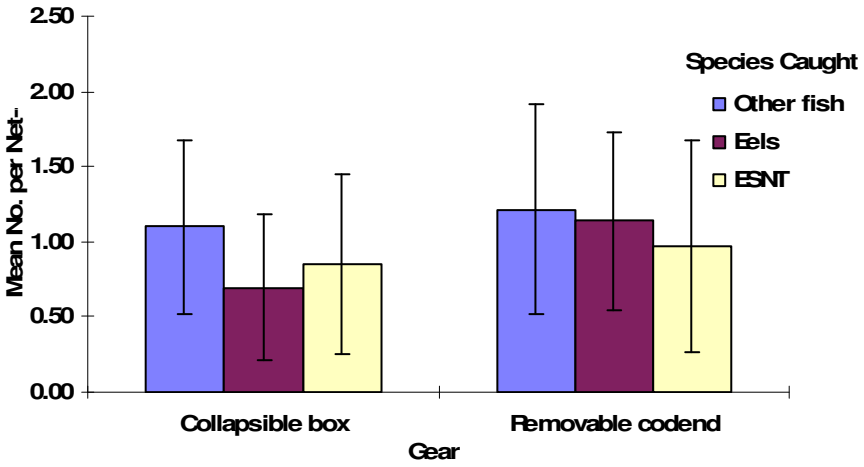

Figure 8. Mean number caught per net by species and gear for nets with removable codends and nets with a collapsible box. The catch of all fish other than eels is combined. The bar indicates the upper and lower 95% confidence levels

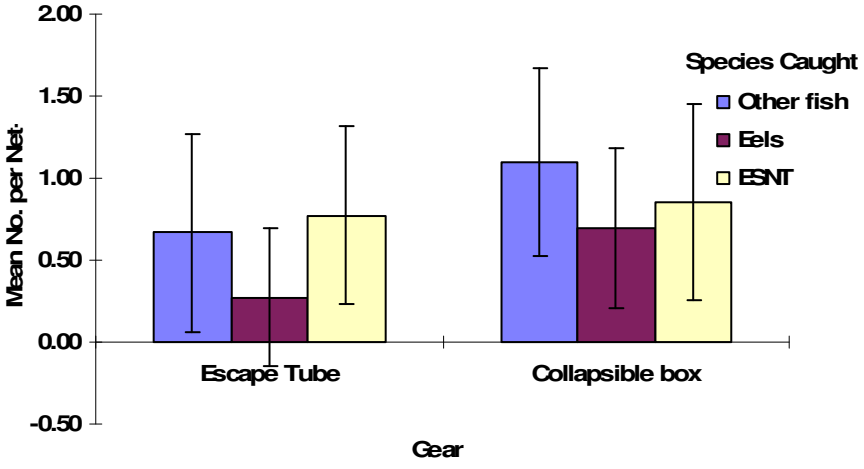

Figure 9. Mean number caught per net by species and gear for nets with escape tubes and nets with a collapsible box. The catch of all fish other than eels is combined. The bar indicates the upper and lower 95% confidence levels

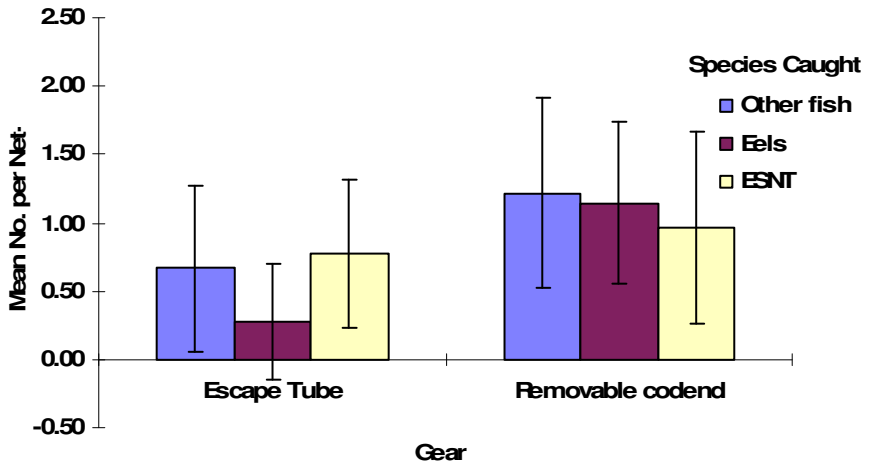

Figure 10. Mean number caught per net by species and gear for nets with escape tubes and nets with removable codends. The catch of all fish other than eels is combined. The bar indicates the upper and lower 95% confidence levels

The eastern snake-necked tortoise was the only protected wildlife species recorded during this project. However from Project 2008/017 (McKinnon and Milner 2009) it was found that platypuses (*Ornithorhynchus anatinus*) could escape from the collapsible box type net by climbing up the sides of the box. It is expected that other species such as water rats (*Hydromys chrysogaster*) and some water birds, e.g. dusky moorhen (*Gallinula tenebrosa*) and purple swamphen (*Porphyrio porphyrio*) would also be able to climb out of the collapsible box net due to their ability to climb vertical surfaces (personal observation). During the field surveys at least one eastern snake-necked tortoise was observed clinging to the side of a collapsible box net, above the surface of the water. It may be possible also for this species to escape this type of net by climbing out of the open box compartment. The results however did not indicate a significant difference in the catch of eastern snake-necked tortoises between gear types suggesting the escape of tortoises from this gear type may have been minimal. For those species which are unable to escape these nets, the collapsible box provides a large volume for the total catch, enabling wildlife to breathe, thus preventing the accidental drowning of these species (Figure 2).

7.2 Effect of modified gear on commercial eel catch

There was no significant difference in the eel catch between nets with extended codends and nets with a collapsible box or between nets with a collapsible box and nets with escape tubes. It is concluded therefore that there is no significant difference in the catch of eels between these modified gear types and that of standard commercial fyke nets. However the eel catch in nets with extended codends was significantly greater than in gear with escape tubes. There is no apparent reason why this was observed, although it may be possible that eels themselves escaped the net through the escape tube. If this was indeed the case, it would be expected that a layer of slime (mucus) would have present on the exposed mesh of the escape tube. To reduce the risk of the escape of eels from nets with escape tubes, the nets could be set with the escape tube on a steeper angle while still providing opportunity for any protected wildlife to escape.

From a commercial perspective it is expected that modified nets will continue to perform as well as standard fyke nets. This is important in terms of industry uptake of the modified net technology, as lower eel catches in modified gear would reduce the likelihood of industry adopting the modified gear for use in commercial fishing operations.

7.3 Survey of eel fishers

A one-day workshop to demonstrate to industry the use and performance of the three modified net designs was held at Werribee on 22 November 2011. The workshop, attended by nine industry members, was convened by the Victorian Eel Fishermen's Association (Inc.). The modified gear was also demonstrated to two eel fishers in East Gippsland who were unable to attend the workshop.

Industry participants were also invited to trial the prototype modified gear in their own allocated waters. A standard set of questions in the form of a survey was provided to industry participants to document feedback. Ten industry members completed the survey.

Results from the survey are summarised as follows:

a) 60% of participants felt the open box modification would be the most practical for use;

b) 100% of participants felt that all designs would work effectively in the waters individually fished;

c) 90% of participants would construct the gear themselves;

d) Participants expected to be able to practicably use between 5 and 30 nets at any one time;

e) All participants expressed interest in trialling the gear at some later stage;

f) The expectation of improving working relationships with other users of waters, including the water managers, ranged from positive to uncertain. There was no expectation of working relationships deteriorating through the use of the modified gear;

g) When asked for further comment on the gear, responses received included the following:

- "May be good to use in smaller waters or reserves"
- "The use of this gear should only be seen as discretionary, not as a licence requirement"
- "Open box may leave eels exposed to some birds (predation)"
- "Would use this gear if it allowed access to waters currently not able to be fished"
- "This gear provides a good option to demonstrate good bycatch management"

The general consensus from industry appears to support the concept of using modified gear, as demonstrated in this project, in the commercial Victorian Eel Fishery. Although the collapsible box type net appeared to show the greatest potential from industry's perspective, it was clear from the feedback from industry that all modified gear types trialled in this project have application in the Victorian Eel Fishery.

7.4 Cost benefit analysis

A simple cost-benefit analysis of all gear modification types is presented in Table 2 . The major constraints seen with using the gear were the bulk of the collapsible cage nets, even when completely collapsed, the mesh size chosen for the collapsible box and the cost effectiveness of the gear.

All three designs trialled in this project were effective in improving bycatch management in the Victorian Eel Fishery. The presence of carp may however reduce such effectiveness as this species was observed to block internal funnels of all net types, thus both reducing the commercial eel catch and reducing opportunities for bycatch to progress to the codend of the nets to escape. Use of the escape tube design could potentially result in reduced commercial eel catch of up to 20%, due possibly to the loss of eels through the escape tube. Such losses are unlikely to be acceptable to industry, but may be mitigated against with further refinement to the escape tube design.

The escape tube and extended codend designs were cost effective to incorporate into existing net designs, with a nominal cost of up to $25–50/net. The cost of construction of the collapsible box is however approximately twice that of a standard fyke net, thereby reducing its attractiveness to industry. Furthermore, industry felt that the bulkiness of this design was a negative feature of this gear type. Despite the various pros and cons of each gear type, industry felt that each gear type could be used practicably in waters currently fished commercially.

Other key benefits from the uptake of this gear by industry include the direct environmental benefits of reduced bycatch retention, and the social benefits arising from the goodwill fostered by industry with the broader community. Furthermore, the goodwill fostered between the research team and industry will help facilitate adoption of the modified fykenet net, and clearly demonstates that the Victorian Eel Fishery is proactive in addressing bycatch management.

Table 2. Cost-benefit analysis of all gear types

Gear type	Benefits	Costs
Standard fyke net	Industry standard Maximises eel catch Risk assessment identified low risks to bycatch and adequate management arrangements in place.	Approx. $250/single wing net Perception of bycatch issues in fishery
Removable codend	No significant reduction in commercial eel or bycatch Bycatch may be more easily removed from net	Nominal cost to construct
Collapsible box	No significant reduction in commercial eel catch Bycatch of protected wildlife may be reduced	Construction cost approx $500/net (about twice that of a standard net) May only be used in shallow (<1m) water. Bulky design, even when collapsed
Escape tube	May be incorporated into existing gear Allows escapement of protected wildlife	Approx $25-50/net Commercial catch may be reduced by up to 20%

8 BENEFITS

The flow of benefits from this project is 100% to the commercial sector (Victoria – 90%, Tasmania – 10%). The benefits of the project may also apply to eel fisheries in NSW and Queensland where fyke nets are not used. In addition, the outcomes of the project will also provide benefits to the wider community through the dissemination of project outputs which will inform the community that the perceived risks associated with protected wildlife in the eel fishery are being addressed.

It is expected that the use of the refined modified gear will be adopted by industry for use in specific situations where increased potential for interaction with protected wildlife may exist. Industry has indicated it will adopt the modified nets for use in waters which are currently fished for eels; however it is not proposed that the modified gear be enforced for use in existing waters, as the overall risk to bycatch in the Victorian Eel Fishery is low, as determined by a detailed risk assessment (Anon. 2007). The beneficiaries of the improved modified gear will also include the broader community through reduced incidental catch of fauna and improved social acceptance of commercial eel fishing activities.

9 FURTHER DEVELOPMENTS

The project has succeeded in refining modified fyke net designs developed in Project 2008/017 (McKinnon and Milner 2009) to improve user-friendliness and therefore increase the likelihood of uptake by industry. It is now necessary for industry to adopt this gear and further develop it, if and as required, at the level of the individual operator. The results of the Victorian based industry survey indicate that industry is indeed willing to adopt the gear and it is expected that this gear will become part of the range of equipment available to the eel fishing industry.

It is anticipated that a number of industry "champions" will routinely use the gear trialled in this project to further refine modifications and report incidence of bycatch interactions in their logbooks. Such activities are expected to further increase the broader uptake of the gear within the industry.

The trial use of this equipment in the NSW and Queensland eel fisheries would be a logical next step in the further development of this equipment.

The data obtained from this project will be maintained on an electronic database under the management of Aquaprime Consulting, 13 Valetta Street, Sale, Victoria, Australia.

10 PLANNED OUTCOMES

The key planned outcomes from the project were the introduction and uptake by the commercial eel fishery of low cost, practical and user-friendly modified fyke nets which reduce the bycatch of, and interaction with, protected wildlife e.g. tortoises and platypuses. The gear trialled in the project should, however, be further refined to improve its "user-friendliness" and thus increase the likelihood of adoption by industry. The results of this project will be discussed during the current review of the Victoria Eel Fishery being undertaken by the Victorian Department of Primary Industries and during the review of the Victorian Eel Fishery Management Plan.

The project's outputs (products produced) have contributed to the planned outcomes as follows:

- Industry workshops March 2010 and November 2011; Acceptance by commercial eel fishers of the advantages of utilizing purpose-built or modified equipment to minimize interactions with non-target species. Provide practical options which minimise the amount of bycatch and protected species interactions.
- Published article in "Fish" magazine; Extend knowledge and findings to wider industry members, the broader community and other comparable fisheries in other states. Community perceptions relating to bycatch of protected wildlife in the fishery are now able to be improved by informing the public that fishers are addressing the issue through the development of gear modifications to improve bycatch management in the fishery.
- Dissemination of project results at Eel Fishermen's Association meetings; Dissemination of each research component results and findings at the completion of each milestone to relevant industry members. Done through direct extension of the project results. Commercial eel fishers now have knowledge and designs for commercial eel fishing gear which minimises the incidental catch of protected wildlife species, and which may be further developed to improve its user-friendliness.
- Cost-benefit analysis to be communicated to Industry.
- Project Final Report; Dissemination of the final results and findings at the completion of the project to all stakeholders.
- Victorian Department of Primary Industries review of the Eel Fishery and Management Plan to incorporate findings of this project in determining any new allocation of waters for commercial eel fishing.

11 CONCLUSION

Objective 1, the identification of potential user-friendly fyke net modifications, was achieved as planned in the project proposal; however the project was faced with a number of constraints which affected the execution and achievement of Objectives 2 and 3. The most important constraint to the project was the extreme flood event in January 2011 which inundated the offices and factory of the Western Victoria Eel Growers' Group in Skipton, severely impacting the business' operation and damaging or destroying much of the equipment to be used in the project. Furthermore the flood event disrupted the planned field survey and industry field days' schedule. In order for the project to be completed in a timely manner the field trials were subsequently contracted into two consecutive sampling events during the winter months instead of two distinct events over summer/autumn and the planned field day demonstrations were reduced, at the request of industry, to a one-day workshop.

Despite these constraints, the project successfully identified, with industry, refinements to modified fyke nets which could be trialled and ultimately implemented by industry. These refined modifications were trialled in the field and were also demonstrated to industry at a one-day workshop, at which the results of the field trials were also presented. Industry has provided important feedback on the design and use of the refined modified gear and has indicated strong interest in the use of the gear as part of the range of tools available for commercial eel fishing.

Refined gear modifications to fyke nets enable improved management of protected wildlife in fyke net fisheries while maintaining commercial catch rates of eels. Such gear modifications may provide opportunities for the use of modified fyke nets in waters which may otherwise be closed to eel fishing, such as wildlife reserves not presently fished commercially for eels, or in eel fisheries where fyke nets are not presently used (e.g. Queensland and New South Wales).

All three designs trialled in this project were effective in improving bycatch management in the Victorian Eel Fishery. The presence of carp may however reduce such effectiveness as this species was observed to block internal funnels of all net types, thus both reducing the commercial eel catch and reducing opportunities for bycatch to progress to the codend of the nets to escape. Use of the escape tube design could potentially result in reduced commercial eel catch of up to 20%, but may be mitigated against with further refinement to the escape tube design.

The escape tube and extended codend designs were cost effective to incorporate into existing net designs, with a nominal cost of up to $25-50/net. The cost of construction of the collapsible box is however approximately twice that of a standard fyke net. Together with the bulky construction of this gear type, this was seen by industry as negative feature of this gear type. Despite the various pros and cons of each gear type, industry felt that each gear type could be used practicably in waters currently fished commercially.

Broader community perceptions relating to the bycatch of protected wildlife in the commercial eel fishery are now able to be improved further by informing the public that fishers are addressing the issue through active development of fishing gear for the improved management of bycatch.

12 REFERENCES

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13 APPENDIX 1. INTELLECTUAL PROPERTY

The research is for the public domain. The report and any resulting manuscripts are intended for wide dissemination and promotion. All data and statistics presented conform to confidentiality arrangements.

14 APPENDIX 2. PROJECT STAFF

The following table lists project staff involved in the project.

Name	Organisation	Funding
Mr. Graham Milner	Western Victoria Eel Growers' Group	FRDC and in-kind
Mr. Lachlan McKinnon	Aquaprime Consulting	FRDC
Mr. Bill Allan	Western Victoria Eel Growers' Group	FRDC and in-kind

15 APPENDIX 3 SURVEY OF EEL FISHERS

Modified Gear Trial: Survey of eel fishers

Of the three modified fyke nets which would you consider to be most practical for use?

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……

Would any of the designs work in waters you fish (if so, which design would work best)

……
……

Would you construct any of these nets yourself or have them made for you?

……
……

How many of these nets do you think you could use at once?

……
……

Would you consider trialling any of these nets?

……
……

What are the major problems or constraints you see with the design or use of these nets?

……
……

Do you think using these nets would improve your working relationship with other users of the waters you fish?

……
……

Please provide an overall rating out of 10 for each of the three modified net designs (10=great, 1=poor)

Extended codend Escape tunnel Open box

Any other comments?

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……
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Thank you!