



Draft Fisheries Management Papers

Victorian Eel Fishery
Bycatch Action Plan

**Fisheries Victoria
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Victorian Eel Fishery Bycatch Action Plan

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Foreword

This plan (2003) was compiled by the Marine and Freshwater Resources Institute (MAFRI), to help ensure the ecologically sustainable development (ESD) of the Victorian Eel Fishery. An extension of the Victorian Eel Fishery Management Plan (2002), this draft bycatch action plan aims to develop strategies and actions to reduce bycatch without decreasing fishing efficiency, and to help reduce the impact of commercial eel fishing on endangered, threatened or protected species. In addition, this plan aims to assist in the economic progression of the fishery through ecologically sustainable development, whilst aligning with the policy frameworks and legislative agreements in which the fishery is confined.

This draft bycatch action plan addresses the pertinent bycatch issues of the Victorian Eel Fishery and the strategies and actions needed to attend to such issues. The recommendations made follow a precautionary approach to management that aims to satisfy the primary needs of all stakeholders.

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Victorian Eel Fishery Draft Bycatch Action Plan 2003

Introduction

The Victorian Eel Fishery is comprised of two target species: the shortfinned eel (*Anguilla australis*) and longfinned eel (*Anguilla reinhardtii*.) The mainland distribution of the shortfinned eel is from the Murray River in South Australia to the Pine River in Queensland and is also found on Flinders Island, Tasmania, New Zealand and Fiji. The longfinned eel is distributed from Wilsons Promontory in Victoria to the Jardine River in Cape York, as well as northern and eastern Tasmania and New Caledonia. Both species are considered to be panmictic. Panmixia is defined as random mating within a breeding population, suggesting that each species have a singular genetic stock (Kaiola, et al. 1993).

Shortfinned eels are the most abundant and fished eel species in Victoria, comprising up to 95% of the total annual catch. The total Victorian catch for both species ranges from 125 – 450 tons (mean 280 tons) at a value of \$1.4 – 4.7 million per annum (McKinnon 2002). Productivity is highly susceptible to short term and seasonal environmental variations in temperature, salinity and river flow hence the significant total catch range (Sloane 1984; Anon 2002).

Eel fishing occurs in estuarine and freshwater river reaches, and natural and artificial impoundments. A maximum of 18 transferable Eel Fishery Access Licences (EFAL) are in operation throughout Victoria. The fishery currently employs approximately 30 full-time and up to 70 part-time people across Victoria (McKinnon 2002).

Eels have multiple life stages (leptocephali ⊗ glass eels ⊗ pigmented elvers ⊗ yellow eels ⊗ silver eels), four of these life stages are commercially utilised in Victoria (Hall, et al. 1990) (Fig 1). Glass eels and pigmented elvers are used for stock enhancement and aquaculture, yellow and silver eels are commercially fished for domestic and export markets. Aquaculture of eels in Victoria is mostly at an extensive level with only a small number of farms producing eels intensively, the possibility of more widespread intensive culturing of eels in Victoria is a future direction presently being investigated (Gooley and Ingram 2002).

Effectively the Victorian Eel Fishery is divided into four sections: wild shortfinned eels, wild longfinned eels, stock enhancement/aquaculture of shortfinned eels and glass eels. Each section contains its own idiosyncrasies, however only the glass eel fishery will be addressed independently in this plan due largely to the different types of gear utilised in glass eel fishing.

There is a necessity to acquire more data on the rate, abundance, composition and impact of bycatch. Presently bycatch is viewed as a relatively minor issue in the Victorian Eel Fishery. This view has some validity on an individual watercourse or even catchment scale. However when bycatch for all allocated and non-allocated waters for an entire year is combined the quantity and impact of bycatch may become a much more pressing issue.

Once knowledge of bycatch is increased, the potential to manage the fishery in a more ecologically sustainable manner becomes a greater reality. Beyond ESD a holistic approach to environmental monitoring is needed, particularly in Wildlife Reserves where ecological impacts are poorly understood and monitoring is currently negligible.

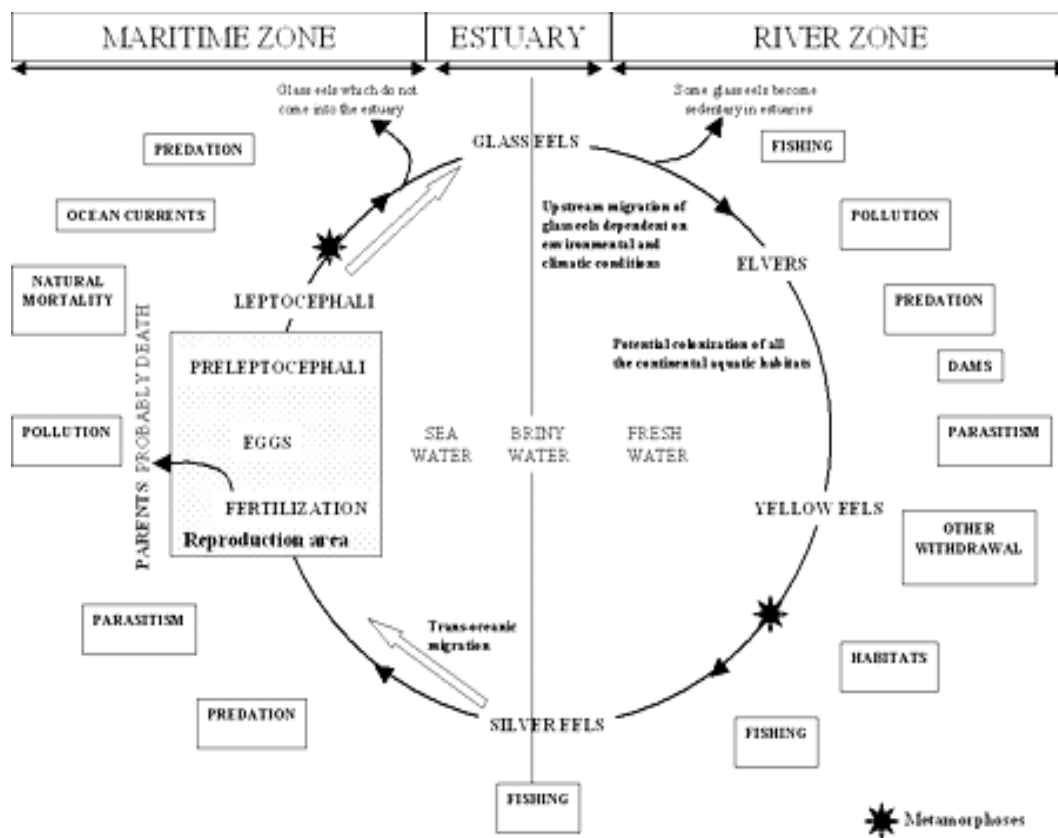


Fig 1. The biological cycle of the eel and the principal threats it faces. From: (Ringuet, et al. 2002)

Management regime

The management structure of the Victorian Eel Fishery is detailed in the Victorian Eel Fishery Management Plan (EFMP) (McKinnon 2002). The following is an outline of the relevant base regulations:

- All commercial licence operators must submit monthly logbooks, of daily catch. There are individual logbooks for both the open water and stock enhanced eel fisheries; all logbooks are processed by the Department of Primary Industries (DPI)
- Restrictions for fyke nets include; mesh size range (15–39mm), maximum number of wings (3), maximum wing length (46m), maximum net drop (67cm) and maximum wing mesh size (32mm).
- A total of 50 fyke nets can currently be set at any one time per licence, each net must be cleared at least once every 48 hours. A set fyke net must not cover more than 50% of the width of a watercourse, and may not be within 5m of another net.
- The minimum legal length for shortfinned and longfinned eels is 300mm; this applies to both commercial and recreational fishers. The EFMP recommends that the legal minimum length be removed for commercial eel fishers. There is a limit of ten eels per person per day for recreational fishers.
- Commercial licence holders are allocated waters in which they have a right to fish. Unallocated waters south of the great dividing range that are not closed to eel fishing are free to be fished by all commercial licence holders.
- Some eel fishers are under permit to fish in wildlife reserves.
- Under a general permit, no fishing operation can commence without prior notification (at least 24 hours) being provided to the regional senior Fisheries Officer.
- Failure to comply with any conditions stated in a permit will render a permit liable to cancellation.

Legislative framework

Fisheries Act 1995:

The purpose of this act is to provide a legislative framework for the regulation, management and conservation of Victorian fisheries and aquatic habitats. Helping to ensure the maintenance of ecological processes and genetic diversity in aquatic habitats through ecologically sustainable development.

Fisheries Regulations 1998:

Provide the statutory rules under which the fishery operates, including licence conditions.

Policy framework

The Victorian Eel Fishery falls under a multi-tiered policy framework from state to national and international policies. The following defines the current policies relating to bycatch in the Victorian Eel Fishery:

Victorian Eel Fishery Management Plan

The Victorian Eel Fishery Management Plan, which was drafted under the Fisheries Act 1995, is the primary policy in which this Draft Bycatch Action Plan operates. The EFMP aims to develop the Victorian Eel Fishery with increasing self-management, as an ecologically sustainable export industry.

Victoria's Biodiversity Strategy:

The aim of this strategy is to conserve Victoria's biodiversity, indicating the existing and proposed mechanisms for achieving the objectives of flora and fauna conservation and management in the context of ecological sustainability. Detailing strategic frameworks to prevent further loss of habitat, and a focus for better management of existing habitats and the continuation of natural ecological processes, highlighting the habitats, major threatening processes and environments that require urgent attention.

National Policy on Fisheries Bycatch:

The objective of this policy is to ensure bycatch species and populations are maintained at sustainable levels. The policy provides a national framework for developing actions to address bycatch, within which individual jurisdictions have the responsibility for implementing the policy (AFFA 1999).

Endangered Species Protection Act 1992:

This act lists all endangered species in Australia and can amend the list if other species are deemed endangered or no longer endangered. This act forms the basis for the Environment Protection and Biodiversity Act 1999 and is used as a device in which to draft recovery plans for endangered species and ecological communities (EA 1998).

Environment Protection and Biodiversity Act 1999:

This act regulates export permits for export fisheries such as the Victorian Eel Fishery, which exports eels to Europe and Asia. This act relates to the Victorian Eel Fishery through the potential bycatch of listed species. Under this act a fishery must meet ESD criteria set by Environment Australia, to maintain its export status. Presently the Victorian Eel Fishery is in the process of assessment under EA's guidelines, demonstrating that it has met all appropriate criteria.

National Strategy of Biological Diversity:

In 1992 Australia signed the International Convention on Biological Diversity. The Convention has been implemented in Australia through the National Strategy for the Conservation of Australia's Biological Diversity. The goal of the National Strategy is to protect biodiversity and maintain ecological processes and systems.

The United Nations Agreement for the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks 1995:

The Victorian Eel Fishery is supplied by a panmictic migratory stock that spawns in the Coral Sea, the distribution of the species places management into international, national and state jurisdictions. Under the International Law of the Sea, Australia has responsibilities for fished species within its economic exclusion zone (EEZ) and must take into account the effects of impacts within the EEZ on the stock as a whole.

Stakeholders

Stakeholders in the Victorian Eel Fishery include:

- Commercial fishers (Seafood Industry Victoria (peak body))
- Victorian Aquaculture Council (peak body)
- Recreational fishers (VRFish (peak body))
- Victorian National Parks Association (peak body)
- Victorian Eel Fishermen's Association
- SeaNet
- Seafood processors, marketers & retailers
- Fisheries Co-management Council
- Environment Australia
- Department of Primary Industry (Fisheries Victoria, MAFRI)
- Department of Sustainability and Environment (ARI) (Flora and fauna division)
- Parks Victoria
- Catchment Management Authorities
- Local governments
- Indigenous communities
- Local communities
- Conservation groups
- Boat owners & other watercourse users
- Land owners

Definition of bycatch

Bycatch is generated essentially by two mechanisms, the type of fishing gear used and/or the regulations in force (Leadbitter 1999). The following is the working definition of bycatch utilised in this plan:

- The part of a fisher's 'catch' which is returned either because it has no commercial value or because regulations preclude it being retained.
- The part of the catch that does not reach the deck of the fishing vessel or landing area but is affected by interaction with the fishing gear.

By-product as opposed to bycatch is the capture of non-target species that are retained for commercial purposes; by-product species in the Victorian Eel Fishery are limited by licence conditions to a small scale production of carp (*Cyprinus carpio*), tench (*Tinca tinca*) and roach (*Rutilus rutilus*). An investigation into potential by-product species may allude to an under utilised resource, however the present catch composition does not suggest this as a likely option.

Present bycatch information

The abundance and composition of potential bycatch is highly variable and dependent on several factors, including the time the nets are set, seasonal variations, reach of the river, depth the nets are set, morphology of the river, flow conditions, number of nets set, proficiency of the fisher, available species, and numerous other natural and anthropogenic variables.

During 1997–2000, an assessment of eastern Australian longfinned and shortfinned glass eel stocks was performed, and included documenting the composition and abundance of bycatch species caught in selected rivers. This study provides a brief composite of many potential species that may be caught as bycatch in glass eel fishing operations (McKinnon, et al. 2000). This valuable assessment has provided a strong base, however knowledge gaps on bycatch are still vast and numerous.

The gear used to fish for glass eels includes glass eel nets, dipnets, stow nets and Japanese glass eel nets (McKinnon, et al. 2001). Fyke nets are the only gear used in the commercial adult eel fishery, the ecological impact of the Victorian Eel Fishery is regarded as low in comparison to many other commercial fisheries that use less passive gear (Buxton and Eayrs 1998). The disparity between gear types suggests that the bycatch profile for each fishing method would be variable. The true extent and composition of potential ecological impacts is presently unknown, however precautionary management is a recommended and practiced strategy. A general view of potential bycatch species for all eel fishing sectors is presented (Tables 1 & 2).

Aims and objectives

The aims and objectives of this plan are to:

- Determine the issues associated with bycatch in the Victorian Eel Fishery.
- Identify strategies and actions to address bycatch issues with impact on fishing efficiency.
- Recommend strategies and actions to help reduce the impact of commercial eel fishing on endangered, threatened or protected species.
- Align with the policy frameworks and legislative agreements under which the fishery operates.

Issues and priorities

Environmental impact issues

- The bycatch of endangered, threatened or protected species is a high priority issue. The quantity of threatened species captured is not expected to be high, however the potential for incidental impacts on localised populations could be significant.
- The possibility of unsustainable catch/mortality of any bycatch species in the Victorian Eel Fishery is low, however assessment and management responses must be instigated to minimise the threat of such an occurrence. In addition, the correlation of eel fishing with the migration of other species and seasonal variations in community composition must be factored into the management of bycatch.

Resource sharing issues

- Commercial fishing operations that share some water resources with the Victorian Eel Fishery include bream and carp fisheries. These operations are small and are not necessarily directly affected by the commercial eel fishery. Issues that may arise between the different commercial sectors include closure of waterways to commercial fishing through the actions of other fishers and the effects of bycatch on another fisheries target species.
- The extent of recreational eel fishing in Victoria is not fully known. A pertinent issue for recreational fishers is the perceived impact of commercial eel fishing on other angling target species through bycatch and habitat disturbance. This creates potential conflict between recreational and commercial fishers. An extension of this issue is the access and utilisation of Crown land. Recreational eel fishing is permitted in crown waters, which are open to recreational fishing. This includes crown waters that are stocked for aquaculture purposes.
- Access to and utilisation of crown land and the legal implications entailed in non-exclusive access areas, makes compliance difficult. The stocking of eels represents an economic investment by

commercial fishers that they have little control over. There is a necessity to strike a balance between protecting these investments without hindering the use of a waterway as a public resource.

- The illegal trading of eels in the domestic market is an issue that requires further investigation. This issue does not appear to be as extensive as in other fisheries such as the abalone fishery, however represents a misuse of the resource and an unquantified impact on bycatch species.
- Indigenous eel fishing is an issue that is treated independently from commercial and recreational fishing practices. There is minimal information available on indigenous fishing; it is assumed that catch rates are low and that environmental impacts are minor. Considerations must be made on access and utilisation of indigenous lands and how this aligns with commercial and recreational resource issues. The main known areas where cultural indigenous eel fishing takes place include the Hopkins River and Mount Emu Creek catchments, and other waters in the Hopkins Basin.

Social issues

- The public perception of bycatch can have strong implications on a fishery, if a fishery is portrayed as damaging to the environment, the backlash can be significant. By developing a bycatch action plan the possibility of a negative industry image is minimised.
- If the bycatch of indicator species (see below) results in the closure of a waterway to eel fishing, then other eel fishers that share the same waterways and other watercourse users, may be directly or indirectly affected. Such a situation could lead to discontent amongst resource users.
- An environmental issue that encompasses significant social consequences is the bycatch of platypuses. The platypus is a national icon that regardless of abundance or rarity of capture can stir emotional sentiment and place the fishery into a negative light if platypus mortalities occur.

Economic issues

- The economic implications of bycatch can be direct and/or indirect, from issues such as the unsustainable mortality of juvenile commercial fish (eg. bream) in fyke nets, to the disturbance of ecosystem functions reducing the productivity of a watercourse. Other costs associated with bycatch are time spent removing bycatch and/or repairs to gear damaged by struggling bycatch.
- The process of reducing bycatch entails its own economic issues including the alteration of gear to install Bycatch Reduction Devices (BRDs), wages and time of compliance officers and the associated costs of added management and assessment. The positive side of costs associated with bycatch reduction is that these costs contribute to greater fishing efficiency and diminish the economic implications of bycatch.

Industry benefits

Introducing a bycatch action plan can help to promote a healthier ecosystem, which translates to a better environment for eel production. By emphasising an ecological approach to fishing, the Victorian

Eel Fishery will gain greater positive promotion in public and private sectors, leading to more attention and investment.

Bycatch reduction

Gear type and operating regulations detailed in the EFMP are designed to minimise the threat of capture to bycatch species. These regulations prevent fishing saturation of a watercourse by commercial fishers and the use of gear that has highly negative environmental impacts.

Information requirements

Reliable information on bycatch is sparse, presently fisheries officers observe commercial operators, however fisheries officers do not formally report the composition and quantities of bycatch species. This sporadic monitoring provides only a minor insight into the bycatch situation. The EFMP recommends that specific monitoring of bycatch in the eel fishery by Fisheries compliance officers be undertaken on a more frequent basis than is presently the case. The BAP recommends at least two visits per licence holder per year be undertaken, and include the specific monitoring of bycatch quantity and composition.

Fishery dependent information is a highly viable method of increasing bycatch data and cooperation between fishers, managers and researchers. One approach is to include formal provisions for bycatch information, and processing of bycatch data with eel catch and effort data. These provisions have been included in eel catch return logbooks from 2003. Historically, recording of bycatch in logbooks was a voluntary process based on fisher observations, and bycatch data were not entered on fishery databases.

Assessment

There is a need for a succinct bycatch risk analysis of all waters allocated to the commercial fishery. Until this is performed all efforts are constrained by generalisations through lack of knowledge. A risk analysis tool such as that used by Stobutzki, et al. (2001) is recommended for adaptation to the Victorian Eel Fishery. This method ranks bycatch species by their susceptibility to capture and mortality, and the population's capacity to recover after depletion (Stobutzki, et al. 2001). A bycatch risk analysis utilising this method would enable management of the fishery to follow a more direct approach and reduce the amount of time and money spent on judgements based on loose assumptions.

Presently the management of the Victorian Eel Fishery practices a precautionary approach to bycatch. Bycatch avoidance strategies using the precautionary approach to management have included the closure of fishing grounds to eel fishing where the waters contain threatened, endangered or protected species, or significant populations of species vulnerable to capture, such as platypus populations. In the absence of suitable fishery-independent data and biological reference points by which to manage, the precautionary approach, although highly conservative, is at present the only reliable means of eel fishery management in Victoria.

Bycatch reduction options

Bycatch Reduction Devices (BRDs) in the form of bycatch exclusion grids on fyke nets are used in some sectors of the fishery, however an effective universal BRD is yet to be introduced. Fishers targeting the larger longfinned eel do not commonly use bycatch exclusion grids; these grids can exclude larger size class eels suggesting a possible reapproach in design.

Canadian eel fishers have developed three devices to reduce the problem of catching juvenile salmon migrating downstream (Leadbitter 1999). These devices need to be tested for suitability to local conditions, by fishers and researchers, before they could be considered for adoption by the Victorian Eel Fishery.

- a) Escape cone exclusion device: A plastic cone (eg. end of a plastic drink bottle) is attached to the end of the net to allow fish to exit. The size of the exit can be varied according to the sizes of the fish and eels involved. This method only applies to fish and other taxa that are smaller than the eels targeted. Presently some commercial eel fishing operators are using similar method to this in Victoria, application of this method has been in practice since the 1970's in some culture waters (Bill Allan, eel fisherman, personal communication).
- b) Separator grid device: Similar to the bycatch exclusion grid, this device is an aluminium grid at the opening of a fyke net that excludes fish smaller than the eels. The device has a forward sloping grid and a passage underneath for eels to enter the next chamber. The smaller fish pass through the grid and down a passage at the top of the device where they can escape the netting. This design is very similar to the Nordmore-grid, which follows a similar principle however is designed for the release of bycatch larger than the target species in prawn trawls (O'Doherty, et al).
- c) Rubber band device: A rubber band is stretched around the guiding funnel tight enough to close it off. Large eels can push past the obstruction but smaller fish cannot. Debris can stretch the rubber band opening up the guiding funnel allowing more fish to enter, however the simplicity, cost and general effectiveness of the device makes it a worthwhile consideration. Some Victorian eel fishers who have trialed the rubber band device have found that it can reduce target catch by 90% when targeting shortfinned eels. In reply to this, some fishers have trialed a rubber o-ring as an alternative, this method has been found to be more effective than the rubber band device however can still significantly reduce target catch (Bill Allan, eel fisherman, personal communication).

Fyke net BRDs have to prevent bycatch both larger (depending on species and size of eels targeted) and smaller biota than eels. This suggests a need to increase the selectivity of the fyke nets. A combination of BRDs that exclude species larger than eels (eg bycatch exclusion grids) and BRD's that exclude species smaller than eels (eg escape cone exclusion device) may aid in increasing the selectivity of a fyke net.

The use of alternative gear types to the fyke net is presently not a realistic option for the Victorian eel fishery. The fyke net is considered to be the most selective and effective passive gear type available to eel fishers, therefore bycatch solutions presently lie in the modification of the fyke net, not necessarily in the utilisation of alternative gear types.

One Victorian eel fisher has devised an innovative method of reducing bycatch, by modifying the material used to construct fyke nets. Presently at an experimental stage the approach is to use a heavier ply material than what is usually used in the construction of fyke nets. The heavier ply reduces entanglement of fish and other bycatch in the wings, which in turn reduces bycatch mortality. In addition the heavier ply reduces net clearing time and damage to gear. A potential problem with this gear is that the heavier ply may sag more than lighter material, reducing the opportunity for air breathing bycatch to breathe. This problem has been resolved by using 20cm diameter polystyrene buoys in each compartment of the fyke net to ensure sufficient airspace (Mark Fletcher, Fisheries Victoria, personal communication). Such modified gear may have wider application in the Victorian eel fishery, and should be explored further. Any permanent changes to gear for the purposes of bycatch reduction may require alteration to the Fisheries Regulations.

Another bycatch reduction method is to raise and/or open the codend of a fyke net creating an opportunity to escape and/or to respire for air breathing bycatch (i.e. birds, water rats and platypus.) This practice is a condition of some eel fishing permits and is recommended to all licence and permit holders.

Eel permits issued for fishing in Wildlife Reserves generally contain conditions for operating hours for eel fishing. Such conditions are in place to minimise impacts of eel fishing on potential bycatch species, which have particular significance to the Wildlife Reserve being fished, and also reduce the potential for conflicts between other resource users.

To minimise the mortality of bycatch species, it is recommended that bycatch species be released without delay. The priority release of bycatch reduces strain on gear and potential damage to the catch. Therefore, to minimise sorting times it is recommended that aluminium sorting trays be installed onto boats (where practical and possible in relation to vessel size) to allow the quick release of bycatch.

The aluminium sorting tray idea was adopted from the volunteer code of practice of one commercial fisher, which provides an example of how some commercial eel fishers have taken responsibility for bycatch without external impetus.

In order to gather as much information as possible and to share ideas, it is recommended that a bycatch reduction workshop for EFAL holders be conducted, and include discussion and demonstration of the design and use BRDs and bycatch reduction methods. By combining the experience and ingenuity of the fishers, new ideas and designs have a greater opportunity to come into fruition.

Indicator species

Commercial eel fishing is not permitted in waters in which populations of indicator species such as platypuses (*Ornithorhynchus anatinus*) and native fish species such as estuary perch (*Macquaria colonorum*), Australian grayling (*Prototroctes maraena*) and Australian bass (*Macquaria novemaculeata*) are perceived to be threatened by the practice of commercial eel fishing. There may be a necessity to expand the indicator species list to include other endangered, threatened or protected species such as the broad-finned galaxias (*Galaxias brevipinnis*), freshwater herring (*Potamalosa richmondia*), pouched lamprey (*Geotria australis*) pipefish and seahorses (*Syngnathid* species) and Tasmanian mudfish (*Galaxias cleaveri*.) In addition the bycatch of any air-breathing species should be recorded, and also any

unusual bycatch events which may occur. Such events may include the capture of species not known to the fisher, capture of species in waters not known to be a habitat or within the distribution range of that species, or capture of an unusually high number of a particular species. The premise is to gather as much information as possible on bycatch, through the utilisation of the observation skills of the fishers, patterns can be determined and appropriate measures taken. Descriptions and diagrams of indicator species are recommended inclusions to the logbooks, and/or the distribution of a bycatch species identification handbook to eel fishers.

Any significant increase in indicator species catch numbers in the fishery would be brought to the attention of Fisheries Victoria and Parks Flora & Fauna, the appropriate management authorities. A review of fishing activities would then be undertaken by the eel fishery review panel, as described in the EFMP, to determine the level of risk to indicator species associated with the continuation of fishing. Monitoring by compliance officers would be increased to ascertain a greater understanding of the situation, and managers and industry would co-operate to devise a means to minimise impacts.

Impacts on endangered, threatened or protected species

Information requirements

Reliable information is available for the distribution of endangered, threatened or protected species, the distribution of eel fishing activities is also known, however the degree of overlap is yet to be quantified. (See Appendices)

Assessment

This report recommends that the impact of the commercial eel fishery on endangered, threatened or protected communities are to be reviewed annually. This should be undertaken through combined reviews of bycatch reports from fishers, and in addition to this, random inspections of fishing operations by Fisheries Officers should be undertaken as part of regional service agreements with Fisheries Victoria (a minimum of two inspections per year per licence holder is recommended.)

Management responses

When indicator species are caught in predetermined significant numbers as determined by the ecological risk assessment the waterway will either be closed or in review to closure at the next stakeholder meeting. The development and implication of efficient BRD's should aid in the reduction of capture and/or mortality of endangered, threatened or protected species. Presently all commercial licence holders permitted to fish in Wildlife Reserves in western Victoria are required to use BRD's, all Wildlife Reserve fishing permit holders must clear their nets every 24 hours.

Site specific permit conditions for some Wildlife Reserves (Clydebank Morass and Heart Morass State Game Reserves) require a 14 day period between clearing nets and reusing them in different waters, in addition all gear including nets and boats must be cleaned prior to use in any other waters. These measures are in place to prevent the translocation of fauna and flora between wetlands. This approach is recommended for all wetlands particularly Ramsar wetlands.

The existing bycatch avoidance strategies, combined with the utilisation of random field observations of fishing activities by Fisheries Officers, ensures that the eel fishery is conducted in a manner that reduces or avoids mortality, or injuries to endangered, threatened or protected species. In addition the management responses provide a mechanism under the EFMP to regulate significant bycatch problems through the closure of waters/reserves and the annual review process.

Strategies

Co-operative agreements

The primary co-operative group in which the Victorian Eel Fishery lies is the Australian and New Zealand Eel Reference Group (ANZERG) which aims to:

- Develop a coordinated approach to the management of eel stocks
- Develop strategies for stock allocation, industry development, compliance and management/administration of the glass eel fishing sector.
- Promote cooperative research on eels between states
- Advise on management policies to promote and enhance eel aquaculture
- Strengthen communication and coordination between fisheries managers, researchers and aquarists.

The key role of ANZERG is to develop a coordinated approach to eel management throughout the region, and to provide direction for all relevant jurisdictions for consistency in the management of eel stocks and ecologically sustainable development of eel fishing and aquaculture industries.

Co-operation is vital to the success of the fishery, through the collaboration of all stakeholder groups the fishery cannot only fulfil its ESD obligations but progress with greater efficiency and economic gain.

Education

Education is a necessary component in instigating the bycatch action plan; possible approaches include:

- Development of a threatened species awareness short course or information booklet, highlighting the necessities of conservation and the species of significance to the fishery.
- Marketing and public education of eels as a food alternative and a well-managed resource to the domestic market.
- Public notices of eel fishing activity, to minimise the reporting of false alarm illegal fishing.
- Articles in industry newsletters and magazines, highlighting the importance of bycatch reduction, means of doing so and listing indicator species.

Summary of Recommendations

Action	Time Frame	Priority
Modify eel fishery return logbooks to include provisions for recording bycatch data.	Completed 2003	High
Monitoring of bycatch in the eel fishery by compliance officers, as part of regional service agreements with Fisheries Victoria. Independent monitoring of bycatch by compliance officers (2 random visits, per licence holder, per year).	Ongoing (Commence July 2003)	High
Review of bycatch data, and performance of the fishery in bycatch reduction, as part of the annual review process.	Ongoing	High
A risk assessment on the Victorian Eel Fishery's impact on endangered, threatened or protected species to be performed, using existing data. The risk assessment would be incorporated into each annual review of the eel fishery under the EFMP.	June 2004	High
Develop an industry code of conduct on bycatch to help make practices universal across the fishery (target species and habitat dependent) and to prevent new operators undermining the work of others.	December 2003	High
Include birds, water rats, turtles and unusual events as bycatch recordings in logbooks.	Ongoing	Moderate
Organise a system of collaboration and development of BRD design between fishers and the DPI.	Ongoing	Moderate
Organise a BRD workshop for fishers to share ideas and develop new methods of reducing bycatch.	June 2004	Moderate
Formulate a means of monitoring bycatch in waters on privately owned land.	June 2004	Moderate
Review indicator species listings	Ongoing	Moderate
Devise strategies and actions for the prevention of illegal eel fishing and trading.	June 2004	Low
Include diagrams and taxonomic keys in logbooks to identify key bycatch species, or circulate a species identification booklet for field identification.	June 2004	Low

Glass eels

Background

Fishing for glass eels is a recent development in Victoria. The primary purpose of this practice is to collect glass eels for intensive grow out to market size, or for aquaculture/stock enhancement. Guidelines for fishing and aquaculture for glass eels are detailed in Gooley and Ingram (2002).

A considerable amount of information has been collated on the capture and husbandry of glass eels in Victoria (McKinnon, et al. 2000; McKinnon, et al. 2001; McKinnon et al. 2002). The environmental impact of glass eel fishing is yet to be quantified, particularly if this practice is to be expanded. It is necessary to determine the potential impacts of glass eel fishing on glass eel stocks and bycatch species through environmental risk assessment.

Management regime

Permit conditions are in place to protect glass eel stocks, bycatch and ecological communities; the present permit conditions for glass eel fishing include:

- Fishing nets must not be left unattended at any time.
- Nets must be hauled and cleared at least once every hour.
- A detailed inventory of all stocks must be kept and made available to any authorised officer of the DPI.
- A minimum of 10% by number of glass eels harvested under the permit must be returned to waters from which they were taken as advanced pigmented elvers (minimum average size 2 g), under the supervision of departmental officers.
- All non-target species except noxious fish are to be returned to the water as soon as possible.

Issues and priorities

- The bycatch issues for glass eels are treated independently from the rest of the commercial fishery due to the different gear types used to harvest glass eels. The multiple gear types used to capture glass eels reduce selectivity increasing the incidence of bycatch.
- Quantity, diversity and mortality of bycatch species, has been found to be high for glass eel fishing in comparison to fyke net fishing for adults. This is largely due to the fine mesh (2.0mm approx) used in netting material, and the method of fishing usually undertaken (fishing nocturnal flood tides in estuaries). The predominant bycatch species include small fish and the juveniles of larger species, many of commercial importance (McKinnon, et al. 2000). The reduction of bycatch in this fishery is vital to the development of this industry. One of the most pertinent issues is how to increase the selectivity of the gear to target glass eels when numerous other species are of a similar size.
- Glass eel fishing can have a significant effect on threatened, endangered and protected species, particularly juveniles and small difficult to identify species such as galaxiids and pigmy perch.

These bycatch species are easily overlooked, however they constitute a significant proportion of the states listed species and play important ecological roles (Koehn and O'Connor 1990).

- A resource sharing issue important to the commercial adult eel fishery is the perception that glass eel fishing may reduce adult stock recruitment. The expected high mortality rate of glass eels in the wild suggests that commercial fishing for glass eels would have to be at an exceedingly high level to affect recruitment. Glass eels are commonly used for restocking once grown out, suggesting a positive influence on recruitment. A minimum of 10% by number of glass eels harvested under the permit must be returned to waters from which they were taken as advanced pigmented elvers.
- Glass eel fishing can have an impact on other commercial fisheries and recreational fishing if the capture and mortality of other juvenile species is significant.

Bycatch reduction

Information requirements

An environmental risk assessment for the glass eel fishery is required to determine the potential impact this fishery may have on endangered, threatened or protected species and ecological communities. Presently it is known what types of species may be susceptible as bycatch in the glass eel fishery, however detailed assessment of the distribution of endangered, threatened or protected species in comparison to glass eel harvesting is yet to be investigated.

Assessment

The glass eel fishery is presently at a preliminary level of development, as the industry grows a proportional level of assessment must be conducted. It is recommended that the glass eel fishery be monitored and assessed in the same manner as the commercial adult eel fishery, requiring logbook entries detailing bycatch and occasional visits (2–3 per year, per licence holder) by Compliance Officers to inspect operations.

An issue that must be addressed is the heightened difficulty of identifying juvenile fish and invertebrate species. This limits the potential for fishers to reliably identify bycatch, however it is unreasonable to expect a fisher to sort through and identify multitudes of taxa. The use of indicator species and the distribution of species identification keys could potentially address this problem in conjunction with the environmental risk assessment.

Management response

The location within an estuary in which glass eel harvesting occurs can impact on the quantity and composition of bycatch, as species diversity tends to decrease with distance upstream. The selection of site location for harvest may play a role in ensuring the ecologically sustainable development of the industry. A potential measure to reduce the level of bycatch is to set zones within an estuary in which harvesting can take place.

Indicator species

Possible indicator species for the glass eel fishery could include: the dwarf galaxias (*Galaxiella pusilla*), freshwater herring (*Potamalosa richmondia*), spotted galaxias (*Galaxias truttaceus*), Tasmanian mudfish (*Galaxias cleaveri*), yarra pigmy perch (*Edelia obscura*) and ewens pigmy perch (*Nannoperca variegata*). Many of the aforementioned species have restricted distributions and are potentially threatened, vulnerable or endangered. Close monitoring of potential bycatch species such as these should be undertaken during the development of the glass eel fishery. Significant bycatch of any of these species would trigger an immediate review of the fishery.

Recommendations

Action	Time Frame	Priority
Log-books altered to have provisions for the recording of bycatch of indicator species and species identification keys located within the logbooks.	Completed 2003	High
Devise a means of increasing the selectivity of glass eel gear, through the development of efficient BRD's.	Ongoing	High
Perform an environmental risk assessment on the Victorian glass eel fishery.	December 2004	Moderate
Investigate and regulate correlations of glass eel fishing times with the spawning and migrations of potential bycatch species.	Ongoing	Moderate

Conclusions

The Victorian Eel Fishery has the potential to be a ESD bench mark for Australian small scale fisheries, through appropriate planning and cooperation, there is no reason why this can not be the case. There is a necessity to build a strong relationship between eel fishers and the Department of Primary Industry to determine the true impact of commercial eel fishing on bycatch and to find means of reducing such impacts.

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Appendices

Acronyms and abbreviations

ANZERG	The Australian and New Zealand Eel Reference Group
ARI	Arthur Rylah Institute
BAP	Bycatch Action Plan
BRD	Bycatch Reduction Device
DPI	Department of Primary Industry
DSE	Department of Sustainability and Environment
EA	Environment Australia
EEZ	Economic Exclusion Zone
EFAL	Eel Fishery Access Licence
EFMP	Eel Fishery Management Plan
ESD	Ecologically Sustainable Development
MAFRI	Marine and Freshwater Resources Institute
VRFish	Victorian Recreational Fishing Peak Body

Table 1: Native bycatch species

Common name	Scientific name	Distribution	Conservation Status	Maximum Length
Platypus	<i>Ornithorhynchus anatinus</i>	Freshwater	Protected (indicator spp.)	450 mm
Water rats	<i>Hydromys chrysogaster</i>	Estuarine and freshwater	Common	310 mm
Birds (multi spp.)	Aves (class)	Estuarine and freshwater	Common	Variable
Turtles/Tortoises (multi spp)	<i>Chelodina</i> (genus)	Freshwater	Indeterminate	Variable
Yabbies	<i>Cherax destructor</i>	Freshwater	Common	250 mm
Crabs (multi spp)	<i>Brachyura</i> (suborder)	Estuarine and freshwater	Common	Variable
Shrimp (multi spp.)	<i>Paratya</i> (genus)	Estuarine	Common	Variable
Jelly fish (multi spp.)	<i>Scyphozoa</i> (class)	Estuarine	Common	Variable
Australian anchovy	<i>Engraulis australis</i>	Estuarine	Common	157 mm
Australian bass	<i>Macquaria novemaculeata</i>	Estuarine and freshwater	Potentially threatened (indicator spp.)	578 mm
Australian grayling	<i>Prototroctes maraena</i>	Estuarine and freshwater	Potentially threatened (indicator spp.)	330 mm
Australian salmon (multi spp.)	<i>Arripis</i> spp.	Estuarine	Common	850 mm
Australian smelt	<i>Retropinna semoni</i>	Freshwater	Common	100 mm
Black bream	<i>Acanthopagrus butcheri</i>	Estuarine	Common	600 mm
Blackfish	<i>Gadopsis marmoratus</i>	Freshwater	Indeterminate	600 mm
Short-finned galaxis	<i>Galaxis brevipinnis</i>	Estuarine and freshwater	Potentially threatened	250 mm
Cobbler	<i>Gymnapistes marmoratus</i>	Estuarine	Common	230 mm
Common galaxis	<i>Galaxis maculatus</i>	Estuarine and freshwater	Common	190 mm
Cox's gudgeon	<i>Gobimorphus coxii</i>	Estuarine and freshwater	Indeterminate	190 mm
Dwarf galaxis	<i>Galaziella pusilla</i>	Estuarine and freshwater	Potentially threatened	40 mm
Estuary perch	<i>Macquaria colonorum</i>	Estuarine	Common (indicator spp.)	540 mm
Ewens pigmy perch	<i>Nannoperca variegata</i>	Estuarine and freshwater	Endangered	60 mm

Flathead (multi spp.)	<i>Platycephalus</i> spp.	Estuarine	Common	1500 mm
Flat-headed gudgeon	<i>Philypnodon grandiceps</i>	Estuarine and freshwater	Common	120 mm
Freshwater herring	<i>Potamalosa richmondia</i>	Estuarine and freshwater	Endangered	320 mm
Glass perch	<i>Ambassis marianus</i>	Estuarine and freshwater	Indeterminate	100 mm
Gobies (multi spp.)	<i>Gobiidae</i> (family)	Estuarine	Common	110 mm
Leatherjacket	<i>Scobinichthys granulatus</i>	Estuarine	Common	340 mm
Luderick	<i>Girella tricuspidata</i>	Estuarine	Common	700 mm
Mountain galaxias	<i>Galaxis olidus</i>	Freshwater	Indeterminate	145 mm
Mullet (multi spp.)	<i>Mugilidae</i> (family)	Estuarine and freshwater	Common	300 mm
Mulloway	<i>Argyrosomus hololepidotus</i>	Estuarine	Common	1800 mm
Pipefish (multi spp.)	<i>Sygnathidae</i> (family)	Estuarine	Protected	450 mm
Pouched lamprey	<i>Geotria australis</i>	Estuarine and freshwater	Potentially threatened	670 mm
River garfish	<i>Hyporhamphus regularis</i>	Estuarine	Common	280 mm
Sandy sprat	<i>Hyperlophus vittatus</i>	Estuarine	Common	130 mm
Short-headed lamprey	<i>Mordacia mordax</i>	Estuarine and freshwater	Common	480 mm
Silver biddy	<i>Gerres ovatus</i>	Estuarine	Common	230 mm
Small-mouthed hardyhead	<i>Atherinosoma microstoma</i>	Estuarine and freshwater	Common	80 mm
Snapper	<i>Chrysophrys auratus</i>	Estuarine	Common	350 mm
Southern pigmy perch	<i>Nannoperca australis</i>	Estuarine and freshwater	Common	82 mm
Spotted galaxis	<i>Galaxis truttaceus</i>	Estuarine and freshwater	Potentially threatened	200 mm
Striped gudgeon	<i>Gobimorphus australis</i>	Estuarine and freshwater	Indeterminate	225 mm
Tasmanian mudfish	<i>Neochanna cleaveri</i>	Estuarine and freshwater	Vulnerable	140 mm
Toadfish	<i>Tetraodontidae</i> (family)	Estuarine	Common	220 mm
Tommy ruff	<i>Arripis georgianus</i>	Estuarine	Common	410 mm
Tupong	<i>Pseudaphritis urvilli</i>	Estuarine and freshwater	Common	190 mm

Yarra pigmy perch	<i>Nannoperca obscura</i>	Estuarine and freshwater	Potentially threatened	75 mm
Yellowfin bream	<i>Acanthopagrus australis</i>	Estuarine	Common	660 mm

Table 2: Introduced bycatch species

Common name	Scientific name	Distribution	Conservation Status	Maximum Length
Atlantic salmon	<i>Salmo salar</i>	Freshwater	Noxious	1500 mm
Brown trout	<i>Salmo trutta</i>	Freshwater	Noxious	900 mm
European carp	<i>Cyprinus carpio</i>	Freshwater	Noxious	850 mm
Goldfish	<i>Carassius auratus</i>	Freshwater	Noxious	850 mm
Mosquito fish	<i>Gambusia affinis</i>	Freshwater	Noxious	60 mm
Rainbow trout	<i>Oncorhynchus mykiss</i>	Freshwater	Noxious	900 mm
Redfin	<i>Perca fluviatilis</i>	Freshwater	Noxious	600 mm
Roach	<i>Rutilus rutilus</i>	Freshwater	Noxious	450 mm
Tench	<i>Tinca tinca</i>	Freshwater	Noxious	720 mm

Figure 1

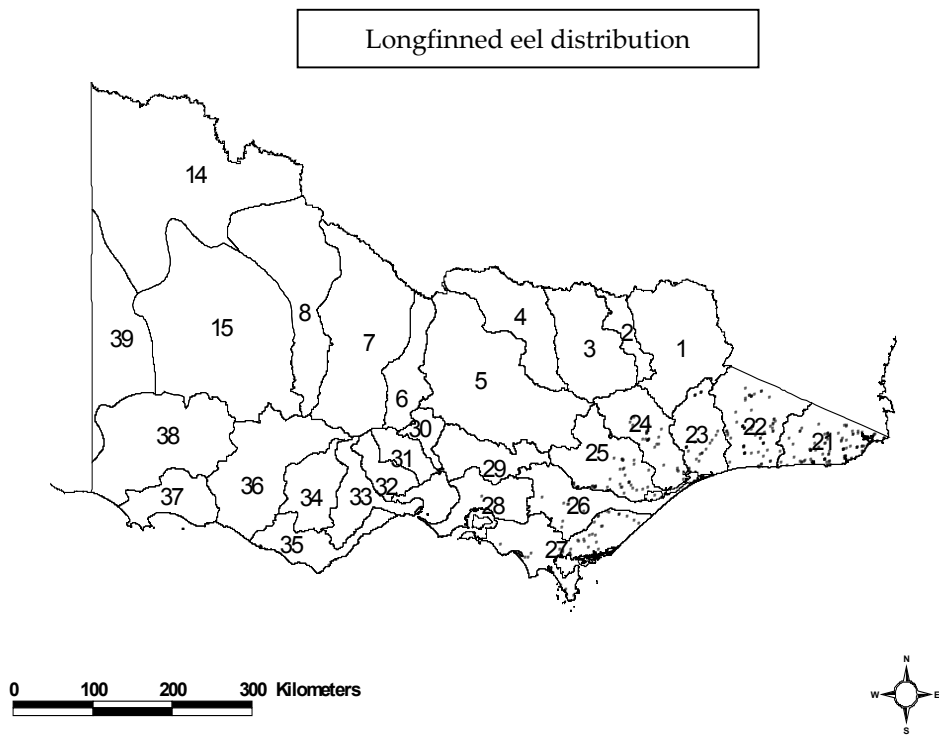


Figure 2

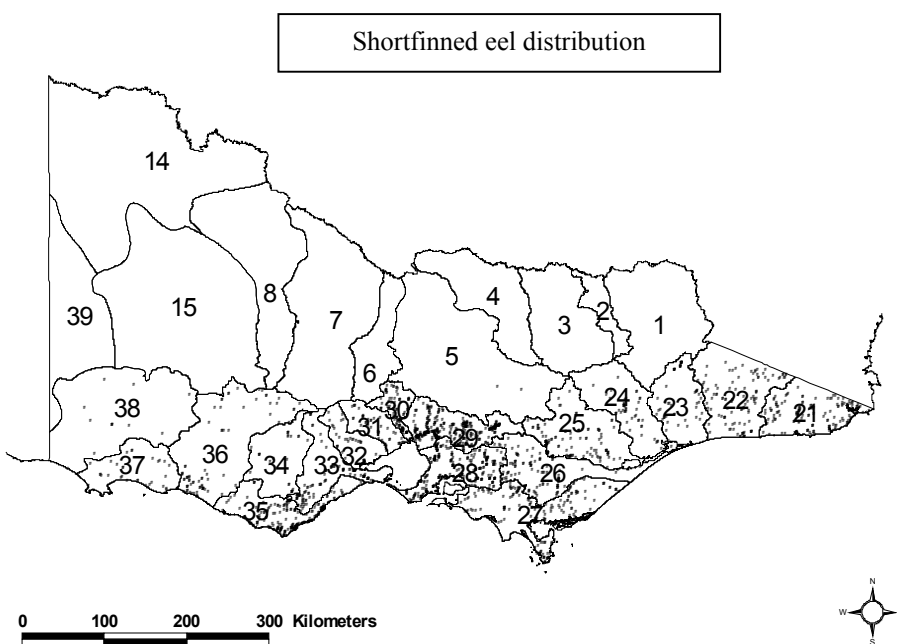


Figure 3

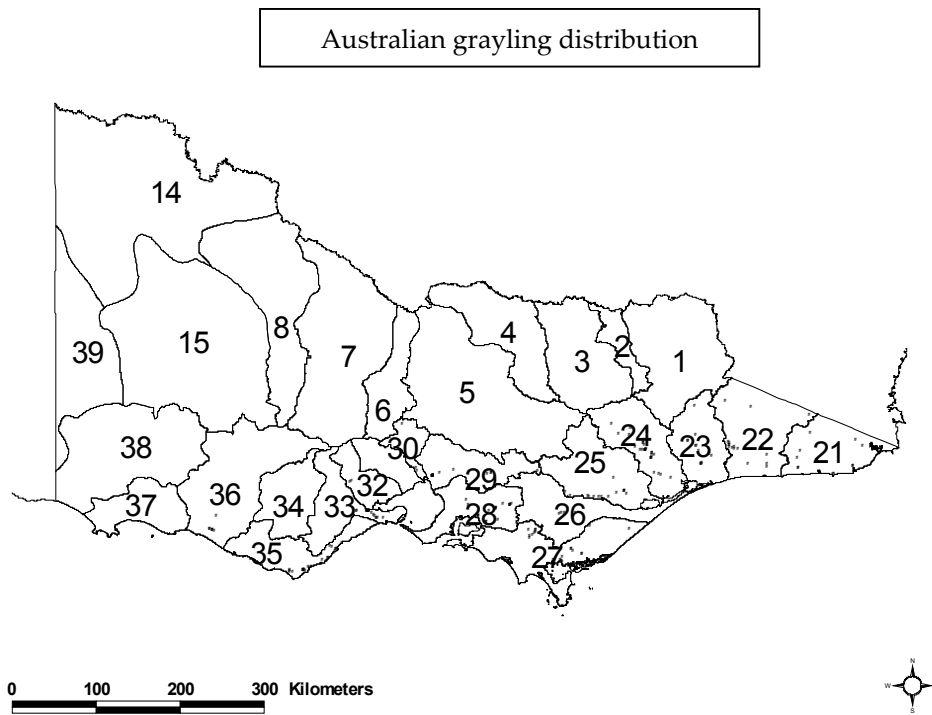


Figure 4

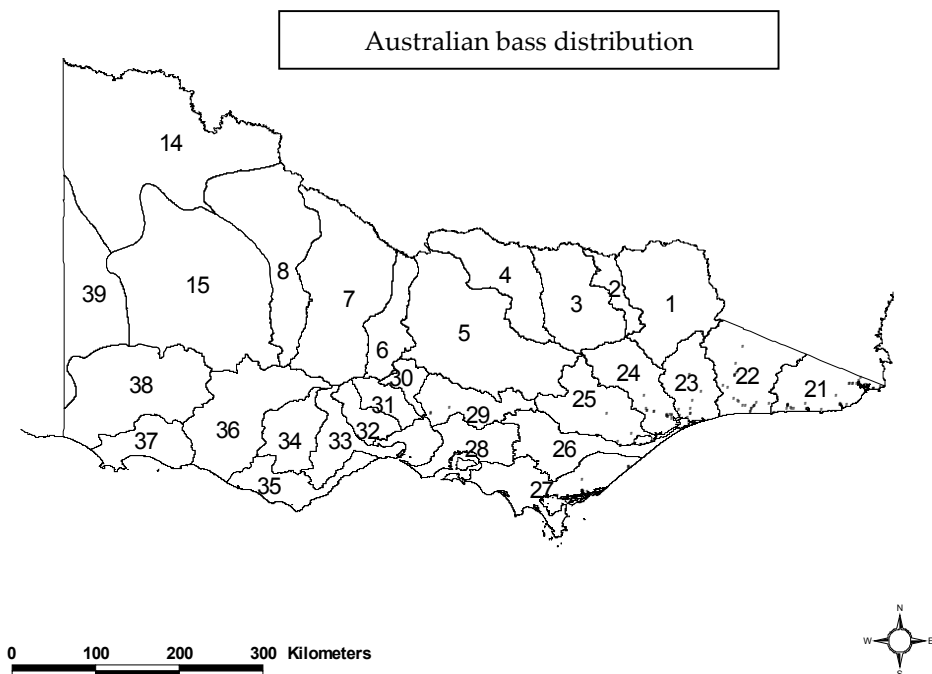


Figure 5

Southern platypus distribution

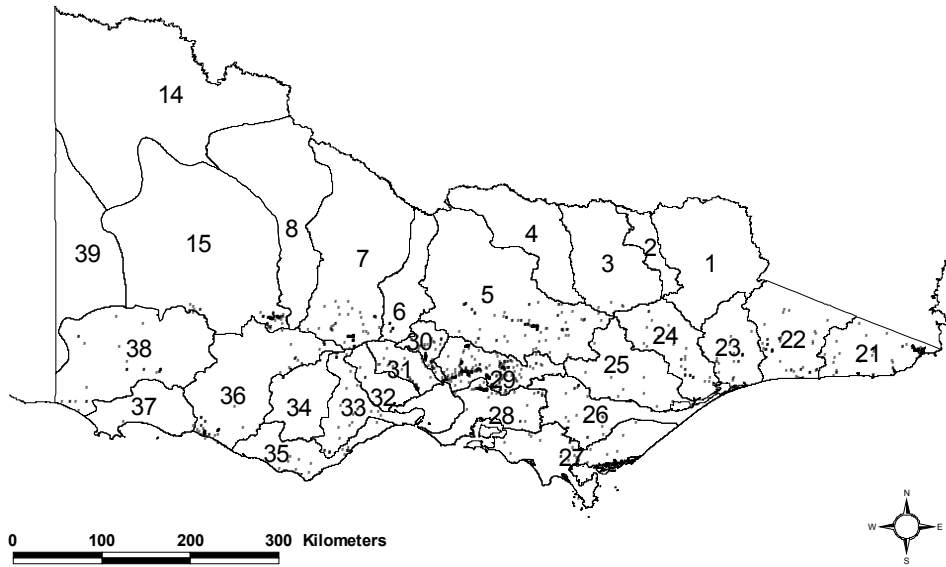


Figure 6

Southern distribution of Common long necked tortoise

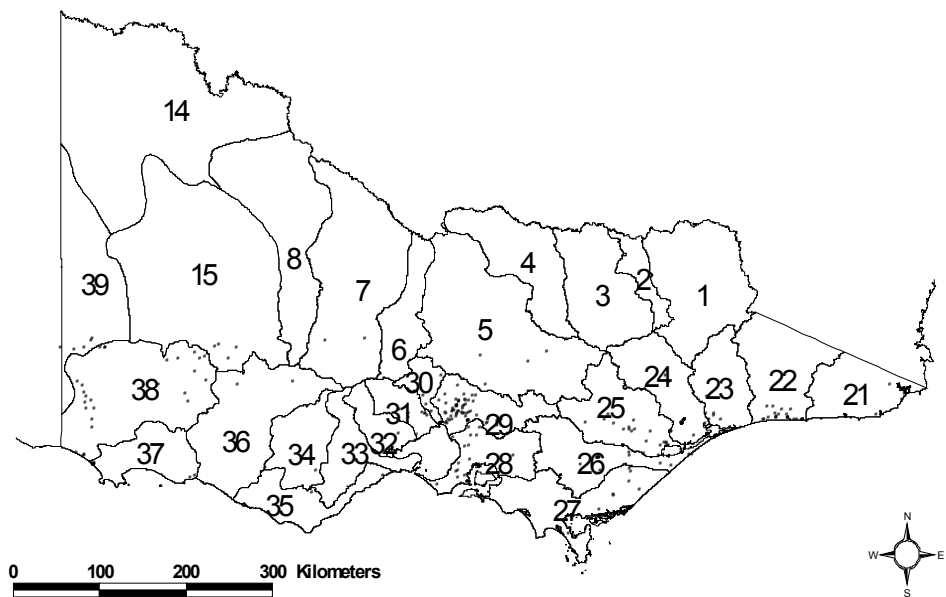


Table 3: Victorian River Basins:	
Basin name	Basin number
Upper Murray	1
Kiewa	2
Ovens	3
Broken	4
Golburn	5
Campaspe	6
Loddon	7
Avoca	8
Mallee	14
Wimmera	15
East Gippsland	21
Snowy	22
Tambo	23
Mitchell	24
Thomson	25
La Trobe	26
South Gippsland	27
Bunyip	28
Yarra	29
Maribymong	30
Werribee	31
Moorabool	32
Barwon	33
Corangamite	34
Otway	35
Hopkins	36
Portland	37
Glenelg	38
Millicent Coast	39