Tasmanian Eel Industry Development and Management Plan

John Purser, Phil Cooper, John Diggle and Tony Ibbott
December 2014
FRDC Project No 2012/208

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Executive Summary

The Tasmanian commercial eel companies, Inland Fisheries Service (IFS) and the University of Tasmania (UTAS), together with other key industry and associated stakeholders have over a period of about 18 months formulated a joint Industry Development and Management Plan which will be used to guide the future of the eel fishery in the state.

This is the first Plan for the state eel fishery designed to provide a framework to inform and guide commercial investment by industry, government policy and management by Inland Fisheries Service, research, development and extension by researchers, and associated activities by other government and non-government organisations and commercial operators.

The Plan was developed through a series of workshops, meetings and feedback sessions with eel fishers and associated stakeholders, and as a "living" document the Plan is expected to evolve over time to cater for the changing needs of industry and government.

Key words:
Eel stock management, catchment management, sustainability, stakeholder communication, industry viability, wild capture, aquaculture, biosecurity, Short-finned eel *Anguilla australis*, Long-finned eel *Anguilla reinhardtii*

Introduction

The Tasmanian eel fishery did not have an industry-driven development plan. After much discussion by stakeholders, it was agreed that on the basis of efficiencies and effectiveness, an Industry Development Plan should not be progressed in isolation of a State Government Management Plan but rather the two should be incorporated into a single document. The resultant Tasmanian Eel Industry Development and Management Plan outlined here was finalised through a consultative process of stakeholders, with the support of Fisheries Research Development Corporation (FRDC). This document identifies the vision, purpose and goals of the Plan and incorporates the outcomes of several meetings and discussions between a range of stakeholders including eel fishers, Inland Fisheries Service, other state government departments, University of Tasmania, Hydro and NGOs. The major contribution for the compilation of the report was from John Purser as lead investigator with assistance from eel industry representative Phil Cooper and the Director of the Inland Fisheries Service, John Diggle. Tony Ibbott (Marine Solutions) was engaged as a facilitator for the major meetings and also assisted in the completion of this report.

Objectives

The original objective of the project was to:

- Formulate a development and directions plan for the Tasmanian Freshwater Eel Industry.

The goals of the development plan are as follows:

- Establish a vision and focussed direction for the Tasmanian Freshwater Eel Industry
- Assess the approaches and techniques available in aquaculture and wild harvest to achieve a measured expansion of the industry with due consideration for ecological sustainability
- Identify strategies to maximise the economic potential of the eel industry whilst maintaining economic sustainability and viability
- Maintain current and create additional investment confidence and opportunities
- Identify strategies to position industry to take advantage of emerging opportunities in the global market
- Guide the research needs of the industry

Methodology

The objective of the investigators at the start was to engage stakeholders across the eel fishery and associated organisations. After discussion it was agreed that an Industry Development Plan should not be progressed in isolation to the government management plans and hence the Industry Development and Management Plan emerged.

Initially a full list of industry and non-industry stakeholders was compiled and issued with an invitation to attend a stakeholder consultation meeting in August 2012. Some eel fishers chose not to become involved principally because they were not actively fishing their licenses. Mr Tony Ibbott was engaged as a facilitator to direct the flow of the workshop and focus on key aspects in the development of the Plan involving discussions around vision, mission, strategic planning and SWOT. Such an approach also allowed the project investigators to tease out key points with the participants and to make additional notes. A planning questionnaire (Appendix 3) was forwarded to all attendees after the workshop asking their opinion on strategies for the Industry from a stakeholders' perspective and a draft report of the key points in the workshop was compiled by Tony Ibbott. Literature searches and interrogation of the Inland Fisheries Service records produced additional relevant information which informed the Plan. The information in the Appendices however does not attempt to provide a comprehensive review of the literature but rather has been summarised in context with the content of the Plan providing background to the "thinking" at the time the Plan was developed. Additional meetings with eel fishers were held in December 2012, February, May and September 2013, though informal meetings and discussions were held over the period of the project. During regular monthly meetings between the investigators and the facilitator, the content, directions and format were discussed.

Results

The result of the project is the Plan itself which is embedded in the document below.

Industry Vision

The Vision of the Tasmanian Eel industry is to be:

1 Highly recognised and respected segment of the Tasmanian fine food industry
2 Profitable, sustainable and market driven
3 Professional, responsible, self-regulated, involved

Industry Purpose

1 To gain high value from a Tasmanian resource for profit and employment in a sustainable way.

Goals

1 To maintain an ecologically and commercially sustainable resource
2 To maintain a reliable supply of quality product from industry
3 To develop a financially viable freshwater eel industry sector

1. Purpose of the plan

1.1. To establish a framework for the ecological and commercial sustainable development of the Tasmanian eel fishery.
1.2. To provide for the expansion of eel production through stock management, enhancement and fattening under culture.
1.3. To maintain a level of self-management within the fishery, working closely with Inland Fisheries Service.
1.4. To identify appropriate research and development strategies.
1.5. To ensure compliance to Department of the Environment (formerly Department of Sustainability, Environment, Water, Population and Communities) reporting requirements to enable maintenance of export approvals.

2. Tasmanian Industry Summary

The commercial eel fishery commenced in Tasmania in the mid-1960's with a summary of the regulatory and policy history listed in Appendix 1.The fishery is managed by the Inland Fisheries Service under the *Inland Fisheries Act 1995* and subordinate legislation, specifically the *Inland Fisheries (Commercial Nets and Fees) Regulations 2009, Inland Fisheries (Recreational Fishing) Regulations 2009* and *Inland Fisheries (Seaward Limits) Order 2004*.

Commercial Freshwater Eel Fishing Licences are issued under the Act. There are currently 12 geographically defined and transferrable licences in place which have remained consistent since 1998, with 10 located on the Tasmanian mainland and one each to Flinders and King

Island (Figure 1). Of these 12 licences 4 are owned by one entity, 3 by another, 2 by another and 3 owned individually. One licence has been unfished for a number of years and several unfished to their potential. Each licence holder pays an annual licence fee and a royalty for each kilogram of eel taken from the fishery to the Inland Fisheries Service (IFS).

There are 48 major defined water catchments in Tasmania (DPIWE 2000) and 38 are allocated to the commercial eel fishery.

The fishery is based on fyke net, eel trap and downstream migratory capture with no total allowable catch (TAC) restrictions in waters allocated within large scale catchments. A fyke net is a net that (a) does not exceed 670 mm in opening height, (b) does not exceed 670 mm in width, (c) has mesh that is not less than 15 mm and not more than 39 mm and (d) any wing or leader of which does not exceed 10 m in length and does not exceed 1 200 mm in drop. An eel trap is a trap that (a) does not exceed 500 mm in height, (b) does not exceed 2 m in length, (c) does not exceed 500 mm in width, (d) does not have wings or leaders and (e) has a mesh of at least 39 mm.

Fyke nets and eel traps set fully submerged must have a platypus exclusion screen fitted with no opening greater than 220mm. In certain waters a screen with a 280mm opening may be used provided that the cod end is raised 300mm above the water surface. There is no limit on the number of nets or traps that can be used however each fyke net or trap must be inspected and emptied within a 24 hour period. Variations and requests to use different gear configurations to suit specific situations are dealt with under Exemption Permit or incorporated in the licence conditions.

Logbooks issued by the Inland Fisheries Service are used to record catch and effort in the fishery. Electronic logbook returns are accepted and submitted monthly with by-catch information which is also recorded for sustainability reporting purposes.

License holders are provided exclusive access rights and it is their responsibility to manage their license to ensure economic sustainability. There is no closed season for the eel fishery however seasonal cold water factors make fishing during mid-May to September unviable with eels tending to hibernate. Constant year-round supply from Tasmania can therefore only be realized through the sale of frozen/value added product or the increased use of aquaculture facilities for long term holding or fattening of small eels.

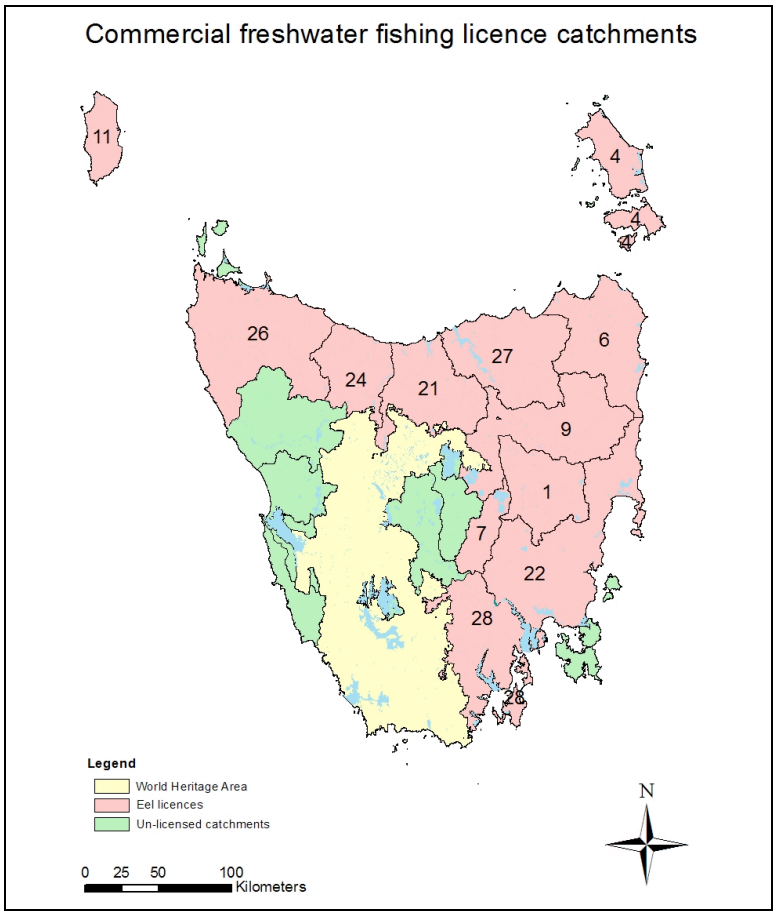

Figure 1: Map of Tasmania indicating the licensed and unlicensed catchment areas.

In order to ensure ecological sustainability a number of catchments are closed to fishing as are most flowing waters. These closed catchment areas are found between the Huon River and Arthur River catchments in the West including a significant part of central Tasmania. Fishing in rivers is specifically limited through licensing with only less than 1% of all rivers permitted to be fished. As a consequence the vast majority of fishing occurs in lakes and dams.

There are currently no eel aquaculture ventures operating in Tasmania though recirculating aquaculture systems (RAS) are used to hold captured eels prior to packing and transport. Likewise there is no indigenous sector and only a small recreational sector within the Tasmanian industry.

The commercial freshwater eel fishery is based on two species of freshwater eels; short-finned eel (*Anguilla australis*, Richardson) and the long-finned eel (*Anguilla reinhardtii,* Steindachner). The short-finned eel is distributed around South East Australia, some South Pacific islands and New Zealand. In Australia, this eel is more abundant in Victoria and Tasmania, and abundance reduces northwards in New South Wales and Queensland. The distribution of long finned eels is similar except that the pattern of abundance is reversed; it is more common in Queensland and New South Wales and decreases further south in Victoria and Tasmania. This species is also found in the northern parts of the North Island of

New Zealand and is only a minor component of the New Zealand eel fishery (Jellyman 2007) with short fin (*A. australis)* and New Zealand long fin (*Anguilla dieffenbachia)*, Gray predominating. Details of the biology of eels can be found in, for example, Jellyman (1977, 1979), Jellyman et al. (1999), Todd (1980) for New Zealand, Baker (2010), McKinnon et al. (2000) for mainland Australia and in Tasmania has been reported by Boxall (2003) and Sloane (1982, 1984 a,b,c,d,e,f). A list of all anguillid species worldwide is shown in Appendix 2.

The fishery is based on the harvest of adult "yellow" feeding eels larger than 300 mm in length captured in inland waters. Migrating mature "silver" eels comprise a minor component of the Tasmanian harvests though the proportion varies seasonally. The Inland Fisheries Service harvests juvenile eels, primarily elvers, for the provision of environmental stock for Hydro Tasmania, commercial re-stocking in Tasmania and South-East Australia, and export. Fishers are not allowed to take fish less than 300 mm unless under permit from IFS specifically for transfer to other waterways.

The average annual harvest of adult eels over the past 30 years is 37 tonnes, with the highest recorded harvest 91.8 tonnes in 1967/68 and the lowest 6.7 tonnes in 2004/05. Short finned eels account for over 95% of this harvest in most years. Harvest figures for 1982 to 2013 are shown in Figure 2.

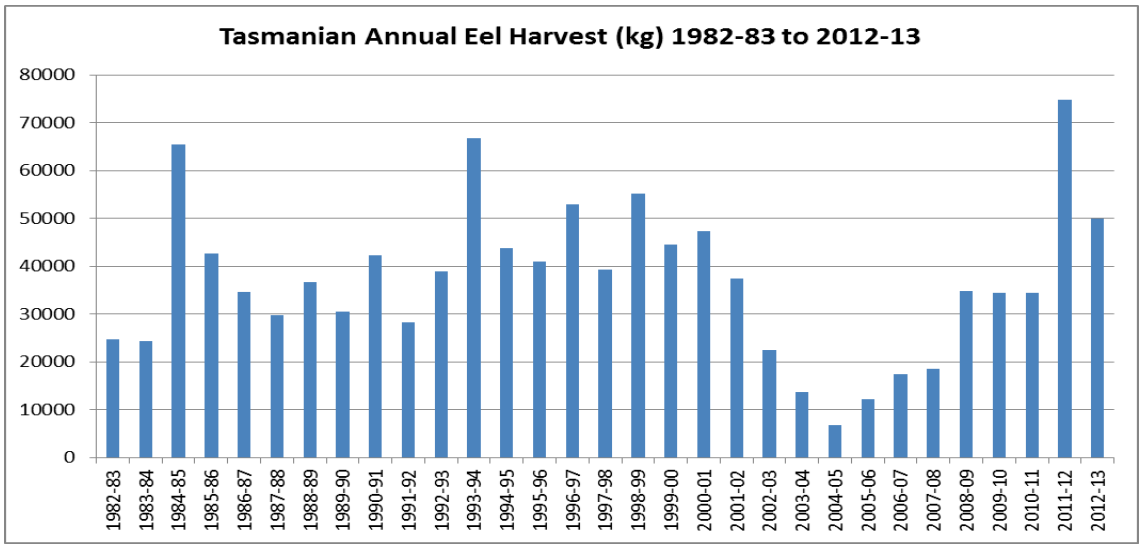

Figure 2: Annual harvest (kg) of eels in Tasmania between 1982 and 2013.

The Tasmanian Inland Fisheries Service reports on the Tasmanian eel fishery to Commonwealth Government agencies (Department of the Environment) to facilitate the continuance of export licences and to demonstrate sustainability within the industry (IFS, 2009, IFS, 2014). The export license is critical to the viability of the Tasmanian eel industry which is fundamentally export orientated towards Asian, European and North American markets.

3. Current Operating Environment

The operating environment for the Tasmanian Eel Industry, comprising professional eel fishers and the Inland Fisheries Service, will be shaped by a number of external trends and forces and a number of internal eel industry issues.

The success in implementing the Tasmanian Eel Industry Development and Management Plan will be determined by the ability of the Tasmanian Eel Industry and other key stakeholders to adapt and respond to these trends and forces. Therefore the Industry must continue to monitor, grow and actively respond with best practice processes to the following:

3.1. External Trends

These establish the Global context in which it must compete, in which it must be relevant, and to which it must adapt. These include the following:

3.1.1. Environmental/Climate Change

Potential Impacts

- SE Australian current
- Changing local currents
- Changing temperatures
- Pests and diseases
- Collapse of the local fishery
- Drought
- Declining recruitment
- Floods
- Facilitated migration
- Changing rainfall patterns (greater propensity to deluge events)
- Stormwater management

3.1.2. Economics (Global and Local)

Potential Impacts

- Increased costs (e.g. live and frozen transport, fuel, supply chain, processing, IFS license fees, labour etc.)
- Unfavourable exchange rates
- Reduced export markets
- Decreasing demand with increasing costs
- Reduced margins
- Pressure for more efficiency

3.1.3. Global collapse of Eel stocks

Potential Impacts

- Shortage of Product
- Increased demand

- Increased price
- Market opportunity for Tasmania

3.1.4. Market and Market access

Potential Impacts

- Access or not (export approval, AQIS, Certification)
- Reduced opportunities
- Increased or reduced costs (Exchange rates, Import duties)
- Need for greater industry collaboration
- International v domestic – develop domestic to avoid some restrictions (e.g. currency)
- Country import regulations (threat of CITES, Government policy)

3.1.5. Australian/NZ stock management

Potential Impacts

- Australia could impact New Zealand and vice versa
- New Zealand stocks show substantial fluctuating catches with downward trend.
- Variation to New Zealand total allowable catch rate and quota management system

3.1.6. Government Policy

Potential Impacts

- Both State and Federal – change of support with change of government or change of policy
- Must ensure sustainable policies
- Have to balance competing interests
- Can assist or hinder development
- Costs associated with licence/levies/royalty charges by IFS
- Current IFS licensing arrangements

3.1.7. Other Industries

Potential impacts

- Seismic surveys (e.g. oil industry)
- Bass Link
- Tamar estuary dredging
- River bank impacts
- Pollution (both general community and industrial)

3.2. Industry Trends

These trends establish the internal environment in which the industry must operate sustainably and economically on a daily basis. The success of the industry will also depend on its ability to collaborate with other stakeholders in the management of these trends.

3.2.1. Health of the Fishery

Potential Impacts

- Reduced quality of product
- Reduced quantity of product
- Reduced ecosystem health
- Reduced sustainability

3.2.2. Elver recruitment

Potential Impacts

- Reduced collection or
- Increased collection
- Effort vs yield
- Redistribution based on scientific and commercial criteria and priorities
- IFS attitude of improved revenue stream through export (Elver allocation 2012/13) versus
- (preferred) support to Tasmanian industry

3.2.3. Migratory Eel Release

Potential Impacts

- Barriers created by Hydro infrastructure
- Assisted escapement to facilitate breeding and stock recruitment e.g. physical relocation, fish ladders
- New dam projects

3.2.4. Aquaculture

Potential Impacts

- Closing the lifecycle of competitive overseas species
- Employing aquaculture systems economically
- Extensive vs Intensive recirculation systems
- Increase capital demand
- Need for a business case regarding financial viability
- Being able to manipulate the characteristics of the product (flesh fat content)
- Better align availability with market demand
- Directly utilise elver stocks
- Need for a balance between distribution of stocks for aquaculture and for enhancement

3.2.5. Access to Water

Potential Impacts

- Need for a review of available and suitable water
- Improved efficiency of use of stock into more suitable waterways
- IFS to maintain certain waterways as non-fished reserves for eel stocks
- Reduced areas to fish
- Agricultural Tasmania Irrigation and hydro use

- Potential use of the Pedder/Gordon or similar closed catchments to enhance the escapement of spawners or to use as sustainability off-sets in developing currently unlicensed catchments

3.2.6. Food Security/Resource Security

Potential Impacts

- Pressure on regulators for licences
- Pressure for seed stock
- Pressure for open/closed waters
- Consider limits to number of licenses
- Pressure for increased participation of license holders
- Assessing the suitability of license applicants
- License monopoly reducing fishery diversity

4. Industry Vision

The Vision of the Tasmanian Eel industry is to be:

4.1. Highly recognised and respected segment of the Tasmanian fine food industry

4.2. Profitable, sustainable and market driven

4.3. Professional, responsible, self-regulated, involved

5. Industry Purpose

5.1. To gain high value from a Tasmanian resource for profit and employment in a sustainable way

6. Goals

6.1 To maintain an ecologically and commercially sustainable resource

6.2. To maintain a reliable supply of quality product from industry

6.3. To develop a financially viable freshwater eel industry sector

The development of measures and targets has been undertaken in an attempt to define clear metrics in relation to the goals. However, in many cases, as the background knowledge and ground work is in its infancy, the ability to clearly define metrics has been limited. Consequently these targets will be adjusted over time as the information is collected.

Table 1: The following tables also include agreed conditions, and key actions. Key actions will be undertaken using specific strategies listed in the table. These strategies will be supplemented with more detail and context in the Appendices.

Goal	Measures	Target
G1: To maintain an ecologically and commercially sustainable resource	• Elver recruitment at indicator sites Meadowbank and Trevallyn dams as established by IFS. • Catch per unit effort • Input-output figures • Unfished catchments as a proportion of total catchments • The level of by-catch per unit effort (incorporating protected fauna and threatened species - released/mortality) • Monitoring the presence or absence of pest species, threatened species, and/or human development and pollution • Increase in the footprint of pest and/or native species	• Sustainable catch levels to be determined during annual monitoring of catch and on a 3-5 year rolling average • Decreasing by-catch • Zero translocation of pest species • Zero mortalities of threatened species
Agreed Conditions: • Maintain current catchment licensing framework • Each catchment licensed for fishers to be sustainable within licenses • Maintain unfished (unlicensed) catchments as locations for natural recruitment and migration • Hydro to maintain transfers of elver above dams • Facilitate downstream migration and escapement of adult eels from impounded waterways • Develop and comply with an industry Code of Practice		

Key Actions:

Planning and Development Strategy

- Fishers to routinely record and forward relevant data to IFS on monthly basis to support the reporting requirements for the export license
- Industry to adopt IFS translocation policy and adopt the "Keeping it Clean" protocols.
- Protocols to be refined to deal with biosecurity issues such as translocation of pest species, transfer of diseases and parasites (e.g. use of gear, clothing and vehicles across geographical regions).
- Industry to continue to follow advice on animal welfare guidelines around field capture techniques (e.g. in relation to platypus, bird capture)
- Monitor status of eels in relation to CITES and engage federal government representation

Stakeholder Engagement Strategy

- Engage key stakeholders to support the Industry Plan; undertake a periodic review and update of the plan
- Continue to engage with eel fishers who are currently not actively using their licenses
- Discuss with IFS the setting of limits on elver sales outside Tasmania – to keep the majority of the resource for use by the Tasmanian fishers
- Pursue collaborations with other state, Commonwealth and New Zealand authorities to manage the Australian and NZ eel resource
- Strengthen and maintain a continuing dialogue with Tasmanian stakeholders including Hydro, Irrigation Tasmania, NGOs (e.g. NRM, Conservation Trust), and Tasmanian community in relation to ecological issues, eel management, biosecurity

Production Strategy

- Explore the use of closed waterways (ie lacking entry and exit points) for additional production opportunities
- Review and negotiate with IFS any perceived need to change regulations
- Review fishery should significant changes to catch rates be detected at key Indicator Sites within each licensed catchment area over extended periods of time

R&D strategy

- Research the level of recruitment, age of elvers in different populations, growth rates of eels in a spectrum of locations from unproductive to productive waterways, time of return of elver

- Quantify cormorant predation on elver at Meadowbank and other key Indicator Sites
- Stocking rates – optimal densities to stock waterways to maximise growth; carrying capacity, stocked waters with natural recruitment
- Negotiate with relevant stakeholders to better facilitate downstream migration of eels
- Offshore migration and breeding; effect of climate change and east Australian current changes; are there different genetic stocks in Tasmania?
- What is the standing stock of eels in Tasmania? How to align this with harvests to maintain sustainability.
- Survival rate in the wild – mark/recapture? What level of elver in to get tonnage out?
- Biosecurity – how to separate eels from by-catch (e.g. vertical climbing grader, anaesthetics) Gambusia, redfin, galaxiid contamination – threat to contained fisheries (some lakes with specific species). Consider Health, Parasites, Genetic (sub-species). Policy around moving stock interstate.
- Impact of environment (e.g. heavy metals and blue-green algal blooms) on quality of fish and impact in marketplace – need to test residues and close markets.
- Swimming speed against currents for fish passage around dams (irrigation, farm dams, Hydro). Ladders, ramping, pipes with water flow. Trevallyn dam has been modified by Hydro (IFS has MOU with Hydro) to allow fish passage.
- Impact of drought on recruitment (e.g. reduced opportunity for fish passage out of the system leading to reduced recruitment + low water to facilitate elver migration up rivers)
- Prediction for the industry to be modelled against models of impacts from climate change

Goal	Measures	Target
G2: Maintain a reliable supply of quality product from industry	• Annual production from wild fishery • Number of restocking events/volumes • Volume of fish from aquaculture • Volume of fish from closed waters • Use of "dead-end" waterways • Use of irrigation water • Cost of production	• Minimum 80 tonne industry production • Determined number of transfers/year • Increased production from aquaculture • Increased harvest from closed systems, dead-ends and irrigation water
Agreed Conditions: • To utilise existing license catchments to maximise harvest • IFS to provide a minimum 50kg elver stock per license for restocking/translocation • Work with Hydro/IFS to ensure optimal placement of additional elver collection. • Maintain unfished waterways for natural recruitment to both unfished and licensed areas • Aquaculture to be developed as a means of expanding production through fattening and should be an initiative undertaken or endorsed by current industry participants • Industry to provide a high quality branded product		
Key Actions: *Planning and Development Strategy* • IFS to work with industry to ensure current licensed catchments are optimally fished and managed • Re-invigorate the industry body (Tasmanian Professional Eel Fishers Association – TPEFA recognised as the peak industry body with government) to work co-operatively on industry issues to support Goal 1 and with the support of IFS work to achieve Goals 2&3 • Establish regular meeting dates IFS/TPEFA • Consider TPEFA Chair or nominee to represent sector on committees (e.g. TasFRAB RAG committee) or as required in relation to industry issues • Assess the transfer of uncollected elver allocations to other fishers/licenses		

- Explore appropriate management and licensing of closed systems

Stakeholder Engagement Strategy

- Liaise with Hydro to maximise environmental and commercial opportunities

Production Strategy

- Continue to translocate small eels to productive waters by IFS and within or between catchments by fishers
- Investigate the opportunities to stock closed systems to enhance production
- Refine handling procedures (catch, transport, purging, packing) building on current standard operational procedures
- Investigate the development of aquaculture techniques, building on prior knowledge and experiences
- Fish welfare guidelines to be developed around capture, handling, holding, killing and live transport techniques

Marketing Strategy

- Production is market-driven; wild caught eels may need to be modified to meet market requirements e.g. fat content, size,

R&D strategy

- Monitor productivity of waters stocked with elver (e.g. closed, dead-end, irrigation waters)
- Further develop feeding techniques for elver in aquaculture systems
- Implement fish husbandry guidelines as part of the Code of Practice
- Optimise packing techniques for live transport
- Investigate and develop the characteristics of eels to suit the market place demands e.g. fat content, size

Goal	Measures	Target
G3: To develop a financially viable freshwater eel industry sector	• Market demand for product • Market price achieved • Cost of production • Perceived value of license • Market diversity	• Maximised live sales (best return) • Optimise price (short v long term relationships) • Minimise cost of production • Increased market penetration and flexibility
Agreed Conditions: • Significant product development and sales undertaken in-house (companies) • Individual companies have developed market networks and contacts domestically and overseas		
Key Actions: *Planning and Development Strategy* • Maintain export license – Industry and IFS to develop performance measures to ensure compliance to Department of the Environment requirements. Ensure liaison with Government trade bodies – e.g. DEDTA , Austrade *Stakeholder Engagement Strategy* • Explore opportunities to jointly produce and market eels within the state and with other state producers (e.g. Victoria), to generate critical mass for transport, marketing and product placement *Production Strategy* • Determine the market preference for products and match the appropriate production strategy *Marketing Strategy* • Produce to market demand (i.e. match product with market requirements), monitor market preferences		

- Maximise domestic market sales
- Employ diversification strategies to reduce risk to product sales
- Identify market advantage measures (e.g. low contaminants, wild, natural, clean-green environment)
- Identify across sector marketing strategies that benefit the state producers, supplementing in-house strategies

R&D strategy

- Research growth and associated fish quality in holding facilities
- Research methods to modify characteristics of products to increase acceptability in the market place

  Optimise holding, processing and packing techniques to transport product to market

Table 2: Summary of Strategies to address goals

Goals / Strategies	G1: To maintain an ecologically and commercially sustainable resource	G2: Maintain a reliable supply of quality product from industry	G3: To develop a financially viable freshwater eel industry sector
Planning and Development Strategy	• Fishers to forward monthly data to IFS • Biosecurity protocols • Animal welfare protocols • Assist IFS in the development of an Ecological Risk assessment as required by Department of the Environment	• Re-invigorate Professional Eel Fisher industry body • Transfer elver allocations between fishers • Licensing and management of alternate waters	• Maintain export license
Stakeholder Engagement Strategy	• Industry support for Plan • Stakeholders acceptance of Plan • Fishers actively engaged in industry • Policy on elver sales outside Tasmania • Interstate and international collaborations; Re-engage ANZERG • Continued dialogue with non-sector stakeholders • Identify key elver indicator sites	• Liaise with Hydro and IFS	• Joint production and marketing opportunities
Production Strategy	• Explore use of alternate waterways • Review fishing gear • Review fishery should significant changes occur	• Translocate eels within and between catchments • Refine handling procedures in accordance "Keeping it Clean" manual • Investigate aquaculture techniques • Husbandry protocols and indices	• Match market preference and production
Marketing Strategy		• Modify product to suit marketplace preferences • Establish clear Standard Operating Procedures	• Cross sector market strategies • Produce to market demand • Maximise domestic market sales • Risk reduction • Market advantage measures

Research and Development Strategy	• Population biology • Predation • Stocking rates • Migratory eels, barriers • Offshore migration, spawning & recruitment • Sustainable harvest levels • Survival rates • Biosecurity • Impact of environment on recruitment	• Monitor productivity of waterways • Feeding techniques • Recirculating aquaculture systems (RAS) • KPI for fish welfare indices • Husbandry techniques • Live transport techniques • Flesh and physical characteristics	• Growth and quality in holding facilities • Product modifications • Processing and packing techniques

7. S.W.O.T. Analysis

Table 3: SWOT analysis of the Tasmanian eel industry. Bold text indicates the higher priorities for industry.

Strengths	Weaknesses
• **Tasmanian reputation for fine food** • **A genuine desire to be sustainable** • **Natural wild resource** • **Managed licenced catchment areas** • **Fledgling industry with potential** • **The resource** • Committed and co-operative stakeholders • Negligible environmental footprint of the fishery • Recognised by Department of the Environment as not harvesting export species listed under CITES • *A. australis* and *A. rheinhardtii* are not CITES listed	• **Limited knowledge of the life cycle** • **Reliance on wild stock resource** • **Lack of Australia/NZ collaboration** • **Unknown sustainable harvest volumes** • **Distance from prime markets** • **Lack of industry research, development and extension** • **Firm meat texture, low fat content and thick skin of wild eel making it currently unacceptable quality for grilled eel consumption.** • Immaturity of the industry sector • Air freight cost and lack of direct export sea freight • Logistics – lack of integration between capture location, processing facilities and freight points • Limited access in Tasmania to AQIS approved export facilities (EU, no Russian export approval) • Local perception of the product (would be considered low compared to other meats)
Opportunities	**Threats**
• **Improve restocking and relocation** • **Domestic market consumption/promotion** • **Aquaculture ventures** • **Improve capture and release of migrating eels** • **Develop *Anguilla australis* to Kabayaki (grilled eel) standard – to reduce need to import kabayaki** • Access to C'wealth/State Research funds • Grow the sustainable output • Product development/diversification • Activate unfished licences/other suitable waters • Increased availability of waters for fishing	• **Failure to maintain export permits** • **International competitiveness** • **Disease** • **Climate change** • **Invasive species** • Unconstrained eel aquaculture development • Failure of the glass/ elver run in Tasmania • Increased harvest volumes in Nth Hemisphere – increased competition • Community attitudes/reactions • Government policy/regulations

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Implications

To date the Tasmanian Eel Industry has not had a development plan. This Plan aims to highlight current production, market and R&D issues faced by the fishers and management issues faced by Inland Fisheries Service. It is intended to guide the development of the Industry, support export permit renewals, inform decisions about research needs, put into context an Industry Code of Practice and provide a framework with which to work with other industry stakeholders. The industry also has identified the need for member representation in discussions with and to lobby state and federal government departments.

This is the first time a documented and more cohesive approach to the management of the industry has occurred. Also it is the first time the eel industry has engaged formally with a number of stakeholders to bring a common understanding of the industry and its needs. To overcome the recent fragmentation of the eel industry, it is a renewed attempt to bring industry partners together to discuss issues.

While the consolidation of the eel management Plan (sustainability) and development plan (economics) into one Plan reduces cost and provides benefits it is to be monitored over time to evaluate how effective and efficient this approach will actually be.

Recommendations

The major recommendations arising from the stakeholder discussions are to:

- Develop a Tasmanian Eel Industry Code of Practice
- Develop an industry R&D plan
- Continue and strengthen the relationship between Tasmanian eel fishers and stakeholders , in particular Inland Fisheries Service
- Pursue collaborations with other state, Commonwealth and New Zealand authorities to manage the Australian and NZ eel resource
- Strengthen market opportunities, both through products and location

Further development

Short- and long-term recommendations include the need to:

- Implement the plan as a guiding document
- Support and show a commitment to the Plan
- Develop an R&D strategy for the industry
- Establish collaborative management of anguillid stocks (national and international)
- Support key R&D needs for the industry and links with other states and NZ
- Research population dynamics (age structure etc) to support sustainability
- Gather knowledge of elver recruitment (returns)
- Support to develop aquaculture and fattening techniques to value add product

- Develop domestic market to reduce reliance on export
- Consider domestic development of kabayaki to replace imported product

Extension and Adoption

The process of formulating the Industry Development and Management Plan involved the major stakeholders: (i) fishers who wanted a development plan and (ii) the Inland Fisheries Service which manages the fishery. There was a deliberate and conscious effort to combine both approaches in one document to promote a more cohesive industry sector. Core and additional stakeholders were invited to contribute to the compilation of the document through stakeholder meetings, individual face to face meetings, request for feedback on document drafts and via emails and phone calls. Once the final plan is approved it will be released publically.

The Tasmanian Inland Fisheries Service as the fisheries regulator and manager is involved in the development of the plan and will use the plan to drive sustainability within the industry. The eel fishers are encouraged to use the Plan to guide their activities and future strategies, to maintain an economically sustainable industry.

The eel fishers and the regulator have and will continue to collaborate with wider stakeholder groups to bring a greater understanding of the issues that the industry faces and generally of industry practice.

The authors will provide copies of the Plan to stakeholders, other government departments both in Tasmania and interstate, and to interested public groups.

Project materials developed

This project specifically compiled an Industry Development and Management Plan for the Tasmanian Eel Industry, that will be used by Tasmanian eel fishers, Inland Fisheries Service (Tasmania) and other stakeholders to guide the future development of the industry within policy and sustainability guidelines.

Appendices

APPENDIX 1: Summary of the Regulatory and Policy History of the Tasmanian Eel Fishery

1965-66	Commercial fishing for eels permitted using fyke nets and traps.
1967-68	Licence fee introduced ($4), plus $1 for each fyke net or trap after the first. Licence subject to IFC discretion in regard to; duration, times and places fished, type and site of fyke nets/traps, marking fyke nets/traps, disposal of other fish and reports of catch (IFC Annual Report year ending 30 June 1968).
1968-69	Marking of fyke nets and traps regulated. Licence fee increased to $50, plus $1 per fyke net or trap thereafter. Restrictions imposed; fyke nets restricted to 30 per commercial fisher, Lake Sorell, Dee Lagoon and Pawleena Dam closed to commercial eel fishing from 1 July to 31 December, dimensions of fyke nets set (diameter 450mm, length ≤4m, mesh 15-40mm, wings ≤ 3m and drop ≤600mm). IFC discourages further commercial eel licence applications.
1969-70	Legal minimum size of 12 inches (300 mm) introduced. Ban on the export of live elvers.
1970-71	Commercial eel fishing returns introduced with number of nets/traps and water(s) specified.
1972-73	Licence fee increased to $100, plus $1 per fyke net/trap thereafter; licence numbers restricted to 13.
1973-74	Further restrictions introduced; fyke nets/traps to be spaced by ≥20m, use of fyke nets and traps in combination banned, fyke nets to be inspected and cleared at least every 24 hours, use of non-licensed assistant fishers banned, commercial fishing nor permitted within 100M of a river mouth or within 25m from an entrance or outlet of a river, creek or drain flowing into or out of a lake or marsh, use of nets in rivers no longer allowed. Dimensions of nets regulated (diameter 450 mm, length ≤4m, mesh 15-40mm, wings ≤3m and drop ≤600mm).
1974-75	Fyke nets to be cleared every 12 hours.
1975-76	Fyke nets to be cleared every 24 hours. All prime trout waters closed to commercial eel fishing (i.e. highland lakes stocked with trout).
1976-77	Inland Fisheries reviews the commercial eel fishery and suggests that it is desirable to establish a new fishery based on migrating eels in river systems (Inland Fisheries Commission Report for the year ending 30 June 1977, Appendix II).
1977-78	Licence fee increased to $100 plus $2 per fyke net/trap thereafter; number of fyke nets increased to 50, assistant eel fishers licence introduced (fee $5), net size increased (opening height ≤670 mm, width ≤670mm, mesh 15-39mm, wings ≤3m and drop ≤670mm), trap size specified (height ≤500mm, length ≤2m, width ≤500mm, mesh ≥39mm and no wings or leaders).
1978-79	Eel traps limited to 50 and combination of traps and fyke nets limited to 50, commercial eel fishery limited to ten licensees plus assistants.

1979-80	Licensee to be present when a fyke net/trap is set or hauled, waters to be fished allocated by municipality.
1980-81	Fyke net wings increased to ≤10M and drop ≤1.2m, migrating eel licenses introduced (fee $100).
1989	Fyke netting permitted on a trial basis in Trevallyn Dam.
1989-90	Feeding eel licence deregulated; by removing previous restrictions (spacing) and (river mouths and drains) imposed in 1973-74 and by allowing the licensee not to be present when a fyke net/trap was set or hauled and by removing the restriction that no fyke net/trap should be set more than half way across the width or centre of a creek or watercourse.
1990-91	Fees Increased for migrating eel licences to $200 and or feeding eel licences to $200 plus $3 per fyke net/trap thereafter.
1995-96	Moratorium on issuing of licences imposed pending management review. With the introduction of a new Act and Regulations (*Inland Fisheries Act 1995 & Inland Fisheries Regulations 1996)* after consultation with all commercial eel fishers a new system of licensing and management was introduced. Licences became transferable and boundaries were based on water catchment areas instead of municipality borders. Migratory and feeding eel licenses were abolished and replaced with the one commercial fishing licence. Relaxation of gear restrictions (the net dimensions remained the same, but no limit on the amount of nets used). Strictly enforced logbook returns. Royalty fee introduce (based on every kilogram of eel taken). The rationale of this new system of management and licensing was to encourage self-management of the eel resource by each individual licence holder.
1999-00	Introduction of *Inland Fisheries (Commercial Nets and Fees) Regulations 1999* and *Inland Fisheries (Recreational Fishing) Regulations 1999.*
2009-10	Regulations revised into present form *Inland Fisheries (Commercial Nets and Fees) Regulations 2009* and *Inland Fisheries (Recreational Fishing)) Regulations 2009.*
2010-11	Commercial fishing trial conducted under permit by licensed eel fisher in Macquarie River using fyke nets.
2010-12	Commercial fishing trial conducted under permit by licensed eel fisher in Lake Meadowbank using fyke nets.
2011-13	Commercial fishing trial conducted under permit by licensed eel fisher in Derwent, Shannon and Ouse River catchments for eels, perch and tench.

2012-13	Commercial fishing trials conducted under permit in Brumbys Creek and Break O Day River. Commercial fishing trial conducted under permit l of Chinese Box traps for eels perch and tench in Lake Echo, Tooms Lake, Lake Leake, Dee Lagoon and Wayatinah Lagoon.

APPENDIX 2: Species in the family Anguillidae

Table 4: A list of species in the family Anguillidae from various locations around the world (from www.fishbase.org). The year indicates the date when named.

Year	Scientific Name	English Name	Distribution	Max. Length (cm)
1758	Anguilla anguilla	European eel	Atlantic Ocean	133 TL
1841	Anguilla australis australis	Short-finned eel	Southwest Pacific	130 TL
1925	Anguilla australis schmidtii		Oceania	
1831	Anguilla bengalensis	Indian mottled eel	Asia	200 TL
1844	Anguilla bicolor bicolor	Indonesian shortfin eel	Indo-Pacific	120 TL
1928	Anguilla bicolor pacifica	Indian short-finned eel	Indo-Pacific.	123 TL
1984	Anguilla breviceps		Asia	
1856	Anguilla celebesensis	Celebes longfin eel	Western Pacific	150 TL
1842	Anguilla dieffenbachii	New Zealand longfin eel	Southwest Pacific	185 TL
1938	Anguilla interioris	Highlands long-finned eel	Oceania	80 TL
1846	Anguilla japonica	Japanese eel	Asia	150 TL
1852	Anguilla labiata	African mottled eel	Africa	175 TL
2009	Anguilla luzonensis		Philippines	100 TL
1856	Anguilla malgumora	Indonesian longfinned eel	Asia	80 TL
1824	Anguilla marmorata	Giant mottled eel	Indo-Pacific	200 TL
1856	Anguilla megastoma	Polynesian longfinned eel	Pacific Ocean	165 SL
1852	Anguilla mossambica	African longfin eel	Western Indian Ocean	150 TL
1844	Anguilla nebulosa	Mottled eel	Indian Ocean	121 TL
1872	Anguilla obscura	Pacific shortfinned eel	Pacific Ocean	110 TL
1867	Anguilla reinhardtii	Speckled longfin eel	Asia and Oceania	165 TL
1817	Anguilla rostrata	American eel	Northwest to western Cent	152 TL
2008	Neoanguilla nepalensis		Asia	3.3 TL

Principal species in the market worldwide

Anguilla anguilla
Anguilla japonica
Anguilla rostrata

APPENDIX 3: Questionnaire provided to eel fishers and stakeholders

QUESTIONNAIRE PROVIDED TO EEL FISHERS AND STAKEHOLDERS

TASMANIAN EEL INDUSTRY

PLANNING QUESTIONNAIRE

Please complete and return to: Tony Ibbott, Marine Solutions, 13 Broadwaters Parade, Sandy Bay. TAS.7005; or email: tonyibbott@gmail.com

By:

1. List 10 major forces you believe will impact on the future of the Tasmanian Eel Industry in the next 5 – 10 years?

2. How would you like the Tasmanian Eel Industry to be in 10 years' time?

3. Why does the Tasmanian Eel Industry exist?

4. What must the Tasmanian eel Industry achieve in order to be successful long term?

5. List up to 5 key words/phrases in the following SWOT grid for the Industry

Strengths	**Weaknesses**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Opportunities	**Threats**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

6. In light of your answers to questions 4 & 5, what strategies must the Tasmanian eel Industry pursue in the next 3-5 years to ensure it achieves its purpose?

7. What do you see as immediate priorities for the 2012/2013 year?

8. Please add any comments or questions that you believe are important.

Thank you for your cooperation. It will ensure a more effective Industry Development Plan is developed.

Please return to: Tony Ibbott, Marine Solutions, 13Broadwaters Parade,
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APPENDIX 4: Stakeholder Meeting

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PHOTOS

APPENDIX 5: Background Information of specific points under the plan

BACKGROUND INFORMATION OF SPECIFIC POINTS UNDER THE PLAN

The purpose of the following information is to record the key literature items and the "thinking" behind the discussions undertaken during the formulation of the Plan. It was considered important by stakeholders that this was not lost so that future constructions of the Plan had a starting point for further discussions. Pertinent points have been selected from Goals 1-3 in Table 1 above.

Goal 1 - To maintain an ecologically and commercially sustainable resource

- ***Maintain current catchment licensing framework***

Would the licensing system change? What may the licensing system look like? The current conditions of license place the responsibility back on the licensee to be sustainable within their catchment. Licenses have been in families for generations and this suggests that their practices are sustainable. Industry supports the catchment system. Transferable licenses are potentially valuable and therefore the plan endorses the current catchment licensing system. The main question is whether further catchments if initiated by Industry or IFS are licensed or run as an insurance resource and therefore as unlicensed catchments. The latter is a positive for the export licensing process and sustainability, and under current circumstances it is the opinion that the current status quo should prevail. Hydro supports the transfer of eels and other species above the Meadowbank and Trevallyn dam to ensure biodiversity is retained. Hydro selects which catchments to stock based on turbine types and expected escapement by species.

- ***Facilitate downstream migration and escapement of adult eels from impounded waterways***

As migration of adult silver eels to the sea is essential to contribute to spawning and recruitment, methods to assist migration around barriers is needed. Migratory eels need to negotiate Hydro dams and with no clear mechanism for escapement in most, these areas could be used as broodstock resources but would require physical relocation around dams before fish could re-enter the migratory cycle. Many migratory eels are currently killed after entering the power generating turbines. Hydro is investigating new techniques including sonar and video tracking devices and is working with licensees to prevent eel entrainment in turbines to reduce mortality. The practice of both transfer and a greater focus on catch and release of migratory eels could be improved with enhanced formal communication links between Hydro, IFS and licensees. Studies on the impact of hydroelectricity dams and power stations on the movement and health of eels include Boubee (2001) and Boxall et al. (2003).

- ***Develop and comply with an industry Code of Practice***

It was acknowledged in meetings that the industry should develop a Code of Practice to guide and standardise processes within the industry and to inform stakeholders of operational practices and standards.
Possible content of the Code of Practice includes:

- Adherence to reporting requirements
- Adherence to IFS regulations
- Adherence to gear requirements
- Biosecurity
- Translocation of pest species
- Impact on endangered species
- Continued improvement
- Guidelines for handling live eels
- Guidelines for harvesting and processing
- Welfare guidelines
- Regular dialogue with all stakeholders

- ***Translocation, biosecurity, "Keeping it Clean" policy***

An active intervention strategy for eel and lamprey translocation above barriers has been undertaken by IFS and Hydro since 2005/6. Glass eels and elver are harvested (c. 500kg) at Meadowbank and Trevallyn dams and relocated to a variety of waters around the state.

Table 5: A matrix of the by-catch translocation measures applied to various harvesting and release situations.

	Location of fishing activity and treatment protocols	
Final release destination	Meadowbank Dam	Travallyn trailrace
Above barrier in same river	No treatment	Pest fish treatment
Other water in Tasmania	Screening	Pest fish treatment
Export from Tasmania	As determined*	As determined*

Note: * = the treatment of fish is determined by the receiver or appropriate regulatory authority.

Outlines of the issues associated with pest and threatened species including by-catch are listed below for elver. In general there is an acknowledged need to follow biosecurity protocols associated with working between waterways. Eel fishers will follow the protocols determined by IFS and guides such as the *Keeping it Clean manual, a Tasmanian field hygiene manual to prevent the spread of freshwater pests and pathogens* (Allan and Gartenstein, 2010). Translocation policies have been developed in other states e.g. McKinnon (2006).

- ***Monitoring the presence or absence of pest species, threatened species, and/or human development and pollution***

Pest and threatened species may be caught during both the commercial fishing (outlined below) and the collection of elver for translocation intra- and inter-state. The latter incurs a greater risk due to the potentially larger numbers and smaller size of animals with an associated greater degree of difficulty in separating them from the eels. A number of techniques e.g. vertical climbing ladder, have been trialed with limited success and currently euthanasia of the by-catch and accompanying anesthesia of the eels (with subsequent recovery) is the preferred method. Translocating non-target species with the eels is a biosecurity risk potentially comprising the biodiversity and genetic integrity of specific water ways (e.g. moving galaxiids), introducing predatory/pest species (e.g. carp, redfin, *Gambusia*), or introducing parasites and diseases. There are a number of parasites and diseases of concern in eels (e.g. Department of Agriculture, Fisheries and Forestry, 2011) and any translocation of live eels from Tasmania interstate (for release) may require testing by the Fish Health Unit (DPIPWE) or similar organisation prior to transfer.

Human development can alter waterways and impact water quality, affecting the survival, growth, flesh quality and migration of eels. In Tasmania two main impacts apart from Hydro dams and irrigation, are heavy metals and blue-green algae. Migrating glass eels and elver also may swim through polluted waterways on their way upstream. Some consideration to residue testing may be needed when fish are extracted from these conditions as 'contaminated' product will impact product quality, marketability and image.

- ***Animal welfare during netting***

The commercial eel fishery is mainly exploited using fyke nets which can result in the capture of fish, water birds, platypus, water rats, frogs or crayfish. The issue of larger birds and mammal is managed by gear restrictions primarily platypus exclusion screens which physically prevent entry provided they in good order and fitted correctly. ""The dominant by-catch in terms of number and weight for the period was redfin perch followed by tench and trout, these introduced fish are abundant in the State with only trout of interest from a sustainability perspective due to a large recreational fishery around these fish. Trout survive well in fyke nets and are released unharmed, the other introduced species are retained and disposed of. Both carp and yabbies are noxious species with access to carp in particular closely managed in Lake Sorell.

For the native species pygmy perch, blackfish, sandies and galaxias were quite abundant in certain dams fished with most released unharmed, Galaxias auratus and Galaxias tanycephalus were part of this by-catch in lakes Sorell and Crescent and Woods Lake respectively, all three lakes have abundant populations and their exposure to the eel fishery is low. A single lake returned 5 Astacopsis gouldi, again these survive well in nets and were released unharmed and overall there was very little interaction with this species. The main by-catch concern remains around the capture of platypus by the eel fishery. The capture rate reported was very low but the take of protected fauna is of concern. The take and reporting

of platypus in the eel fishery has been the subject of a major investigation by the Inland Fisheries Service and Wildlife enforcement officers in 2013, the outcome from this process will be used to formulate a more targeted compliance routine for the fishery in future years.

- ***Monitor status of eels in relation to CITES***

The Convention on International Trade in Endangered species (CITES), also known as the Washington Convention, aims to protect wild fauna and flora from over-exploitation through international trade. While the Australian stocks of short- and long-finned eels are not currently listed under the CITES convention, there is some concern that they may be listed for two reasons. Firstly, they are declining in number in some parts of the distribution in Australia and are of "conservation concern" (Baker, 2010). Secondly, all anguillid eels could be grouped together under this banner in the future, principally because some commercially exploited species in other parts of the world are declining. For example, the European eel, *Anguilla anguilla* has been categorised in the IUCN Red List of Threatened Species as "Critically Endangered" and listed in Appendix II of CITES in 2007 (Hirt-Chabbert 2011). *Anguilla bicolor*, *A. bengalensis*, *A. celebesensis*, *A. luzonensis* are all listed in the Red List as "Near Threatened" while *A. borneensis* is "Vulnerable" and *A. japonica* is "Endangered".

- ***Discuss with IFS the setting of limits on elver sales outside Tasmania – to keep the majority of the resource for use by the Tasmanian fishers***

The shortage of returning glass eels and elver internationally has driven enquiries of the Tasmanian government for sales of the local product. The Tasmanian eel fishers believe it essential that a limit is set on elver sales by IFS to overseas operators and their aquaculture operations. While this could be a lucrative market for IFS and the Tasmanian state government, the fishers believe the priority should be with the sustainability of the local industry. There is a belief that the returning elver support the wild harvest through recruitment to the system and would be used to value add through aquaculture in the future. Reliable statistics and collection data for elver has historically been subject to question and there is a need to quantify the level of returns. IFS have worked to rectify this critical management tool. The industry would like input into the future priorities of elver allocation.

- ***Pursue collaborations with other state, Commonwealth and New Zealand authorities to manage the Australian and NZ eel resource***

The Tasmanian industry should be viewed as a part of the whole national and international (with NZ) program. Research suggests the stock appears to be genetically panmictic i.e. each population belongs to a single genetic stock which contributes to the recruitment across a large geographic area. With this in mind, the Commonwealth government is well placed to manage the eel fishery across its range with input from state jurisdictions. Such an approach would allow holistic rather than regional management and a better understanding of the influences of for example climate change, changes to the east Australian current, drought and floods on the recruitment and distribution of migratory adult and juvenile eels.

- **Explore the use of closed waterways (ie lacking entry and exit points) for additional production opportunities**
- **Maintain unfished (unlicensed) catchments as locations for natural recruitment and migration**

The general notion of closed waterways offering additional production opportunities and sustainability requires further investigative and collaborative effort between IFS and licenced fishers to identify the real benefits. The principle of large unfished catchments being protected provides added confidence to the future sustainability of the industry along with the already well managed license areas.

Closed or unproductive and barren waterways should be categorised in relation to the value to natural movement of migratory and returning elver. Lakes Gordon/Pedder as "dead ends" for example have often been referred to but the tangible value or otherwise remains a mystery. There may be real potential for catch and release of large eels to add to the migratory run in conjunction with Hydro.

- ***R&D***

Stakeholders agreed that the industry production and growth strategy should be a balance of evidence based science, sustainable management and economic viability with an aim to grow the industry through existing and alternate means e.g new waters (irrigation waters, new dams), unproductive and closed waters as referred to above (shorter term), and aquaculture (longer term) opportunities.

Numerous topics were identified in consultation with stakeholders as potential research projects, driven by the needs of the eel fishers and the Inland Fisheries Service. The overarching theme of sustainability is the key focus, under which unfold the topics of wild population dynamics and biology, stock assessment, aquaculture, product development and marketing. Stakeholders felt there was a strong need to understand natural populations, migration, recruitment, feeding, waterway capacity and associated growth and survival.
Field research on the eel populations has been undertaken previously by for example Boxall (2003) and Sloane (1982, 1984 a,b,c,d,e,f) in Tasmania, by Silberschneider (2005), Skehan and De Silva (1998), McKinnon et al. (2000) in mainland Australia, and Jellyman (1977, 1979), Jellyman et al. (1999) and Todd (1980) in New Zealand while studies on the nutritional requirements have been conducted by Engin (2001), Engin and Carter (2001, 2002, 2006), De Silva et al. (2000, 2001). The industry should explore means of funding associated with research and development. In developing the plan our information was not confined to the references listed in the bibliography but rather generic issues across the broader literature were also considered.

Goal 2 - Maintain a reliable supply of quality product from industry

- Maintain unfished waterways for natural recruitment to both unfished and licensed areas

Approximately 20% (10 of 48) of catchments in Tasmania have been left unlicensed for a number of reasons and it is suggested that stocks from these areas will supplement recruitment in the licensed fishery. Closed catchments occur between the Huon River and Arthur River catchments in the west of the state and some areas of the central Tasmania. These closures were initiated in the 1980's around fears of heavy metal contamination but provide an eel resource across the state (migrating brood eels and returning glass eels).

To be successful in the long term the Tasmanian Industry needs to ensure the successful and sustainable elver collection and migratory management.

Aquaculture

- Aquaculture to be developed as a means of expanding production through fattening and should be an initiative undertaken or endorsed by current industry participants
- Investigate the development of aquaculture techniques, building on prior knowledge and experiences
- Production is market-driven; wild caught eels may need to be modified to meet market requirements e.g. fat content, size,

Fattening wild caught elver in recirculating aquaculture systems (RAS) was a strategy employed by one company in Tasmania over a decade ago. The company also extended similar RAS operations to long fin eels in Queensland. However these operations were discontinued around a decade ago and similar operations have not been employed in Tasmania since that time for either fattening or holding prior to processing. Flow through systems are currently being employed for holding commercial eels prior to processing, packing and transport to markets. Other studies to investigate the value of aquaculture systems for eel fattening and on-growing of juvenile eels include Gooley and Ingram (2002), Hirt-Chabbert (2011), Ingram and Gooley (1996), Ingram et al. (2001), Ingram et al. (2001), Kearney et al. (2011), McKinnon et al. (2001), Watene (2003).

While the "wild natural" element of eel fishing has great selling appeal it has limited short term potential to establish a critical mass necessary to justify an industry level of significance either in the eyes of the industry government or buyers. Although substantial work has been carried out, especially in Japan, it has not been possible to close the life cycle of eels. Therefore aquaculture success at this stage lies in the ability to on grow from glass (intermediary transparency stage between leptocephalus and elver – est. 5,000 units per kilo) or elvers (pigmented juvenile- estimated 1000 units per kilo).

At this point limited research has been conducted on glass eel collection in Tasmania and is prohibited under current regulations. Elver collection occurs but again requires greater research and effort to quantify population numbers. North Asia and European experiences demonstrate the ability to on grow from glass eel stage but limited success is apparent at the elver stage. No work has been conducted on glass eel growth in Tasmania and very little on successful elver growth. In other Australian states and New Zealand some research on glass eels has been undertaken in relation to aquaculture (e.g. De Silva et al. 2001, Kearney et al. 2011). Most recent activity has been initiated by Chinese interests whereby elver have been supplied for ongrowing trials in Southern China. IFS maintain a monitoring brief. This is an area where further R&D is required.

In addition to the above, aquaculture is seen as a future means of stabilising supply, improving quality and fat content and enhancing commercial viability. While not specifically studied in Tasmania, the lipid content of wild New Zealand eels has been shown to vary seasonally (Hopkirk et al. 1975) with rapid increases in lipid content after resumption of feeding by yellow eels following winter hibernation, while the lipid content of silver eels declined with time. It is noted that the New Zealand industry through the Auckland University of Technology is also working on an eel conditioning project. These studies have shown that juvenile yellow eels may be fattened by feeding extruded diets in RAS systems (Hirt-Chabbert and Young 2012).

Some Tasmanian trials have been conducted whereby "small restock" eels have been fed pelletised food with good growth and very positive improved fat results.

Experience with techniques used in Chinese and Japanese farmed or cultured eels sites suggest the preferred option for Tasmania is intensive recirculation systems. Chinese methods are predominately of an extensive earthen pond nature where access to labour is plentiful and by Australian standards cheap. Japanese culture was historically of a similar nature though now most have substantial concrete pond structures utilising underground water, polythene coverings and diesel-generated heating.

Clearly the high initial capital costs of recirculation systems, water, labour and power need to be assessed and calculated against a background of extensive modelling. Several ventures of a similar nature on mainland Australia have already failed but this is no reason not to progress with rigorous costing procedures in Tasmania.

- ***Fish welfare guidelines to be developed around capture, handling, holding, killing and live transport techniques***

In Tasmania the current method for packing export frozen is that eels are ice comatosed then packed and frozen. They may be processed whole or gutted. Fish are processed at George Town Seafoods in EU approved facilities or Mures, Hobart for North Asia. For European markets there is a customer preference for deslimed eels however this is in conflict with industry standards as the practice requires being deslimed whilst alive through the addition of salt prior to freezing. It is a practice banned in Europe.

Fish are also transported live by air freight in an oxygen/water mix in plastic bags each approximately 13 kilo net weight polystyrene containers. This practice has wide spread acceptance and high approval rating with export eels being despatched successfully with low mortality levels to Canada and East Coast USA.

Fish welfare indices are being incorporated into a number of fishing and aquaculture ventures worldwide, as part of Code of Practice, good husbandry and to provide a market advantage. The welfare of eels in a captive environment has already been highlighted in articles such as EFSA (2009). The principal concerns include stunning and killing eels and pre-slaughter conditions (e.g. water quality, handling, netting, transport, grading). A variety of stunning/killing techniques are used internationally: electrical stunning, salt bath (desliming), ammonia (desliming), exposure to ice (and salt), decapitation, neck cut, percussion stunning (needle and air pressure) and chilling. Eels may be packed whole or eviscerated after stunning/death. Many of these techniques have been assessed from a fish physiology perspective and evaluated in welfare terms; most techniques carry concerns.

In New Zealand, the National Animal Welfare Advisory Committee (NAWAC) has deemed desliming of live eels with salt to be inhumane, despite the industry outlining the effectiveness of desliming fish while alive (rather than dead), and has given the industry until 2015 to find an alternate method.
R&D - Further develop feeding techniques for elver in aquaculture systems

Greater achievements have been had in RAS systems with the feeding of glass eels rather than elver. As it is currently not legal in Tasmania to utilize glass eels for aquaculture ventures, methods to feed and grow elver require development. Some work has previously been undertaken to evaluate wet feeds with limited success. One of the challenges involves the weaning of elver from natural feeds to those used in or suitable for high density RAS facilities. A number of studies on the feeding nutrition of eels have been undertaken (Engin, 2001,Engin and Carter, 2001, Engin and Carter, 2002, Engin and carter, 2006, De Silva et al. 2000, 2001) but more work in needed.

Goal 3 - To develop a financially viable freshwater eel industry sector

- ***Company focus***

From a commercial perspective, major strategic issues need attention. These include a focus on sales and market diversity, aquaculture and cost reductions. The major historical volume market for live wild exports include China however the fickle nature of supply and demand, market entry restrictions and pricing pressures requires more emphasis on alternate market diversity. Whilst live export prices can be higher the variability in demand and holding of stock linked to catch effort often means pressure on holding facilities with possibility of mortalities and infection. Greater continuity and flexibility is sought with market development in the European Union where frozen orders mean a far more streamlined

movement of stock from catch to market. Aquaculture offers the added benefit of well-conditioned healthy fish in a reliable supply stage, extended season as well as the potential benefit of critical mass to generate cost reductions.

- ***Significant product development and sales undertaken in-house (companies)***

There is a need for greater investigation in the area of product development especially in the potential of expanded hot smoked and value added products. However the research resources available are limited based on the economies of small business and the need for licensees to focus on the mainstay of fishing. The ultimate sales growth of the industry will be greatly dependent on conflicting priorities.

- ***Determine the market preference for products and match the appropriate production strategy***

Again the formulation of an appropriate strategy will be based on licensee resources and potentially leads to a production driven rather than market driven environment.

- ***Maintain export license – Industry and IFS to develop performance measures to ensure compliance to Department of Environment (DE). Ensure liaison with Government trade bodies – eg DEDTA , Austrade***

The export license granted by the Department of the Environment is critical to the viability of the Tasmanian eel industry which is fundamentally export orientated towards Asian, European and North American markets. It is essential therefore that the export licenses are maintained. Inland Fisheries Service provides a report to DE (e.g. IFS, 2009) detailing the management arrangements and practices of the fishery contributing to its ecological sustainability. Important data is currently collected by IFS personnel, and industry through its reporting lines to IFS but more is needed in the R&D space to generate the data critical to the ongoing management of the fishery. A number of research areas have been identified under Goal 1 of the Plan above.

- ***Explore opportunities to jointly produce and market eels within the state and with other state producers (e.g. Victoria), to generate critical mass for transport, marketing and product placement.***

There is a current joint venture initiative combining Tasmanian / Victorian stocks to regenerate interest in the European frozen market which has been both neglected and under supplied over the past ten years. Difficulties in re-entering the market include EU economic conditions, low market prices, high export costs and reengagement of customers that have drifted into other lines and interest.

- ***Maximise domestic market sales***

In line with the successful market development for the Tasmanian salmon industry one of the main issues is to educate the public. This would include the ability to -

1. Teach people to desire eel products.
2. Identify with ethnic groups
3. Promote an understanding of eels to the local/domestic market.
4. Create industry awareness and ensure social inclusion on industry progress.
5. Promote recipes and nutritional information via electronic and other media
6. Package product, to include promotional recipe ideas.

- ***Research growth and associated fish quality in holding facilities***

Marketing background and strategy

Sales and market diversity requires assessment of live, frozen, smoked, grilled and value added eel opportunities along with markets that offer continuity, price maximisation and reduced risk. Aquaculture offers improved consistency of supply, quality and opportunities to supply huge North Asia grilled eel market but must be weighed against high capital outlay. In any event cost reductions must come in handling procedures, freight, packaging and processing by increased critical mass.

Tasmania is substantially impacted in its commercially competitive nature particularly compared with Victorian eel fishers in regard to freight, the cost base and the New Zealand fishery in respect to currency.

Establishing a cost competitive position with Victoria is exceptionally difficult with live air freight costs from Hobart to Melbourne of around $1.30 per net kilo before a comparative starting base can be established. Frozen freight costs by sea incur around 35 cents per kilo extra. New Zealand has enjoyed an exchange rate benefit of around 25%. The limitation of competitive processing facilities, the impact of small scale and packaging also adds further cost burden.

Further, the export climate has been severely impacted by external forces that are beyond the control of local operators. By far the major impediments to the growth and profitability of the industry have been the unprecedented high value of the Australian dollar in the last year, the global financial crisis and major live export markets in Japan, South Korea and China all suffering varying degrees of economic problems. Added difficulties were experienced with China where the issue of customs duties are the subject of question for most Australian seafood exports. The preferred entry point for importers is through Hong Kong however the so called “grey” entry channel means continual shipment disruption dependent on importer attitudes. Importers shy away from direct imports to China where added import and customs duties are incurred.

The current small scale of the Tasmanian Industry plus the isolation, strongly promotes the desire and incentive for a greater partnering link between the Tasmanian and Victorian industries. Already joint venture arrangements are in place for frozen production but this requires further levels of fine tuning to maximise joint opportunities. The non-existence of direct export sea freight from Tasmania further inhibits potential.

Aside from the operational factors Tasmania must also address the realities of the unique features of the natural wild product. This is especially so on a domestic market where eel consumption is not so readily accepted unless in ethnic outlets. Progressively more adventurous restaurants/chefs are embracing eel on their menus.

Domestic market

Tasmania currently enjoys a strong demand for live eels within Sydney where the Chinese and Vietnam communities have greater influence. Consistency and continuity are critical factors in maintaining market share where airfreight charges from Hobart are around $2.70 per kilo. Overnight road transport from Melbourne makes this market highly attractive with Victorian suppliers. Queensland offers opportunities and additional live demand exists in Perth but again air freight charges are in excess of $5.00 per net kilo.

The excessive impact of remoteness and Australian domestic airline freight rates are highlighted when compared with $4.80 per net kilo for airfreight to Seoul and $3.90 to Hong Kong. Smoked eel from Victoria achieves limited volume acceptance in Sydney but wider opportunities need to be developed. Tasmanian production at this stage cannot compete purely on a price basis and while quality production has been proven it has been temporarily shelved as a value added priority.

Hot smoked eel pate production also has strong domestic possibility for the future.

International markets

Tasmanian export priority is generally given to live shipments to China, South Korea, Japan and the United States. Each market has a specific size preference but it should be emphasised that Tasmania supplies larger size wild caught *Anguilla australis* for restaurant trade whereas the major consumption in the North Asia market is for farmed small size Anguilla Japonica for grilled eel or kabayaki production.

A challenging opportunity exists for frozen in North Asia if quality factors for wild eel can be resolved but generally this is covered by a huge farmed eel production from China.
Frozen eel production for size 600g and above (a preference is shown for 1 kilo plus) is predominately for Europe where it is used in traditional hot smoking. Small volumes for sizes between 300/600g eels have been placed into China. Only one EU approved frozen eel processing facility exists in Tasmania with one other factory engaged for China. Both facilities are sub contracted to take in whole live eels for frozen whole and gutted production.

It is expected that frozen demand and volumes will increase into EU. In Europe the *Anguilla anguilla* stocks are under severe ecological and sustainability pressures which has allowed frozen exports from Tasmania/Victoria to be well received for their traditional smoking recipes. The market is also being revived after the Victorian drought years and customers gradually re-established.

However the opportunities for Tasmanian wild smaller *Anguilla australis* eels to China have stalled.

Unlike the farmed *Anguilla japonica* and *Anguill*a *anguilla*, Tasmanian wild eel fat content is lower, there is a firmer texture and a tougher skin. Processors in Japan, China and South Korea have been unable to replicate the grilled eel equivalent with our species even though considerable cost, effort and research have been spent to date. It should be emphasised that more research into a method to resolve these factors would open up another huge potential market in grilled eel processing in North Asia generally. It should also lead to import replacement of grilled eel into Australia. Clearly exchange rates impacted in 2012 – 2013.

As pointed out earlier the resources available to achieve the above are questionable based on the economies of the small business entity and the need for operators to focus on the mainstay of fishing. The ultimate sales growth of the industry will be greatly dependent on ability to identify and resolve conflicting priorities.

APPENDIX 6: Catch data for the eel industry over the past 5 years (2009-2014) – species and weight retained

Table 6: The total industry combined annual harvest (kg) (retained) for the past five years - *for 2013-14 data is to the end of October 2013 only.

	2013-14	2012-13	2011-12	2010-11	2009-10
Short-finned eel	7 590*	51 710	75 422	30 755	32 185
Long-finned eel	1 800*	1375	74	3 609	5 402
Total	**9 390***	**53 085**	**75 496**	**34 364**	**37 587**

APPENDIX 7: Eels released or transferred to another location (non-retained) over the past 5 years (2009-2014)

Table 7: The total industry combined annual catch (kg), released at point of capture or transferred to other waters within each respective licence catchment area over the past five years. *for 2013-14 data is to the end of October 2013 only.

	2013-14	2012-13	2011-12	2010-11	2009-10
Short-finned eel	1 425*	14 401	5 616	8 906	7 004
Long-finned eel	0*	0	0	637	2 583
Total	**1 425***	**14 401**	**5 616**	**9 543**	**9 587**

APPENDIX 8: Juvenile eel harvest by IFS for translocation purposes

Table 8: The juvenile eel harvest for the past five years is presented in the table below. *The figure for 2013-14 is for the season to the end of January 2014. Eels captured by IFS at Meadowbank and Trevallyn and translocated to Tasmanian catchments.

Year	Meadowbank Dam (kg)	Trevallyn Tailrace (kg)	Total (kg)
2009-10	330	820	1 150
2010-11	230	1 163	1 393
2011-12	295	588	883
2012-13	663	967	1 630
2013-14*	1379*	922*	2 301*

APPENDIX 9: Summary of ecological risk assessment

Table 9: The issue of ecological risk was considered and through a number of workshops it was agreed by the group that the main ecological risks posed by the industry were translocation of pests and diseases, bycatch of protected fauna, welfare of animals generally including target species and accurate and timely data reporting. These issues along with standard components have been considered in the table below. The issue of pests and disease is managed through check clean and dry protocols as well as treatment with "Phytoclean" for equipment used between catchments.

Component		Risk	Comments
Fishery	Over fishing of eel populations		There is a moderate risk of overfishing however there is suite of management measures in place and capacity to restock particular catchments if required.
	Protected species		There is demonstrated take of protected species by the fishery. There is a possible compliance risk regarding reporting and compliance with management prescriptions in the conditions of licence.
Habitat	Physical damage		Impacts on waterways and the riparian zone from the activity of small runabouts, four wheel drive vehicles and deploying fyke nets is considered negligible.
Ecosystem	Retained species		The eel fishery operates on a small proportion of the freshwater system in Tasmania and eels are not fulfilling a keystone role.
	Restocking-transfer of pest species		There is potential for the transfer of pest species primarily redfin perch and Eastern Gambusia from restocking activities. A strict chemical grading protocol has been applied since 2012 to manage this risk.
	Transfer of undersized eels resulting in transfer of pest species		This issue is not well understood and requires a management response as soon as possible. There has been no recorded incidence of such a transfer occurring to date
Social/Political			The Tasmanian industry is a small export a small number of fishers are employed across the State.

Negligible	Low	Moderate	High	Extreme

The ecological risk rating has been summarised into categories based on a combined consequence and likelihood assessments of the impact of the eel fishery with existing management controls in place.