Ministry of Fisheries
Te Tautiaki i nga tini a Tangaroa

NEW ZEALAND
EEL (TUNA) FISHERY

INFORMATION BRIEF

2009
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Table of Contents

INTRODUCTION

1 This information brief provides an up to date overview of information on freshwater eels in New Zealand. The brief would be a useful resource for future planning for the fishery. This brief is designed to present current knowledge of the eel fishery and includes relevant information from the South Island eel plans developed between 1994 and 1998, as well as information relevant to the fishery throughout the country.

Background

2 There have been a number of regional planning initiatives facilitated by the Ministry of Fisheries (MFish) between tangata whenua and industry representatives in New Zealand that have provided information and planning for eel fisheries.

3 A South Island Eel Management Plan (the South Island Plan) was approved in December 1996. This was developed by the Te Waka a Maui me ona Toka Mahi Tuni (TWM) working group which included iwi and industry representatives. TWM and regional management committees were formally established as ministerial advisory bodies under the Ministry of Agriculture and Fisheries (Restructuring) Act 1995. The regional management committees developed regional plans, complementing the South Island Plan, and these were completed in 1998. The regional plans are:

- Te Tau Ihu Mahi Tuna (Nelson/ North Marlborough) Eel Management Plan;
- North Canterbury/ South Marlborough Eel Management Plan;
- Te Waihora (Lake Ellesmere) Eel Management Plan;
- South Canterbury/ Waitaki Eel Management Plan;
- Arai Te Uru (Otago/ Southland) Eel Management Plan;
- Tai Poutini Tuna (West Coast) Eel Management Plan.

4 Participants at a workshop on eel management (Ngai Tahu Tuna Wananga), convened by Ngai Tahu in July 2006, requested a review of the South Island Plan. In addition, there have been other regional planning initiatives facilitated by MFish between tangata whenua and industry representatives in the North Island. Several management objectives have already been incorporated into management actions taken by MFish and the Minister over the last decade or more. Fishing industry representatives in the South Island have recently reviewed their assessment of the South Island fishery in a plan dated September 2009. This document can be considered along with all other sources of information.

5 MFish considers that it is timely to review information and planning work that has been undertaken to date as a means to enable future planning for freshwater eels.

SCOPE OF THIS INFORMATION BRIEF

6 This information brief provides information under the following chapter headings:

- **Ecosystem information:** information on the biology of eel species, and the ecosystems in which they are found;
- **Use and value information:** how these fisheries are used and the values achieved from them; and
- **Management information:** how these fisheries are managed, including research and other services currently provided.

7 These topics are aligned to the outcomes contained in the MFish **'Statement of Intent'** document, as follows:

- **The health of the aquatic environment is protected;**
- **People are able to realise the best value from the sustainable and efficient use of fisheries;**
- **Credible fisheries management.**

8 The scope of this document relates to the following freshwater eel species found in New Zealand:

a) longfin eel (*Anguilla dieffenbachii*);

b) shortfin eel (*Anguilla australis*);

c) Australasian longfin eel (*Anguilla reinhardtii*).

9 For the purposes of fisheries management, shortfin eels and the rarer Australian longfin eel are managed together under the fish stock code SFE in the North and Chatham Islands. Longfin eel is managed separately under the fish stock code LFE in the North and Chatham Islands. Eels in the South Island are currently classified under one code; ANG, given the requirement to bring eel species in that area into the quota management system no later than 1 October 2000.

Ecosystem information

Biology

10 The biological characteristics of eels make them vulnerable to overfishing. Eels are generally long-lived, and only breed once at the end of their lifecycle, having migrated to an oceanic breeding area. Large eels are the top predator within the freshwater ecosystem.

11 Three eel species are found in New Zealand. The endemic longfin eel (*Anguilla dieffenbachii*) is found only in New Zealand and is distributed throughout the country, including the offshore islands. All references to 'longfin eel' in this document are references to the endemic species. The shortfin eel (*Anguilla australis*) is found throughout New Zealand, eastern and south-eastern Australia, New Caledonia and other island groups of the South Pacific. The Australasian longfin eel (*Anguilla reinhardtii*) is principally found in northern and eastern Australia. In 1996 the Australasian longfin eel was confirmed as present in small quantities in commercial fishing landings from the upper North Island. There is little information available about the Australasian longfin eel in New Zealand. Given similar growth characteristics, the latter species is managed as a component of the shortfin eel fishery.

Productivity

12 Both shortfin eel and longfin eel are considered to be species with low productivity, based on their natural mortality rate, fecundity, size and age at maturity, breeding strategy, maximum age and growth characteristics.

13 Female eels take several decades to reach reproductive maturity. Until they reach maturity and migrate to sea, eels are susceptible for a long period of time to fishing activities as well as mortality caused by non-fishing activities (e.g. drainage clearance).

Natural mortality rate

14 Estimates of natural mortality are only available from two sites. Estimates for shortfin range from 0.038 - 0.042, whereas the estimate for longfin is 0.036.

Fecundity

15 Fecundity is an important consideration for management as the fishery is based on pre-spawning fish. Larger female eels make a greater reproductive contribution by producing a higher proportion of eggs for potential recruitment to New Zealand fisheries waters, and other countries in the case of shortfin. For example, a female longfin eel of 4 kg in weight is likely to carry approximately eight million eggs, whereas a female longfin eel of 2 kg is likely to carry approximately 3.5 million eggs. The level of egg production to ensure sufficient recruitment of eels is unknown.

Length and age at maturity

16 Age at migration may vary considerably between areas depending on growth rate. Males of both species mature at a smaller size than females. Migration appears to be dependent on attaining a certain length/weight combination and condition. Recorded age and length at migration for shortfin males is 5-22 years and 40-48 cm, and for females 9-41 years and 64-80 cm. For longfin eels, recorded age and length at migration is 11-34 years and 24-67 cm for males, and 27-61 years and 90-158 cm for females. However, because of variable growth rates, eels of both sexes and species may migrate at younger ages.

Maximum age

17 Maximum recorded age is 60 years for shortfin and 106 years for longfin. The technique used for ageing eels in New Zealand has been validated.

Growth

18 Growth rates are usually linear. Growth in freshwater is highly variable and dependent on food availability, water temperature and eel density. Shortfin eels often grow considerably faster than longfins from the same location, although in the North Island longfins grow faster than shortfins in some areas. South Island shortfins take, on average, 12.8 years (range 8.1-24.4 years) to reach 220 grams (minimum legal size for commercial fishers), compared with 17.5 years (range 12.2-28.7 years) for longfins, while in the North Island the equivalent times are 5.8 years (3-14.1 years) and 8.7 years (range 4.6-14.9 years) respectively. No information is available for shortfin or longfin eel from the Chatham Island stocks.

Sustainability indicators and stock status

19 There is no formal stock assessment available for freshwater eel stocks in New Zealand. Conventional stock assessment techniques are difficult to apply to freshwater eel stocks because of their biology and stock structure.

20 Evidence from catch-per-unit-effort (CPUE) indices throughout New Zealand and observations of changes in length / weight, species composition, and sex ratios of some eel populations suggest that eel stocks have significantly declined in recent decades.

21 For the fishing years 2003-04 to 2005-06 shortfin landings in the North Island comprise from 69 to 77% of total longfin and shortfin landed weight, which is higher than observed in the 1970s.

Similarly, there is no clear trend of improvement in population size structure of either shortfin or longfin sampled from North Island commercial catch. On-going monitoring of the fishery is underway, which will gauge the effect of further reductions in commercial catch limits implemented on 1 October 2007. For the period 1991-92 to 2004-05, the North Island provided on average 65% of the total New Zealand eel catch.

22 In the South Island longfins are the dominant species in most areas except in a few discrete locations such as lakes Te Waihora (Ellesmere) and Brunner, and the Waipori Lakes.

23 Estimates of current and reference biomass of longfin eel have recently been derived using GIS techniques that classified all waters throughout New Zealand. Field survey data of biomass per kilometre was extrapolated from field studies (212 sites) to all New Zealand waters, noting that biomass was strongly related to the mean annual low flow and gradient of the waterway in question. The biomass estimate of longfin eels in the North Island was the same as that for the South Island, almost 6,000 tonnes each. The highest longfin eel biomass was found in large rivers in coastal and lowland regions. Further, computer simulations demonstrated that fishing activities systematically reduced both the mean length and mean weight of harvestable eels (>220 g) and the total biomass of eels present.

24 Conventional modelling studies on eel populations in New Zealand are still relatively new. Initial results indicate that exploitation rates of 5 to 10% are sufficient to reduce the spawning per recruit of female longfins by 83% and 96.5% respectively. Longfin female eels are considered recruitment over-fished at these exploitation levels. Preliminary assessments indicate that exploitation rates prior to the application of the QMS may have previously been in this range. Initial catch limits applied to eel stocks since 2000 in the South Island, and 2004 in the North Island, have reduced these exploitation rates. Additional reductions in catch limits have been implemented for North Island eel stocks from October 2007 to further reduce the risk of recruitment over-fishing, and to allow more certainty in rebuilding eel stocks.

25 Some preliminary work has been undertaken in 2006-07 and 2007-08 on development of a conventional, but suitably structured, population dynamics stock assessment model that may serve to provide a basis for future recommendations on catch limits. This model was developed for the Southland longfin eel fishery given the available information. In the medium term, refining the biomass estimates derived from the GIS modelling approach would also be of assistance. Some further evaluation of the modelling technique, and its potential application to other areas, and shortfin eel, is under consideration.

26 The MFish convened Fishery Assessment Working Group concluded in May 2009 that based on CPUE data as an estimate of abundance, longfin eel CPUE show declines of 25-75% from 1990-91 to 2003-04. Further CPUE analyses have been completed up until the end of 2007-08 for North Island stocks and are due for publication soon. Indications from preliminary analyses suggest that CPUE has stabilised. Longfin fisheries in the South Island showed increasing CPUE from 2001-02 to 2005-06. Based on available information, the Fishery Assessment Working Group did not consider that the same level of risk applied to shortfin eels.

27 The working group considers that more specific management action is required to improve the spawner escapement of longfin eels. It is not possible to recommend specific reductions in total allowable catch (TAC) that would be desirable, but measures are required to increase the spawner escapement of longfin eels to improve recruitment. Measures could include changes to catch limits, and area closures.

Biodiversity

Legislative framework

28 MFish has a statutory obligation under Section 9 of the Act to take into account the environmental principle of maintaining biological diversity when statutory powers are exercised under the Act. There are a number of tools available under the Act to achieve this obligation. Examples where biodiversity values are enhanced under the Act include the closure of areas to fishing access, the catch limits applied to the taking of the stock, and the use of a maximum size limit (large eels are not able to be taken by all sectors/users).

29 Additional to measures that MFish may take to deliver on its statutory commitment to biodiversity, there is a range of statutory controls under other legislation that support the objective of maintaining biodiversity (eg, National Parks).

General context

30 The direct impact of eel fishing activities on the biological diversity of the aquatic environment is low. The direct modification of habitat for other purposes unrelated to fishing activities (e.g. farming, flood control, irrigation, drain clearance, dams and culverts) is likely to be of more consequence. However, fishing activities are likely to be of consequence to biodiversity in an indirect way.

Eels as a top predator

31 As a top predator, eels are important in determining the trophic structure of the aquatic environment, and therefore have a role in maintaining biodiversity. At a certain size, the diet of eels shifts from aquatic insects and snails to fish species including small eels. The loss of a significant proportion of large eels from an area may therefore influence the abundance and inter-relationships between prey species. For example, the number of goldfish present in Lake Omapere (Northland) has reportedly increased since the population of eels was significantly reduced over a short period in 2000 and early 2001.

32 A significant displacement of large eels may also enable introduced species to fulfil a similar role as a predator (e.g. brown bullhead catfish, trout). The actions of these introduced species may have negative impacts on the aquatic environment. For example, the distribution and abundance of these predatory or omnivorous fish may increase, to the broader detriment of the aquatic environment, including possible effects on biodiversity values associated with native species. Further, the foraging activities of some introduced species (eg, koi) are likely to be particularly destructive to native freshwater habitat. Accordingly, the role of large eels in maintaining biodiversity is an important factor to consider when setting sustainability measures for the eel fishery.

Risk associated with fishery use

33 As the eel fishery is mainly undertaken in the freshwater environment there are different risks associated with its use in comparison to resources fished from the marine environment.

34 Certain introduced species of plants and animals taken in fyke nets or hīnaki may be accidentally or deliberately transferred to locations where those species do not exist. There are laws in place that prohibit the transfer or release of live aquatic life into freshwater without an appropriate authority.

35 The risks of species being transferred to new locations can be mitigated. For example, brown bullhead catfish must be killed on capture by amateur fishers, while commercial fishers cannot sell live brown bullhead catfish. This will ensure that live catfish are not made available to the market, reducing the risk that people do not dispose of live catfish to the wild.

36 There are other measures available to reduce the risk of early lifestages of various species being transferred or released into the wild (eg, periodic salt bath of fishing gear used in freshwater, washing down trailers before being used in another major catchment area). MFish developed a Code of Practice to reduce the risk of catfish being distributed to other waters in October 2007.

37 Eel fishing is a reasonably benign activity and fishing methods have little known physical impact on the benthic environment.

Habitats of particular significance to fisheries management

38 As juveniles, eels are frequently encountered in flood plains and lowland lakes and estuarine areas, and may burrow into the sediment. The density of eels found is related to the slope and altitude of the habitat. Longfin eels are often found in the headwaters of many catchments and dominate waters of higher altitude and slope. Vegetative stream bank cover is important for larger eels. Where riparian vegetation or normal water flow characteristics have been modified, the ability of the habitat to support the full size distribution and number of eels within a population is likely to be affected.

39 Eels undertake a spawning migration towards the end of their lifecycle, which requires unimpeded access to the sea. The placement of barriers across rivers and lakes is a major problem where these structures do not allow for fish passage. Fish passage issues are the responsibility of Councils under the Resource Management Act 1991. Also, without adequate fish passage, juvenile eels may not be able to enter a catchment that earlier generations once had free access to. Further, their efforts to move upstream may be futile if an obstruction similarly affects their downstream migration. Further discussion of the impacts of human activities on habitat values is outlined in the subsequent 'Other resource users' section.

40 Research using Geographical Information System (GIS) modelling has been undertaken to assess the amount and quality of habitat that is potentially available for eels across New Zealand. About 5% of longfin eel habitat is in waters that are closed to commercial fishing and have safe egress for migrant females. Another 11% is in waters that are protected in their upper reaches but where migrant females could be fished further downstream and 17% is located in small streams that are rarely fished. In all, it is estimated that about 33% of present habitat in both the North and South Islands is either in reserves or is rarely fished.

Associated and dependent species

41 Maintaining associated and dependent species above a level that ensures their long term viability is one of the three environmental principles set out in section 9 of the Act. 'Associated and dependent species' are defined under the Act as any non-harvested species taken or otherwise affected by the taking of any harvested species. The extent of species deemed non-harvested varies depending on the laws applying to the taking of such species, and that varies according to whether the person taking the aquatic life is a commercial or non-commercial fisher, as well as other factors.

42 There is no information to suggest that 'associated or dependent species' have been affected by eel fisheries to such a level that their long term viability has been threatened.

43 Cormorant or shag species, whether pied, black, or little black, are sometimes attracted to the movement of fish caught in fyke nets set in shallow water. These birds are partially protected under the Wildlife Act 1953, such that they generally may not be taken with lawful authority by either commercial or non-commercial fishers. Their capture is known more from northern waters of the North Island, but is likely to occur in suitable habitats elsewhere.

44 The following species are not able to be taken by a commercial fisher with lawful authority as a result of provisions in other legislation:

a) 'sportsfish';

b) 'unwanted aquatic life';

c) 'restricted fish'(without specific authorisation);

d) 'Whitebait' (seasonally);

e) 'Koura'.

45 However, an authority to lawfully take some of these species may be granted to individuals from time to time eg, koi authorizations, restricted fish authorisations.

46 The following species are not able to be taken by a non-commercial fisher with lawful authority, as a result of provisions in other legislation:

a) 'Sportsfish' (without a licence applicable for the open season);

b) 'Restricted fish' (without specific authorisation);

c) 'Whitebait' (during closed season);

47 While non-commercial fishers are able to take a wider range of associated and dependent species, there are a couple of other species that are not able to be possessed in a live state. Upon capture, even as a bycatch of the eel fishery, non-commercial fishers must kill species such as koi and catfish.

48 There are a variety of species, not being associated and dependent species (partially or all the time), taken as a bycatch of the eel fishery. These include goldfish, flounders, mullets, brown and rainbow trout, catfish, rudd, koi and smaller species such as bullies or adult galaxiids. Koura may be taken in some circumstances, although the quantity involved is unknown, but likely to be small.

49 The principal fishing methods used to take eels are quite target specific, and are unlikely to give rise to significant levels of catch of associated and dependent species. Methods such as gaff, hand-gathering, bobbing, and spear are very unlikely to result in any bycatch, while fyke net and pots / hīnaki are capable of taking a range of species. The range of associated and dependent species taken will vary according to the area of fishing activity. Some fish species taken are either more common (e.g. koi or trout in SFE 21 / LFE 21 stock areas) or absent in some areas of the North Island.

50 Eels were once considered a threat to the introduced trout fishery, and efforts were made to cull eels or restrict their movement into waterways stocked with trout. However, research has since indicated that eels do not prey extensively on juvenile trout. The predatory behaviour of large eels on trout may also ensure that the population structure of prey populations is enhanced from an angling perspective. Large eels may remove weak trout or trout with stunted growth. MFish does not consider that the long-term viability of trout will be affected by eel management practices.

51 There are no protected species, as defined in the Act, found in conjunction with the fishery for eels.

Other resource users

52 Eels are subject to significant sources of mortality due to non-fishing activities. The actual mortality from non-fishing activities has not been quantified.

53 Previous regional planning initiatives undertaken by fishery interests have expressed concerns about certain non-fishing activities having significant detrimental effects on eel populations. Activities noted include drainage, spraying, contamination of waterways, channel-clearing, water extraction, and hydro-electric power generation. Although the actual reduction in eel numbers from these activities is unknown, the existing plans suggest that the reduction in eel numbers from non-fishing activities is likely to be greater than from fishing.

54 The existing plans note that eel populations are significantly reduced since European settlement from the 1840s, largely due to wetland drainage, habitat modification brought about be irrigation, channelling of rivers and streams, and the subsequent reduction in aquatic habitat.

55 Eel populations are likely to have been significantly reduced by wetland drainage (wetland areas have been reduced by up to 90% in some areas), and habitat modification brought about by irrigation, channelling of rivers and streams and the reduction in littoral habitat. These effects were significant historically, and are of on-going concern. It is estimated that only 9.4% of New Zealand's original wetlands remain, and it is likely that most lowland wetlands are privately owned[1].

56 On-going drain maintenance activities by mechanical means to remove weeds may cause direct mortality to eels through physical damage or by stranding and subsequent desiccation. The distribution of eels in some rivers may also be affected by a lack of protection of riparian vegetation, either through a lack of fencing on farms, or creation of adequate buffer zones near urban or forestry developments. Point and non-point pollution of waterways leads to degradation of aquatic habitat, deterioration in the health and size of eel stocks, and chemical residues in eels affecting export markets. Removal of gravel and sand from within streams has detrimental effects on aquatic habitats and eels.

57 Dams present physical barriers to upstream migration of elvers, and downstream migration of larger, migrating eels. Direct mortality occurs through the mechanical clearance of drainage channels and damage by hydro-electric turbines and flood control pumping. Hydro-electric turbine mortality is affected by eel length, turbine type and turbine rotation speed. The mortality of larger eels (specifically longfin females), is estimated to be 100%. Given the large area of water in hydro lakes, this source of mortality could be significant and have an impact on the number of eels migrating to sea in spawning condition. Most of the South Island lake habitat suitable for longfin eels is in catchments containing hydro-electric power schemes.

58 Attempts were made to impede the progress of juvenile eels above hydro dams up until the early 1970s – mainly by trout fishing interests. The impact of these historical efforts on the current biomass of eels is not known. Efforts have since been made to improve fish passage past manmade obstacles in recognition that eel species are a valuable part of the ecosystem. However, the provision of adequate fish passage measures remains a significant problem in New Zealand, not only for eels, but also for a range of other indigenous species.

[1] Ministry for the Environment, 2007: Protecting Our Places: Introducing the national priorities for protecting rare and threatened native biodiversity on private land.

59 MFish only has tools directly available to it to control fishing and fishing related effects. Other agencies have the responsibility of controlling land based activities and the use of water resources. MFish would welcome suggestions from stakeholders as to how non-fishing activities which impact eel populations and the eel fishery might be addressed by those parties responsible for those impacts.

60 Regional Councils have responsibility under the Resource Management Act 1991 (RMA) for managing the effects of all land-based, non-fishing activities of concern. Under the Conservation Act 1987, regulations can be made requiring the provision of fish passages in dams or other structures which impede the natural movement of freshwater fish. More land and water resource users undertaking voluntary initiatives would better ensure that fish passage and habitat values are enhanced. Increased efforts by Regional Councils to monitor the conditions of resource consents, and take enforcement action when required, would also be beneficial.

61 Land and water resource users normally require consent for many of their activities under the RMA. Alternatively, some activities are described as discretionary, and no consent is required. The consenting requirements, if any, will depend on the Council's consideration of the importance of the issue within the geographical area of its responsibility. There does not appear to be any national overview of the combined impacts of habitat modification for species such as eels.

62 New Zealand is a party to the Ramsar Convention on Wetlands (the Convention). Waituna Lagoon, Southland, and Farewell Spit in Nelson are both included on the List of Wetlands of International Importance (the list). As well as designating wetlands for inclusion on the list, parties to the Convention undertake "to formulate and implement their planning so as to promote the conservation of the wetlands included in the list, and as far as possible the wise use of wetlands in their territory."[2] Thus, the Convention indirectly provides protection for eel habitat. Eel habitat in other parts of the conservation estate managed by the Department of Conservation, or councils, may also help to mitigate the effects of non-fishing impacts on eel populations.

Information status

63 The amount of information on the characteristics of the fishery and the means to monitor changes in relative abundance, size and age structure, and species composition has improved considerably since the early 1990s. The development of integrated stock assessment models for the eel fishery is dependent on the collection of such information over time, and further analysis of the feasibility of applying such models. Preliminary investigations conclude that suitably structured models should be able to provide useful summaries of the current state of longfin eel populations.

64 The level of information available to support management decisions for eels remains limited. MFish is committed to the collection of further information about the various eel stocks and species characteristics, particularly where the collection of such information is of assistance to understanding trends or informing management decisions at a range of levels.

Research

65 MFish has commissioned a considerable amount of research on the eel fishery since 1994. MFish-commissioned research is documented in the report entitled "Freshwater Eel Fisheries:

[2] Article 3(1) of the Convention

Chronology of Research 1994/95 to 2008/09" (August 2009). The current MFish research focus is documented in the report entitled "Freshwater Eels: Draft Medium Term Research Plan 2009/10 – 2014/15" (September 2009).

66 Previous and future research activity includes:

a) characterisation (species, sex, length, weight and age by catchment);

b) monitoring of the commercial eel fishery, including CPUE indices;

c) studies to better evaluate age and growth;

d) feasibility of developing eel stock assessment models;

e) evaluation of transfer techniques to enhance the resource;

f) eel population status surveys in local areas of importance to non-commercial interests;

g) monitoring the recruitment of juvenile eels;

h) assessing the adequacy of escapement of adult eels in spawning condition;

i) a GIS mapping project to deliver better estimates of expected biomass in lakes, rivers and streams; and

j) estimating the non-fishing mortality of eels as a result of other water resource users (e.g. drainage and drain clearance, fish passage restrictions, pollution, irrigation works, flood control pumping etc).