

Description of the biology and an assessment of the fishery for adult longfinned eels in NSW

Edited by B.C. Pease

Cronulla Fisheries Centre
P.O. Box 21, Cronulla, NSW, 2230
Australia



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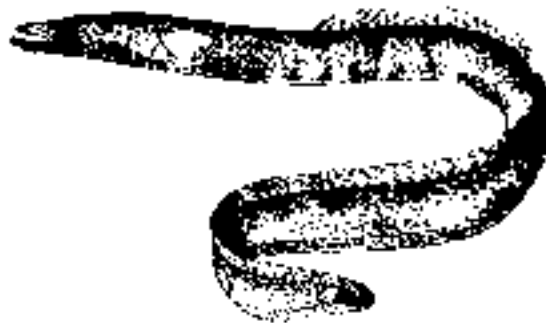


Australian Government
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Development Corporation

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NON-TECHNICAL SUMMARY

98/127	Description of the biology and an assessment of the fishery for adult longfinned eels in NSW.
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OBJECTIVES:

1. Compile all available survey data on longfinned eels in NSW to provide a quantitative summary of their distribution and relative abundance in coastal catchments.
2. Compile and cross-check all available historic catch and effort data for the commercial fishery on longfinned eels in NSW from all sources (monthly catch returns, permit logs, and export records) into a database of catch and effort information.
3. Conduct a literature review of fishery-dependent techniques for assessing adult anguillid eel stocks.
4. Describe the size, age, reproductive status and stock structure of the commercial catch of longfinned eels and their populations in representative fished and unfished catchments of NSW.
5. Assess the magnitude of the recreational fishery and the magnitude and cultural significance of the traditional fishery for freshwater eels in NSW.
6. Develop a preliminary fishery dependent model for stock assessment of longfinned eels which incorporates relevant catch, effort, recruitment and growth information.
7. Develop a strategy for monitoring the commercial fishery for longfinned eels and associated impacts related to glass eel harvest in the future.
8. Provide advice to fishery managers on the status of the stocks of longfinned eels in NSW, along with an assessment of the adequacy of existing management restrictions.
9. Provide advice to the Australia – New Zealand Eel Reference Group about the development and implementation of fishery dependent techniques for assessing other anguillid eel stocks of eastern Australia.

NON TECHNICAL SUMMARY:

Freshwater eels have a long history as a food source in Australia, firstly as part of the subsistence diet of aboriginal people and then as a commercial fishery developed by European settlers since 1912. In the late 1980s a high-value Asian market developed for live longfinned eels. In response to the new market, statewide catches of longfinned eels in the early 1990s increased dramatically to a peak of 388 tonnes in fiscal year 1992/93. Since 1992/93, statewide catches of longfinned eels have declined to approximately half the peak value. This decline in commercial catch in conjunction with continuing interest in the harvest of juvenile eels for aquaculture and a general lack of biological and ecological knowledge about longfinned eels highlighted the need to study the biology of this species. The primary objective of this study was to determine key aspects of the population biology of longfinned eels relevant to assessing the stocks of this species.

All available information about the distribution and abundance of the two river eel species in NSW was compiled into a single geographic information system. The presence/absence data from this spatial database was then summarised to provide an insight into the occurrence of these species within and among catchments. It was concluded that longfinned eels probably occur in virtually every coastal waterbody in NSW and they are among the most ubiquitous fish species within the coastal catchments of eastern Australia. They are known to occur in every aquatic habitat within this region, from marine and occasionally hypersaline waters at the mouth of the estuaries to montane streams, freshwater lakes and isolated freshwater impoundments. In many of the habitats they occupy, they are the largest or “top” carnivore. Due to their ubiquity and trophic status, they play a key role in the ecological structure and function of aquatic communities in the coastal catchments of eastern Australia.

Sex and stage of gonadal development of longfinned eels from a range of catchments and habitats were macroscopically and histologically examined to determine their reproductive biology. Typical of other river eel species, testes were found to be lobed in structure, and ovaries were frilled. Histology showed that sex identification by macroscopic observation was justifiable. However, to accurately define stages of gonadal development, particularly in individuals less than 600mm in total body length, it was found that histological preparation and microscopic examination were essential. Gamete development was not synchronous in males and females, indicating that the timing of sexual maturity and spawning migrations may differ between sexes. However, there was no evidence of lobed (male) organs containing oocytes, or gonads containing both male and female sex cells, indicating that this species does not change sexes. Gonadal development stages were positively correlated with body size in both sexes. However, female eels were significantly larger than males and their gonads matured over a broader size range. Size at sexual differentiation (42-60cm for males and 50-76cm for females) was much larger than for most other river eel species that have been studied, with the exception of the New Zealand longfinned eel. All of the evidence indicates that this species spawns only once before dying, similar to other river eels that have been studied. The most advanced cells present in migrating male and female eels were spermatocytes and pre-vitellogenic oocytes, respectively, indicating that the spawning site for this species is a relatively long distance from the nursery estuaries compared to most of the other river eel species that have been studied. Corresponding with its large range in size at sexual differentiation was a relatively large range in the size of sexually mature eels prior to migration to the oceanic spawning grounds (44-62cm for males and 74-142cm for females). Therefore, most males reach sexual maturity before reaching the marketable size of 58 cm or 500 g.

The annual nature of growth rings in otoliths of “yellow eel stage” (fully pigmented, pre-migratory) longfinned eels was validated using a combination of laboratory and field experiments. Eels were injected with oxytetracycline (OTC) and tagged with external “T-bar” tags. Microscopic examination of thin transverse sections of the sagittal otoliths from recaptured eels showed that one opaque annulus was typically formed in the otolith during each year subsequent to OTC marking. The seasonal timing of opaque annulus formation was highly variable, but generally occurred between May and October. Supernumerary (false or incomplete) rings were observed in many of the otoliths. Examination of otolith sections from a sample of very small, untagged, yellow eels verified the age at first annual increment formation. Marked and tagged longfinned eels did not have a significantly higher mortality rate than controls in the laboratory experiment but tag loss rates may be high.

The field tagging studies were also used to evaluate the movement patterns of yellow-stage longfinned eels within the coastal catchments of NSW. Of the original 865 tagged eels, there was an overall recapture rate of 19%. One individual was recaptured in the same location after 720 days at liberty. All except two of the recaptured eels were found close to their original tagging site, indicating that the home range of longfinned eels is generally less than approximately 300m. Both

eels that moved greater distances were females that moved downstream from the freshwater zone, possibly in anticipation of the spawning migration.

Sex ratios, catch per unit of effort (CPUE) and population age and length structure were examined in three zones (fresh water, upper tidal, and lower tidal) in the Hacking, Hawkesbury and Clarence River catchments. Females were found in relatively high proportions in all zones, ranging from 97% in a freshwater (non-tidal) site down to 59% at a tidal site. Males were found primarily in tidal zones (only two of the 677 eels caught in non-tidal fresh water were males), with the greatest proportions being found in the brackish upper tidal areas. The mean number of eels captured per trap were significantly higher in the freshwater and upper tidal zones than in the lower tidal zones. The mean age ($17.9 \text{ years} \pm 0.29 \text{ S.E.}$) and age range (5-52 years) for females were significantly higher than those of males ($12.2 \text{ years} \pm 0.39 \text{ S.E.}$; range 5-22 years), which is typical of other river eel species. Eels captured in fresh water were found to be significantly larger and older than those in tidal zones due to the almost exclusive predominance of females in the freshwater zone. Therefore, the existing closure of non-tidal fresh waters provides significant refugia for female spawning stock. Male spawning stock in the heavily fished upper tidal zone could be effectively protected by increasing the minimum size limit to 58 cm or 500g (mean size of sexual differentiation for females). Yield per recruit modelling of the eel fishery as part of collaborative studies by the Queensland Department of Primary Industries also indicate that the increased size limit would result in an increase in the relative yield per recruit to the estuarine and impoundment large yellow eel fisheries, as well as an increase in the relative egg production of females in these habitats, while decreasing the harvest of males.

Growth rates of long-finned river eels among the three zones and coastal catchments were also examined. Mean annual growth rates for the total population of sampled eels were calculated through age-length analysis (42mm/yr^{-1}) and individual tag-recapture (35mm/yr^{-1}). Both methods showed high intra and inter-population variability in growth rates of eels, even within the same sex at similar sites. Growth rates (based on body length) were found to be significantly faster in younger (5-15 years) eels than older (>15 years) eels with females growing an average 10 mm/yr^{-1} faster than males of similar ages. These differences may be attributed to the different life history strategies employed both within and between sexes. The mean growth rate of eels in tidal areas was found to be significantly higher than in freshwater areas, with eels in the tidal areas of the Clarence River showing the greatest growth. Consistently faster growth of longfinned eels in tidal areas of catchments through a wide latitudinal range may be attributed to a longer growing season in the highly productive estuarine habitats. Other factors influencing variability in growth rates include sex ratios, density and fishing pressure.

Genetic samples from 447 glass and adult eels were collected from nine geographically distinct locations throughout NSW, Qld and New Caledonia. These samples were screened using six polymorphic dinucleotide microsatellite nuclear loci and allelic diversity at all six microsatellite loci was high. Both Chi-squared and F_{ST} testing indicated moderate but highly significant levels of genetic structuring that are comparable with other fish species with high dispersal ability. Importantly, the level of genetic differentiation reported here for Australian longfinned eels is an order of magnitude higher than previously shown for other freshwater eel species. However, the level of genetic structuring reported here is also based on incomplete data sets and should be treated as preliminary. If genetic structuring is verified by further analysis, this result will have significant management implications. Based on the “precautionary principle”, these preliminary results indicate that the NSW population of longfinned eels should be managed as a discrete unit, independent of recruitment from spawning stocks in other parts of the extensive geographic range.

Four different commercial fisheries for longfinned eels (glass eel, small yellow eel, estuarine large yellow eel and impoundment large yellow eel fisheries) were described and summarised. Glass eels (post-larvae) are harvested for aquaculture grow-out from the upper tidal reaches of the estuary by

fishers with special permits using fine meshed fyke nets. The estuary and impoundment fisheries for large yellow eels have similar biological (females) and method (trap) characteristics but distinct fishing areas and management controls. The small yellow eel fishery has identical management characteristics to the estuarine large yellow eel fishery but targets the smaller male and undifferentiated yellow eels which are often in different areas from the larger female eels. Only the catch and effort data from the estuarine large yellow eel fishery is currently stored in the centralised catch and effort corporate database and reported on annually. Catch and effort data for all four eel fisheries should be stored in the corporate database and reported on annually.

The glass eel fishery has remained a very small-scale (annually much lower than the 40,000 longfinned glass eel peak), experimental fishery since its inception in 1995. Along with the problems associated with sourcing and identifying glass eel seedstock, aquaculturists have encountered problems with weaning then finding appropriate diets for the subsequent life-history stages. Mortality rates of these early life-history stages are often high. Therefore, aquaculturists have turned their attention primarily to small yellow eels from the yellow eel trap fishery for seedstock in the late 1990's. Unfortunately, the landings of these small yellow eels for aquaculture are not reported separately from the landings of the larger yellow eels that are harvested for the export market. Therefore, we only have anecdotal evidence from commercial fishers and aquaculturists that annual landings of small yellow eels have been less than 20,000 eels in recent years and we have no associated fishing effort information. The low level of harvest in both the glass eel and small yellow eel fisheries is primarily related to limited demand by the aquaculture industry rather than limitations of stock size or CPUE.

The impoundment trap fishery for large yellow eels has remained a small, limited-entry fishery since permits were first issued in 1992. The number of fishers and total annual landings in this fishery have declined since the mid 1990's but the catch per unit of effort has remained high since the fishery began. It is estimated that 30 to 40 thousand eels have been harvested annually by this fishery in recent years. The high CPUE and stability of the annual landings since the mid 1990's indicate that this fishery is operating within sustainable limits. However, stability and sustainability of this fishery are dependent on a complex mixture of factors related to the number of fishers and how often they harvest the isolated stocks with variable recruitment and growth rates from a large number of small impoundments.

The majority of eels that are commercially landed in NSW are harvested by the estuarine trap fishery for large yellow eels. This fishery has operated since at least 1970 and the number of fishers has remained stable since at least 1984. Annual landings and catch per fisher-month increased through the 1980's to a peak in the early 1990's when the high-value export market developed. Fishing effort, as measured by catch per fisher-month, has remained high since then but annual landings and catch per unit of effort (CPUE) declined in the mid 1990's, then levelled off. This temporal pattern in CPUE indicates that harvest prior to the early 1990's was having little impact on eel stocks, but increased effort in the early to mid 1990's rapidly reduced the level of available surplus production. This is typical of a new fishery. The stable nature of annual landings (estimated at 150 to 170 thousand eels in recent years) and catch per unit of effort since the mid 1990's, indicates that this fishery is now operating within sustainable limits.

Annual harvest rates and market values are not necessarily the only indicator of the importance of a fishery. Some harvested species may have special cultural or social significance to ethnic segments of the population. There is considerable archaeological and anthropological literature on Aboriginal use of eels in New South Wales. In this study, the nature and cultural significance of the indigenous fishery for eels in New South Wales was evaluated based on the available literature. Eels are often depicted in Dreamtime stories and rock engravings. Information from early European settlers depicts indigenous fishers capturing eels with a wide range of methods. More recent literature indicates that eels remain a popular food item with the indigenous population.

The magnitude of the indigenous and recreational eel fisheries in NSW were assessed using data from the 2000/01 national recreational survey and relevant tag/recapture data from our study. The two independent methods produced very similar estimates for both the total annual indigenous and recreational harvests of longfinned eels, which each ranged from 1748 to 2897 eels or from 2185 to 3677 kg, respectively. It is not feasible to estimate the variance associated with these estimates. Estimates from the tagging study were based on simplistic assumptions of proportionality between harvest and tag return rates while estimates from the national recreational survey were based on spatial sampling frames smaller than the state level. However, the consistency of these independent estimates verifies that the indigenous and recreational harvests of longfinned eels from NSW are each low (probably less than 3000 eels or 4 tonnes per year) compared to commercial harvests. Therefore, the total non-commercial harvest is probably in the order of 4000 to 6000 eels or 6 to 8 tonnes per year, which is less than 3% of the recent average annual commercial harvest of large yellow eels.

Strategies for monitoring longfinned eel stocks in NSW are discussed. Existing commercial catch and effort monitoring programs should be continued, as specified by the Estuary General Fishery Management Strategy. Long-term trends in catch and CPUE have been useful in assessing the status of stocks. This report also demonstrates that it is feasible to monitor size and age structure of fishery independent and fishery dependent catches. However, ongoing monitoring of size and age structure may not be cost effective because of the high variability of sex ratios, size and age among habitats and catchments. Monitoring of spawning stocks (out-migrating silver eels) is not technically feasible at this time. However, cost-effective techniques for monitoring annual glass eel recruitment have recently been developed. A glass eel recruitment monitoring program would provide useful information about the long-term status of yellow eel stocks, as well as the annual status of glass eel stocks for the glass eel fishery.

Outcomes Achieved

1. All available survey data on longfinned eels in NSW up through the year 2000 have been compiled into an Access database called Eel Distribution. Based on the information in this database and the available literature, a quantitative summary of the distribution of longfinned and shortfinned eels in NSW is provided in Chapter 2.2. The Eel Distribution database has been archived at NSW Fisheries for future reference.
2. All available catch and effort data for the commercial yellow eel fisheries in NSW have been cross-checked and compiled into an Access database called Lcatch Eels. Based on the information in this database, a quantitative summary of the catch and effort of the commercial eel fisheries of NSW are provided in Chapter 3. The Lcatch Eels database has been archived at NSW Fisheries for future reference.
3. An international workshop was held at the Fisheries Research Institute, Cronulla to assess fishery independent and fishery dependent strategies for sampling adult eels. The proceedings of the workshop were published in a report by Walford and Pease (1999).
4. Estimates of the magnitude of the indigenous and recreational fisheries for longfinned eels in NSW are provided for the first time.
5. Fishery independent and fishery dependent samples of longfinned eels were collected from a range of habitats, in a number of coastal catchments in NSW over a three-year period. The environmental, morphometric, age, gonad condition and sex data from this study has been compiled into an Access database called Adult Eels. After using this database for the analyses summarised in this report, it has been archived at NSW Fisheries for future reference.
6. Many of the biological and ecological results of this study, including aspects of anaesthesia, reproduction, age, movement and demography of longfinned eels, have been published in a

- series of four journal publications (Walsh and Pease 2002; Walsh, Pease and Booth 2003; Pease, Reynolds and Walsh 2003; Walsh, Pease and Booth 2004).
7. Data from this study have been used in the collaborative development of a yield per recruit model for longfinned eel populations by the Queensland Department of Primary Industries in a study funded by FRDC.
 8. Bycatch data from fishery independent eel trapping for this study were used in the Environmental Impact Statement for the Estuary General Fishery (NSW Fisheries 2001) and a journal publication on freshwater turtle bycatch in trap fisheries by Lowry, Pease, Graham and Walford (2004).
 9. Advice on the status of longfinned eel stocks and the adequacy of existing management strategies for eel stocks was presented to the Australia-New Zealand Eel Reference Group at a meeting in Melbourne on 12 July 2002 and to the NSW Estuary General Management Committee at a meeting in Cronulla on 20 September 2002.
 10. Based on the results of this study, a recommendation to increase the minimum legal size of longfinned eels from 30 cm to 58 cm was proposed in a discussion paper on the longfinned eel fishery of NSW that was sent to all commercial eel fishers in December 2003.

KEYWORDS:

Longfinned Eels, *Anguilla rienhardtii*, Reproduction, Age, Growth, Stock Structure, Stock Assessment

1. INTRODUCTION

1.1. Background

Freshwater eels belong to the genus *Anguilla* and four of the 16 known species occur in Australia. The two most common species in eastern Australia are the Australian longfinned eel (*Anguilla reinhardtii* Steindachner, 1867) and the Australian shortfinned eel (*Anguilla australis australis* Richardson, 1841). Both of these species are commercially harvested from the coastal catchments of eastern Australia. The widely distributed longfinned eel (also known locally in NSW and Victoria as the spotted or conger eel) is a predominantly tropical species that occurs along the entire east coast of Australia from Cape York south to Tasmania, west to Melbourne and east to Lord Howe Island.

Freshwater eels are catadromous fishes that spawn in the ocean. The exact location of the spawning grounds of the East Australian species is unknown but it is believed that they spawn in depths greater than 400 metres in the Coral Sea. The leaf-shaped larvae, called leptocephali metamorphose into transparent eel-shaped “glass eels”. As the eels migrate up the estuaries they become pigmented and are then called elvers. As one of the primary apex carnivores in the upper parts of coastal catchments in Eastern Australia, adult longfinned eels are extremely important components of these ecosystems. Longfinned eels are reported to be relatively long-lived species, Tasmanian studies indicate that they reach sexual maturity after 10 to 40 years, when they migrate out of the estuary and return to their oceanic spawning grounds. They may attain a length of 1.6 metres and a weight of over 20 kg.

Freshwater eels have a long history as a food source in Australia, firstly as part of the subsistence diet of Aboriginal people and then as a commercial fishery developed by European settlers since 1912. The first commercial eel fishery developed in Victoria and has been based primarily on the Australian shortfinned eel, producing between 200 and 350 tonnes per year since 1976. In NSW and Queensland the commercial fisheries are based primarily on longfinned eels. The Queensland fishery started in the 1980s and has remained small (less than 50 tonnes per year). The commercial fishery in NSW started in the late 1960s. Reported catches remained relatively low (less than 100 tonnes per year) until the early 1990s. Most of the catch during this period was obtained from the Clarence River catchment and the northern region of the state. During this period both longfinned and shortfinned eels were primarily exported as frozen product. In the late 1980s a high-value Asian market developed for live longfinned eels. In response to the new market, statewide catches of longfinned eels increased dramatically to a peak of 388 tonnes in fiscal year 1992/93. Most of the increased catches came from Port Stephens and the Hawkesbury River in the central region and a new fishery for eels from impoundments and farm dams. Since 1992/93, statewide catches of longfinned eels have declined to approximately half the peak value. Despite this decline, the 1996/97 eel catch ranked fifth by weight and third by value (approximately one million dollars) of commercial estuarine finfish in NSW. Therefore, the longfinned eel fishery is a significant component of the estuarine fisheries in NSW.

The number of fishers reporting eel catches in NSW has remained relatively stable at 180 to 260 fishers per year since 1984. In 1997, access to the fishery was limited by requiring an endorsement to use eel traps and the number of estuarine eel fishers has declined. Since the inception of the fishery in NSW, trapping has been the only legal commercial harvest method for freshwater eels. Fish and eel trapping during this period has been restricted to tidal waters, except for a few large impoundments since 1989 and some small coastal farm dams since 1992, where eels have been harvested by special permit. Since 1989 a maximum size limit has been imposed by the

specification of a maximum entrance tunnel diameter of 10 cm for eel traps. In 1997 a minimum legal length of 30 cm was introduced.

Information on the magnitude of either the traditional or recreational catch of freshwater eels in NSW is not readily available, but these catches are believed to be small in comparison with the commercial catch. However, eels may be totemically significant within the culture of Aboriginal people. There is also very little information on the magnitude of the by-catch in other estuarine fisheries, but this component is also believed to be very limited.

Eels have been extensively cultured in Victoria since the early 1970's. Culturists are still unable to spawn any of the freshwater eel species in captivity so Victorian lakes are stocked with undersized eels and elvers from the commercial fishery and a commercial fishery for glass eels has developed in Queensland for supplying local aquaculture facilities. As a result, there is growing interest in all the eastern states of Australia in the potential for intensive and extensive culture of eels using wild caught glass eels and elvers. Export of glass eels and elvers (less than 30 cm) from NSW is currently prohibited but a limited number of permits have been issued for harvest of glass eels to provide seed for experimental eel culture facilities within the state. Expansion of the harvest of glass eels may be possible but the level of exploitation should be determined using appropriate information on all relevant life history stages and their interaction. Therefore, uncertainty about the impact of glass eel harvest on adult eel stocks makes it even more important to gain an understanding of the status and dynamics of adult eel populations.

1.2. Need

Internationally, the demand and resulting value of glass eels has increased tremendously in recent years. Live glass eels have been sold for over \$15,000 per kilo. This international demand results from over-fishing of adult and glass eels in Asia, North America and Europe. This world experience indicates that recruitment over-fishing of long-lived freshwater eels can be catastrophic. Because of the increasing significance of adult eels in the estuarine fisheries of NSW, decreased catches in recent years and the prospect of increased future catches of glass eels for aquaculture, it is important to undertake research which will lead to an understanding of the current status of adult stocks in NSW. Stocks of adult eels must be managed properly to ensure continued production of the commercial fishery for adult eels, continued recruitment of glass eels and elvers for aquaculture and stability of coastal catchment ecosystems.

Limited research into the basic biology and ecology of longfinned eels has been carried out in Victoria and Tasmania, but there have been no biological studies conducted in NSW. The only published age and growth information for this species comes from one catchment in Tasmania and indicates that they are relatively long-lived (40 years), but this age data has not been validated. The available literature indicates that growth rates of freshwater eel species are highly variable among habitats and distributional ranges. Therefore, there is need to determine the basic biological parameters of NSW longfinned eels stocks, including validated age structure, growth and mortality rates, and reproductive characteristics for use in stock assessment modelling.

Since there is a significant commercial fishery for adult eels in NSW, fishery-dependent techniques based on sampling of commercial catches may represent the most cost effective stock assessment and monitoring methodology. Age and growth monitoring of many commercial finfish species in NSW is currently carried out by sampling fish at the Sydney Fish Markets and regional fisherman's co-operatives. Most of the commercial eel catch in NSW is exported live through a few (currently four) specialised processors. Therefore, it may be necessary to establish a specialised monitoring regime and fishery-dependent model which will provide data on which to base advice for the future sustainable management of exploitation of the resource.

1.3. Achievement of Objectives

1. Achieved - All available survey data on longfinned eels in NSW up through the year 2000 have been compiled into an Access database called Eel Distribution. Based on the information in this database and the available literature, a quantitative summary of the distribution of longfinned and shortfinned eels in NSW is provided in Chapter 2.2. The Eel Distribution database has been archived at NSW Fisheries for future reference.
2. Achieved - All available catch and effort data for the commercial yellow eel fisheries in NSW have been cross-checked and compiled into an Access database called Lcatch Eels. Based on the information in this database, a quantitative summary of the catch and effort of the commercial eel fisheries of NSW are provided in Chapter 3. The Lcatch Eels database has been archived at NSW Fisheries for future reference.
3. Achieved – All literature relevant to stock assessment of anguillid eels has been compiled into a Procite database of eel literature with over 500 references. This database (Eel Refercnces) has been archived at NSW Fisheries for future reference.
4. Achieved – Fishery independent and fishery dependent samples of longfinned eels were collected from a range of habitats, in a number of coastal catchments in NSW over a three-year period. The environmental, morphometric, age, gonad condition and sex data from this study has been compiled into an Access database called Adult Eels. After summarising this information in Chapter 2, it has been archived at NSW Fisheries for future reference. Many of the biological and ecological results of this study, including aspects of anaesthesia, reproduction, age, movement and demography of longfinned eels, have been published in a series of four journal publications (Walsh and Pease 2002; Walsh, Pease and Booth 2003; Pease, Reynolds and Walsh 2003; Walsh, Pease and Booth 2004). Detailed information about the reproductive biology, ecology and demographics and genetic stock structure are presented for the first time.
5. Achieved – Based on a review of available literature, the cultural significance of the indigenous fishery is discussed in Chapter 4. The magnitude of the indigenous and recreational fisheries for longfinned eels in NSW is estimated for the first time in Chapter 5, using the national recreational survey and tag recapture data.
6. Not achieved – A model for assessing longfinned eel stocks based on fishery dependent data was not developed because a modeller was not available at NSW Fisheries during the contract period. However, information from this NSW study was provided to Simon Hoyle for collaborative development of a yield per recruit model for longfinned eels. This model will be presented in the final report to FRDC on the collaborative study of longfinned eels by the Queensland Department of Primary Industries.
7. Achieved – Methods for monitoring longfinned eel stocks are discussed in Chapter 5 and final recommendations for monitoring are given.
8. Achieved – Advice on the status of longfinned eel stocks is provided in Chapter 3 and recommendations for improving the management of eel fisheries in NSW is provided in Chapter 5. A summary of the management recommendations from this report were presented to the Estuary General Management Advisory Committee on 20 September 2002. Based on the results of this study, a recommendation to increase the minimum legal size of longfinned eels from 30 cm to 58 cm was proposed in a discussion paper on the longfinned eel fishery of NSW

that was sent to all commercial eel fishers in December 2003 and endorsed by the Estuary General Management Committee in July 2004.

9. Achieved – Based on the findings of this study, recommendations on the development and implementation of fishery dependent techniques for assessing anguillid eel stocks were presented to ANZERG at a meeting in Melbourne on 12 July 2002.