Review of the Eastern Freshwater Cod Recovery Plan

October 2016

Introduction

This document reviews the Eastern Freshwater Cod (*Maccullochella ikei*) Recovery Plan. The review assesses the implementation of recovery actions in NSW and progress in meeting the stated recovery objectives. The review also aims to clarify any required changes in management actions or priorities necessary for the recovery of the species.

The Eastern Freshwater Cod Recovery Plan was approved as a final plan in 2004. The overall objectives of the recovery plan are to ensure the recovery and natural viability of Eastern Freshwater Cod populations in their former range in the Clarence and Richmond Rivers.

Short term objectives of the recovery plan are to:

- Ensure the security of existing Eastern Freshwater Cod populations in the Mann and Nymboida rivers by maintaining and enhancing, where necessary, the aquatic habitat values in that locality, and through statutory protection mechanisms;
- Establish and protect additional reproducing populations of Eastern Freshwater Cod at selected locations in its former range;
- Gain a greater understanding of the size, distribution, ecological requirements, historical and existing genetic status of the population of Eastern Freshwater Cod;
- Gain a better understanding of the threats to the survival of Eastern Freshwater Cod, and initiate management actions to reduce identified threats;
- Coordinate and initiate new community awareness and education programs relating to Eastern Freshwater Cod;
- Coordinate and support appropriate actions by the community and government to provide a strategic, regional approach to Eastern Freshwater Cod survival and effective threat management; and
- Monitor the outcomes of past and present recovery actions and the species' ongoing conservation status.

Long-term objectives of the recovery plan are to:

- Promote the recovery of Eastern Freshwater Cod to secure the ongoing natural viability of the species; and
- Periodically assess species ongoing conservation status.

The plan will be judged a long-term success in NSW if the status of Eastern Freshwater Cod is revised from 'endangered' to 'vulnerable' and eventually removed from lists under the NSW *Fisheries Management Act 1994* and Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* schedules.

The recovery plan requires a major review within ten years of its publication. This document comprises the review and complies with section 220ZR (review of recovery and threat abatement plans) of the NSW *Fisheries Management Act 1994*.

Review of Recovery Actions

The review of the Eastern Freshwater Cod recovery actions was undertaken in consultation with a range of managers and scientists and drew on several sources of information (e.g. Fisheries Scientific

Committee's Annual Reviews of the threatened species lists, scientific papers, consultant reports, internal DPI reports and personal communication with a range of professionals with involvement in Eastern Freshwater Cod research, management and compliance operations).

The recovery plan includes six program areas including "Habitat protection / restoration", "Minimising impacts from fish introductions", "Reducing impacts of fishing", "Establishing new populations through stocking", "Research and monitoring" and "Community awareness, involvement and support". The implementation details for each program area are outlined in Tables 1 to 6.

Table 1: Review of recovery actions – 11.1 Habitat protection / restoration

Recovery Action	Implementation Details
11.1.1: Prepare a strategic habitat protection / restoration plan.	
Prepare a strategic plan for the protection of key Eastern Freshwater Cod habitats in the Mann-Nymboida River sub-catchment and identify, restore and protect potential habitats to re-establish additional viable populations.	**Not commenced.** Although a formal strategic plan for the protection of key Eastern Freshwater Cod habitat has not been prepared, some work has been undertaken to restore and protect Eastern Freshwater Cod habitats (see 11.1.3).
11.1.2: Ensure the security of the existing population of Eastern Freshwater Cod.	
11.1.2.1: Survey existing habitat in the Mann-Nymboida River sub-catchment and determine the key habitat requirements for Eastern Freshwater Cod.	
Complete a distributional survey of Eastern Freshwater Cod using electro-fishing, angling, netting/trapping and snorkelling techniques and investigate aquatic habitat associations. Assess stream reaches using a standardised regime for habitat descriptors.	**Commenced, ongoing.** Habitat selection identified and described within the remnant Eastern Freshwater Cod population in the Mann-Nymboida rivers (Butler and Rowland, 2009; Butler *et al*. 2014). Larger catchment wide surveys have not commenced. Distributional surveys are complete.
11.1.2.2: Ensure that the risk of degradation of existing Eastern Freshwater Cod habitat is minimised.	
Investigate the use of critical habitat protection as a means of protecting key Eastern Cod habitats.	**Not commenced.**
Encourage land use activities in the upper catchment (eg. agriculture, forestry, industry, mining, municipal) that minimise the risk of pollution, sedimentation and other adverse impacts on the Nymboida-Mann system by:	**Commenced, ongoing.** NSW DPI has put in place measures to ensure that the risk of degradation of aquatic habitat including threatened species habitat, is minimised. The NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management was updated in 2013 and is available at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf This document outlines policy and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species. It also contains up-to-date legislative and policy information for planning and development assessment processes, including threatened species assessment. Environmental Impact Assessment Guidelines for all threatened fish species were prepared in 2008. The guidelines are available on the NSW DPI website at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/226536/Threatened-Species-Guidelines.pdf
1) identifying, assessing and negotiating, where necessary, mitigating measures for pollution point sources.	**Not commenced.**

Recovery Action	Implementation Details
2) assessing, and modifying where appropriate, land and water management policies and practices which may contribute to reduced stream flows, catchment alienation, loss of riparian vegetation or excessive soil loss.	**Commenced, ongoing.** NSW DPI has been actively involved in negotiating the terms of the Integrated Forestry Operations Approvals (IFOA). An IFOA describes the forestry operations and conditions covered by the approval. The approval contains the terms of a licence under the *Protection of the Environment Operations Act 1997* and the *Fisheries Management Act 1994*. NSW DPI has successfully negotiated aquatic habitat protection conditions to ensure no significant impacts on Eastern Freshwater Cod or their habitat (e.g. riparian exclusion zones, buffer zones and special operational zones). The Water Sharing Plan for Coopers Creek was modified to reduce the impacts of modified stream flows on Eastern Freshwater Cod. The Coopers Creek Water Sharing Plan commenced in 2004. The plan established a water sharing regime that provided water for the environment and water for extractive purposes such as irrigation. Following negotiations the flow rules ensured pools and low flow riffles were protected from extraction for the protection of the species. Full implementation of the necessary flow requirements for Eastern Freshwater Cod was also achieved for the Orara River Water Sharing Plan. A number of land and water management practices have been identified in the range of Eastern Freshwater Cod that have potential for negative impacts on aquatic habitats. These include for example grazing pressure from cattle and wild horses, illegal dredging and reclamation activities and road maintenance activities adjacent to waterways. Many of these issues are yet to be fully addressed to reduce impacts on Eastern Freshwater Cod habitat.
3) incorporating aquatic habitat protection mechanisms into plans of management for adjacent National Parks	**Not commenced.**
4) including harm reduction measures in Bush Fire Hazard Reduction Plans, particularly those managed by State Forests and DEC. For example, burning operations can be scheduled to minimise the risk of ash run-off during Eastern Freshwater Cod breeding season.	**Commenced, ongoing.** NSW DPI is investigating incorporating Eastern Freshwater Cod distribution data and protection provisions into the Bushfire Risk Information Management System (BRIMS). BRIMS is accessed and used by a range of government agencies (e.g. OEH, Rural Fire Service etc.) when undertaking bushfire hazard reduction works.
Incorporate NSW DPIs Eastern Freshwater Cod environmental flow recommendations as part of the water management planning process.	**Complete.** NSW DPI staff attended regular meetings and negotiated positive outcomes in the design and implementation of NSW Water Sharing Plans relevant to Eastern Freshwater Cod (e.g. Coopers Creek Water Sharing Plan). NSW DPI prepared a position paper which set out the recommendations for minimum river flows for Eastern Freshwater Cod especially during the breeding and juvenile dispersal phase of the species life cycle (See 11.1.2.2(2).
Ensure the construction of an effective fish passage structure on the Nymboida weir.	**Commenced, ongoing.** Various studies have been undertaken to determine the need and type of fishway required on the Nymboida weir (see Stuart and Butler 2013; Butler *et al.* 2014). An effective fish passage structure had not been constructed on the weir at the time this review was prepared (January 2016).
11.1.3: Identify, protect and enhance potential habitats in other areas within the previous natural range of Eastern Freshwater Cod with a view to re-establishing viable populations.	
11.1.3.1: Identify suitable sites to re-establish Eastern Freshwater Cod populations.	**Complete.** Suitable sites to re-establish Eastern Freshwater Cod populations were identified and selected as part of the pre-stocking approval process. Conservation stocking of Eastern Freshwater Cod was undertaken from 1997 to 2004. The conservation stocking program for Eastern Freshwater Cod no longer operates (see 11.4 below).

Recovery Action	Implementation Details
11.1.3.2: Protect and enhance identified sites.	
Ensure that the risk of degradation of potential Eastern Freshwater Cod habitat is minimised.	**Commenced, ongoing.** NSW DPI has put in place measures to ensure that the risk of degradation of aquatic habitat including threatened species habitat, is minimised. The NSW DPIs Policy and Guidelines for Fish Habitat Conservation and Management were updated in 2013 and are available at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf This document outlines policy and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species. It also contains up-to-date legislative and policy information for planning and development assessment processes, including threatened species assessment. Environmental Impact Assessment Guidelines for all threatened fish species were prepared in 2008. The guidelines are available on the NSW DPI website at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/226536/Threatened-Species-Guidelines.pdf
Initiate direct protection for the habitat through legislative mechanisms.	**Not Commenced.**
Restore aquatic habitat in identified locations to a state suitable for long term Eastern Freshwater Cod survival.	**Commenced, ongoing.** NSW DPI and various community groups (such as Landcare) have been involved in restoring aquatic habitat for Eastern Freshwater Cod. For example, NSW DPI has been involved with revegetating, weed control and fencing works for 31km of aquatic habitat suitable for Eastern Freshwater Cod. A further 194 ha of floodplain has been effectively managed to reduce acid sulfate soil impacts on current and/or former waterways supporting Eastern Freshwater Cod. An Eastern Freshwater Cod Demonstration Reach was established in the Richmond Basin in 2005-06 to show best practice on-ground habitat rehabilitation for the species (NSW DPI, 2006).
Ensure that management approaches are put in place to maintain restored habitats in the long term.	**Commenced, ongoing.** The primary management approach to maintain restored Eastern Freshwater Cod habitat includes the provision of training to landholders, council staff and the general public on aquatic habitat restoration techniques and pollution minimisation (see below). Promotion and adoption of relevant DPI policy and guidelines (e.g. Policy and Guidelines for Fish Habitat Conservation and Management) also assist to maintain restored habitats.
Ensure that the risk of pollution, sedimentation and other adverse impacts are minimised.	**Commenced, ongoing.** NSW DPI staff undertook workshops with council engineering and road/bridge construction staff from three local government areas within the range of Eastern Freshwater Cod. The workshops focused on ensuring that the risks of pollution and sedimentation from council activities have minimal impacts on aquatic habitats within the species' distribution. Day-to-day interactions with stakeholders also provides opportunities to educate stakeholders on reducing the risk of pollution, sedimentation and other adverse impacts on Cod habitat. Permits issued under Part 7 of the NSW *Fisheries Management Act 1994* are only issued based on prior negotiation of no impact to threatened species or their habitat thereby ensuring that adverse impacts on aquatic habitats are minimised.
Ensure the retention of remaining snags.	**Commenced, ongoing.** NSW DPIs policy and guidelines for snag management are detailed in the Departments' Policy and Guidelines for Fish Habitat Conservation and Management and are available on the DPI website at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf The policy and guidelines inform land use and natural resource management planning, development planning and assessment processes. They are taken into account when assessing and either approving or refusing proposals for developments or other activates affecting fish habitats.

Recovery Action	Implementation Details
Establish linkages with existing conservation groups.	**Commenced, ongoing.** NSW DPI has established links with a number of groups including Project Big Fish (now disbanded), Landcare (ongoing) and the North Coast Local Land Services (formerly North Coast Catchment Management Authority). Positive relationships have also been established with a number of private landholders who have undertaken works to protect Eastern Freshwater Cod habitat including for example, stock exclusion fencing, and weeding and revegetation works to stabilise eroding river banks.
Adopt policies and instigate actions aimed at protection of these waterways.	**Complete.** NSW DPIs Policy and Guidelines for Fish Habitat Conservation and Management were updated in 2013 and are available at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf This document outlines policy and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species (including waterway crossings). It also contains up-to-date legislative and policy information for planning and development assessment processes, including threatened species assessment. Environmental Impact Assessment Guidelines for all threatened fish species were prepared in 2008. The guidelines are available on the NSW DPI website at: http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/226536/Threatened-Species-Guidelines.pdf
Encourage the adoption of NSW DPIs Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures 1999.	**Commenced, ongoing.** NSW DPI encourages adoption and compliance with the Policy and Guidelines for Fish Habitat Conservation and Management (see above). This supersedes the Policy and Guidelines for Bridges, Roads, Causeways, Culverts and Similar Structures 1999. In 2014, three disused road crossings were removed from Terrania Creek. Furthermore, two causeways on the upper Wilsons River were also made 'fish friendly'.
Establish fish passage structures on relevant barriers to fish migration (e.g Richmond River 'Norco' weir).	**Commenced, ongoing.** NSW DPI has improved 698 km of fish passage in Eastern Freshwater Cod habitats up to October 2015. This includes weir removals (Norco and Manyweathers weir on the Richmond River) and fishway installation (Jabour and Kyogle). A rock-ramp fish ladder was also constructed at Skews Crossing in the Orara River.
Encourage implementation of 'best practice' soil conservation practices within the Clarence and Richmond drainage areas.	**Not commenced.**
Investigate the feasibility of resnagging operations or the suitability of creating Eastern Freshwater Cod habitats using artificial materials.	**Commenced, ongoing.** Various techniques for the restoration of snag complexes have been trialled. To date, three snag complexes have been restored in the Richmond River.
Encourage land managers to adopt 'best practices' in the protection and regeneration of riparian vegetation.	**Commenced, ongoing.** Whenever possible landholders are encouraged to adopt best practices to protect or restore riparian vegetation. A private landholder in the Wilsons River catchment installed 1.6km of stock exclusion fencing and 600m weeding and revegetation to stabilise eroding river bank to encourage the growth of native riparian vegetation. Demonstration of appropriate riparian restoration techniques including bush regeneration and revegetation to the local community and associated landholders has been undertaken as part of some habitat rehabilitation programs (e.g. Eastern Freshwater Cod Demonstration Reach). A range of advisory materials have also been prepared to provide information to landholders on ways to manage and protect fish habitats including riparian vegetation. For example, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/448926/Primefact-178-Eastern-cod.pdf http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/590052/Eastern Freshwater Cod-brochure-web-version.pdf

Table 2: Review of recovery actions – 11.2 Minimise impacts from fish introductions

Recovery Action	Implementation Details
11.2.1: Minimise risk of impact from non-endemic fish introductions.	
Ensure that all stocking related activities are conducted according to the requirements set out in NSW DPIs "Freshwater Fish Stocking in NSW" strategy.	**Commenced, ongoing.** All stocking activities in the range of Eastern Freshwater Cod habitat are undertaken in accordance with the NSW DPI Freshwater Fish Stocking Fishery Management Strategy (NSW DPI 2005).
Maintain prohibition on the taking, possession, sale, stocking and aquaculture of Murray cod in Eastern Freshwater Cods range and increase law enforcement/education activities to maximise compliance.	**Commenced, ongoing.** A section 8 Fishing Closure prohibiting the taking, possession, or release of live of Murray Cod in the range of Eastern Freshwater Cod was enacted in 1999 but lapsed in 2004. Despite the closure lapsing, NSW DPI staff continue to actively discourage the possession, sale, stocking and aquaculture of Murray Cod in Eastern Freshwater Cod's range. Advisory material has also been prepared on appropriate species to stock into farm dams that notes the need to prevent stocking of Murray Cod in northeast NSW to protect the Eastern Freshwater Cod (see http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/40663/Fish-in-farm-dams.pdf).
Conduct surveys to determine the extent and spread of translocated species such as banded grunter, Murray cod, golden perch, gold fish, and silver perch.	**Commenced, ongoing.** Ongoing opportunistic sampling of the fish communities throughout the Clarence and Richmond river systems has been undertaken whenever possible. All exotic species have been counted and recorded in NSW DPI databases. Relevant survey programs include the NSW Monitoring, Evaluation and Reporting Program 2006-07, 2009-10 and 2012-13; the Clarence Fishtrack Program 2006-ongoing; the Clarence Ecohealth Program 2014 (Butler *et al*. 2014); and surveys for Tilapia on the NSW North Coa
Develop and implement a public education program on identifying undesirable species and encourage reporting.	**Commenced, ongoing.** NSW DPI has prepared web information for a number of pest species with potential impacts on Eastern Freshwater Cod (e.g. Banded grunter, goldfish and gambusia). A public reporting program has also been implemented and promoted (see http://www.dpi.nsw.gov.au/fisheries/pests-diseases/reporting).
Allow the sale of Eastern Freshwater Cod for farm dam stockings.	**Complete.** The stocking of Eastern Freshwater Cod from the commercial hatchery licenced to produce fingerlings was abandoned in 2004. There are currently no permits authorised to culture Eastern Freshwater Cod.
Encourage farmers who wish to stock dams on their properties to stock appropriate endemic species such as Eastern Freshwater Cod and Australian bass.	**Commenced, ongoing.** Currently, farmers who wish to stock dams on their property are encouraged to stock endemic species such as Australian Bass. When the commercial hatchery was in operation (1997-2004) some Eastern Freshwater Cod were stocked into farm dams; however the exact numbers and location of stocking events are unknown. NSW DPI advisory material and advice from staff strongly discourage the stocking of Murray Cod into farm dams into North East catchment as the species could compete or hybridise with Eastern Freshwater Cod (see http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/40663/Fish-in-farm-dams.pdf).
11.2.2: Minimise risk from impact of genetically unsuitable Eastern Freshwater Cod.	
Maintain strict genetic controls for Eastern Freshwater Cod conservation stocking programs.	**Complete.** NSW DPI developed the genetic protocols used by the commercial hatchery to produce Eastern Freshwater Cod from 1997-2004. Finclips were collected from broodfish to ensure quality assurance. Independent assessment of genetic management indicated that while the protocols were appropriate, they were not always adhered to. The conservation stocking program for Eastern Freshwater Cod no longer operates.

Recovery Action	Implementation Details
Increased awareness about the potential impacts of stocking genetically unsuitable Eastern Freshwater Cod in the Clarence and Richmond rivers.	**Complete.** During the time the stocking program was operating direct consultation was undertaken with Fisheries Compliance Officers and Aquaculture Licencing Officers regarding monitoring and compliance.

Table 3: Review of recovery actions – 11.3 Reduce impacts of fishing

Recovery Action	Implementation Details
11.3.1: Reduce or prevent fishing induced mortality.	
Assess the effect of catch and release fishing on Eastern Freshwater Cod by conducting a study of the closely related Murray cod on post-hooking mortality.	**Complete.** A study assessing the effect of catch and release fishing on Eastern Freshwater Cod using Murray Cod as a surrogate species was completed in 2012 (see Hall *et al.* 2012).
Use increased knowledge to modify, if necessary, fishing regulations/activities in known Eastern Freshwater Cod distribution e.g, lure & fly only (no bait).	**Commenced.** NSW DPI has prepared educational material advising of fishing tips to maximise the survival of Eastern Freshwater Cod (see **http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/590052/EFC-brochure-web-version.pdf).**
11.3.2: Reduce impacts of fishing on pre-spawning fish.	
Review information on seasonal fishing activities and Eastern Freshwater Cod spawning times.	**Complete.** Breeding behaviour and spawning times have been identified for the remnant population of Eastern Freshwater Cod (see Butler and Rowland 2009).
Assess the need for total fishing closures, seasonal fishing closures and fishing gear restrictions in appropriate areas of the Nymboida-Mann river system.	**Commenced, ongoing.** An annual three month fishing closure of the Mann and Nymboida Rivers and their tributaries from 1 August to 31 October is in place. The possession of fishing gear in, or adjacent to closed waters is an offence. All fishing in the specified area is prohibited during the closure period to enable Eastern Freshwater Cod to spawn uninterrupted during its breeding season. No general restriction of fishing gear types has been implemented for Eastern Freshwater Cod.
11.3.3: Maximise compliance with fishing regulations.	
Increase enforcement capabilities of regional Fisheries Officers.	**Not commenced.**
Increase number of Fisheries Officer angler contacts in the Clarence and Richmond River drainage areas.	**Commenced, ongoing.** Fisheries Officers patrolling Eastern Freshwater Cod habitat make regular contact with anglers. Since the integration of Marine Parks into general Fisheries compliance additional Fisheries Officers have been available for Eastern Freshwater Cod compliance and enforcement activities enabling regular patrols into the species habitat. Joint patrols with neighbouring Fisheries Districts and large scale operations incorporating multiple agencies now occur on a regular basis in some areas. This has helped to increase Fisheries Officer angler contacts in the range of Eastern Freshwater Cod habitat.
Investigate the suitability of providing appropriate Fisheries enforcement powers to Office of Environment and Heritage (OEH) – (Parks Services Division) rangers.	**Not commenced.** While the provision of Fisheries enforcement powers to OEH staff has not been investigated, Fisheries Officers conduct joint patrols with OEH rangers. This assists with gaining access to patrol remote locations in prime Eastern Freshwater Cod habitat.
Investigate the options available to improve procedures for reporting illegal activities and providing feedback on enforcement actions.	**Commenced, ongoing.** Since the adoption of the Eastern Freshwater Cod Recovery Plan additional procedures for reporting illegal activities have been introduced. In addition to an online reporting form members of the public who suspect illegal activities taking place can now also report the activity using a dedicated phone line (Fishers Watch Phone line). NSW DPI has also developed social media strategies for providing feedback on enforcement actions including Facebook (https://www.facebook.com/NSWDPIFisheries/) and Twitter

Recovery Action	Implementation Details
	(https://twitter.com/nswdpi).
Implement a program for volunteer education officers (Fishcare Volunteers).	**Complete.** In 2000 twelve people from the North Coast region completed training as Fishcare Volunteers. The training program included information specific to Eastern Freshwater Cod conservation issues. The presence of the volunteers in the region greatly assisted in communicating the endangered status of the species amongst fishers. The Fishcare Volunteer program remains active in the area.
Increase public awareness of protected status of Eastern Freshwater Cod.	**Commenced, ongoing.** Extensive advisory signage concerning the protected status of Eastern Freshwater Cod and the annual fishing closure has been installed and kept updated along many of the publically accessible sections of Eastern Freshwater Cod habitat. For example, advisory signage regarding the annual fishing closure has been installed at a total of 39 locations in the Mann River and its tributaries from 2013-2015. Similarly, the Eastern Freshwater Cod endangered species sign has been installed at a total of 28 locations within the same period in the Mann, Boyd, Nymboida, Henry, Sara and Timbarra Rivers. Advisory materials have also been prepared and updated for the species including the 'Eastern Freshwater Cod Primefact", various factsheets on the closure, 'A guide for fishers and land managers'; and numerous research papers in scientific journals. NSW DPI regularly drafts media releases regarding the endangered status of Eastern Freshwater Cod and the three month fishing closure. This often leads to media coverage in local newspapers (e.g. http://www.dailyexaminer.com.au/news/three-month-fishing-ban-in-mann-and-nymboida-river/2017517/).

Table 4: Review of recovery actions – 11.4 Establish new populations through stocking

Recovery Action	Implementation Details
11.4.1: Maintain strict genetic management protocols for the breeding of Eastern Freshwater Cod.	**Complete.** NSW DPI developed the genetic protocols used by the commercial hatchery that produced Eastern Freshwater Cod from 1997-2004. Independent assessment of genetic management indicated that while the protocols were appropriate, they were not always applied. The conservation stocking program for Eastern Freshwater Cod no longer operates.
Retain and monitor adherence to strict genetic management permit requirements.	**Complete.** NSW DPI put in place the genetic management permit requirements for the Eastern Freshwater Cod stocking program while in operation. For example they included that a report be submitted to NSW DPI prior to stocking events detailing the broodstock collection, breeding and management techniques used and production activities; number of successful spawning pairs of Eastern Freshwater Cod broodstock; and compliance with the relevant genetic guidelines and proposed number of juveniles to be stocked from each pair.
Review and implement appropriate genetic management protocols in the light of genetic study results.	**Complete.** Analysis of genetic material collected from hatchery bred and wild Eastern Freshwater Cod is complete. A decision was made to suspend the program in 2004 due to reduced genetic diversity in hatchery bred fish.
Introduce tagging program for broodstock released from breeding program to prevent repeat use.	**Complete.** All broodfish held by the commercial hatchery were PIT tagged and records kept to ensure that animals were regularly rotated and not accidentally reused.
11.4.2: Optimise strategic conservation stocking programs.	
Ensure that all stocking related activities are conducted according to the requirements set out in NSW DPIs "Freshwater Fish Stocking in NSW" strategy.	**Complete.** All stocking activities in the range of Eastern Freshwater Cod habitat are undertaken in accordance with the NSW DPI Freshwater Fish Stocking Fishery Management Strategy (NSW DPI 2005).

Recovery Action	Implementation Details
Ensure the most effective use of wild broodstock.	**Complete.** NSW DPI monitored the quantities held and the exchange of broodfish when the stocking program was functioning. All broodfish were tagged with PIT tags and records were kept during and post-release to ensure fish were not reused.
Assess stability of Eastern Freshwater Cod numbers at previous stocking sites.	**Commenced, ongoing.** Stocking sites were monitored for the first three years post-stocking and then intermittently monitored post 2004.
Select potential new stocking sites with reference to existing River Styles and other available studies.	**Complete.** A number of potential new stocking sites were selected prior to the cessation of the stocking program in 2004. The potential new stocking locations were provided to stocking groups and commercial hatchery staff.
Prioritise stocking sites by undertaking habitat characterisation surveys of potential and previous sites as they relate to site selection criteria.	**Not commenced.**
Identify funding opportunities and secure funds.	**Not commenced.**
Determine optimum stocking levels based on genetic objectives and environmental considerations.	**Not commenced.**
Investigate and implement, if appropriate, methods for chemical tagging of stocked fish.	**Complete.** A successful trial of chemically marking fingerlings using strontium chloride, alizarin red and oxy-tetracycline was undertaken.
Determine optimum timing of stock release to minimise environmental stress and maximise dispersal.	**Complete.** NSW DPI provided advice to both the commercial hatchery and to community stocking groups regarding optimal timing of stocking Eastern Freshwater Cod fingerlings.
Design and implement a long term monitoring program to assess stocked populations.	**Commenced.** A monitoring program was designed and included twelve sites sampled once a year for four years (2000 – 2004). The full implementation of the monitoring program was constrained by lack of funding. All sites sampled post 2004 has been done on an opportunistic basis.

Table 5: Review of recovery actions – 11.5 Research and monitoring

Recovery Action	Implementation Details
11.5.1: Biology, ecology, distribution and habitat requirements. Phase 1 – evaluation of survey methodology and site selection:	**Complete.** Research has been undertaken into the species reproductive biology, age and growth, movement patterns, habitat selection, early life history and diet, with several publications resulting (Butler and Rowland 2008, 2009; Butler *et al*. 2012; Butler and Wooden 2012; Butler *et al*. 2014). A PhD thesis (Butler 2010) was also completed which synthesised the available biological and ecological information. An acoustic telemetry movement study that commenced in 2010 is ongoing.
Evaluate in the field the use of electro-fishing, angling, netting/trapping and snorkelling as effective techniques in surveying Eastern Freshwater Cod.	**Complete.** All techniques for surveying Eastern Freshwater Cod (electrofishing, angling, netting/trapping, snorkelling) were trialled. Electrofishing was found to be the most consistent and non-lethal for sampling juvenile and adult cod (Pollard and Wooden 2002). Angling was generally used in hard to access locations. Underwater cameras were also used successfully to monitor breeding behaviour and larval ecology (Butler and Rowland 2009).
Simultaneously evaluate the most suitable sites for regular monitoring, as well as aquatic habitat associations / characterisation of stream reaches using a standardised regime for habitat descriptors.	**Commenced.** Twelve monitoring sites were chosen but monitoring was only done intermittently on an opportunistic basis post 2004. Meso- and micro-habitat requirements of adult remnant populations within the Mann-Nymboida rivers were identified and described (Butler and Rowland 2009; Butler *et al*. 2014).

Recovery Action	Implementation Details
Phase 2 – seasonal surveys: Undertake at least one monitoring survey per year for the duration of the recovery plan, using the techniques found most appropriate and a minimum of 12 sites per survey.	**Commenced, ongoing.** Twelve sites identified and monitored within the Clarence and Richmond rivers between 2000 and 2004. Post 2004 all twelve sites have only been sampled opportunistically and intermittently due to lack of funding.
Sites to include both regular (surveyed each year) and a number of previously unsurveyed sites selected on the basis of; stocking history, habitat quality and anecdotal reports of extant Cod.	**Commenced, ongoing.** Twelve sites identified and monitored within the Clarence and Richmond rivers between 2000 and 2004. All twelve sites sampled only opportunistically and intermittently post 2004. Opportunistic sampling of other sites have been surveyed intermittently as part of other programs e.g. the NSW Monitoring, Evaluation and Reporting Program 2006-07, 2009-10 and 2012-13; the Clarence Fishtrack Program 2006-ongoing; and the Clarence Ecohealth Program 2014 (Butler *et al*. 2014).
Determine population abundance and structure, assess changes in population demographics and habitat preference, as related to seasonal habitat variation or migratory tendencies. It is envisaged that the spring survey will provide information on natural reproductive requirements and habits.	**Commenced, ongoing.** No attempt has been made to determine abundance within the remnant Eastern Freshwater Cod population. A comprehensive survey of the Clarence Basin was completed as part of Clarence Ecohealth Program in 2013-14 (Butler *et al*. 2014). Furthermore, regular monitoring of 27 sites throughout Clarence Basin (2006-2013) was undertaken as part of Clarence Fishtrack Program (Butler *et al*. 2014). No comprehensive survey has been undertaken for the Richmond Basin. Further monitoring has been undertaken as part of the NSW Monitoring, Evaluation and Reporting Program 2006-07, 2009-10 and 2012-13. Reproductive requirements of Eastern Freshwater Cod have been identified and reported by Butler and Rowland (2009).
Provide detailed information on overall and seasonal distribution and abundance of Eastern Freshwater Cod.	**Commenced, ongoing.** Surveys undertaken but only intermittently with little or no targeted sampling of Eastern Freshwater Cod populations. Seasonal movements have been quantified with no changes evident in distribution (Butler *et al*. 2014).
11.5.2: Long-term monitoring.	
Evaluate the results of Phase 1 & 2 in terms of techniques, timing and site selection to develop and implement a long-term program to assess the response to recovery actions.	**Not commenced.** A long term monitoring program has not been implemented to date. The ongoing status of stocked fish has been determined intermittently via opportunistic sampling, generally as part of other sampling programs such as the NSW Monitoring, Evaluation and Reporting Program 2006-07, 2009-10 and 2012-13; Clarence Fishtrack Program 2006-ongoing; Clarence Ecohealth Program 2014 (Butler *et al*. 2014).
11.5.3: Evaluate genetic status.	**Complete.** The genetic structure and effective population size was determined based on historic and current samples (Nock *et al*. 2011).

Table 6: Review of recovery actions – 11.6 Community awareness, involvement and support

Recovery Action	Implementation Details
11.6.1: Enhance advisory activities.	**Commenced, ongoing.** Two separate advisory signs have been prepared and installed throughout various locations within the range of Eastern Freshwater Cod habitat (see 11.3.3). The signs advise that catching and keeping the species is an offence and significant penalties apply. They also include information on the identification of Eastern Freshwater Cod. There was a targeted Eastern Freshwater Cod Fishcare Volunteer Program in place in early 2000. The Fishcare Volunteer Program is still active in the area.
Develop an education program to increase community awareness of the problems faced by Eastern Freshwater Cod.	**Commenced, ongoing**. NSW DPI maintains a database for sighting records of protected and threatened fish that covers the NSW north coast where Eastern Freshwater Cod occurs. NSW DPI encourages community reporting sightings of the species via the DPI website (http://www.dpi.nsw.gov.au/fisheries/species-protection/report-it).

Recovery Action	Implementation Details
	Various information materials are available to stakeholders via the NSW DPI website to assist with increasing community awareness of the issues facing Eastern Freshwater Cod and to encourage community reporting of sightings. In addition, numerous articles and media releases have been prepared and published in local newspapers regarding Eastern Freshwater Cod conservation issues and advising of the three month fishing closure in the Mann and Nymboida Rivers and tributaries.
Investigate the feasibility of an educational kit for use in schools.	**Not commenced.**
11.6.2: Encourage community involvement in the implementation of the recovery plan.	**Commenced, ongoing.** NSW DPI has been active in encouraging community involvement in the implementation of various aspects of the recovery plan. NSW DPI staff has met with various Local and State government agencies to improve awareness of the recovery plan and the actions required to recover the species. NSW DPI has also established links with a number of community groups (e.g. Project Big Fish and Landcare) to assist with the implementation of the recovery actions.
Advertise and widely distribute information on the recovery plan and what the community can do to assist with recovery actions.	**Commenced, ongoing.** Advisory materials specifically targeting Eastern Freshwater Cod and the recovery plan have been prepared and widely distributed. The Primefact prepared for the species includes information relating to why the species is threatened and possible conservation and recovery actions (see http://www.dpi.nsw.gov.au/fisheries/species-protection/conservation/what-current/endangered-species/eastern-freshwater-cod). A guide for fishers and land managers on protecting Eastern Freshwater Cod has also been prepared and includes information on how to assist with the recovery of the species (http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/590052/Eastern Freshwater Cod-brochure-web-version.pdf).
Support activities of Project Big Fish and other local organisations.	**Commenced, ongoing.** Project Big Fish was fully supported by NSW DPI when it was active. NSW DPI has and continues to provide support to other local organisations (e.g. Landcare) via for example providing presentations and training.
Encourage participation of local indigenous people through direct consultation and targeted advisory activities.	**Commenced, ongoing.** Indigenous groups were consulted during the public exhibition of the Eastern Freshwater Cod recovery plan with public submissions and feedback invited from indigenous groups (such as Local Aboriginal Land Councils). Since the adoption of the recovery plan NSW DPI has had interactions with various indigenous groups and has provided presentations on Eastern Freshwater Cod when required.
Encourage the reporting of incidental Eastern Freshwater Cod captures and reporting of suspected illegal activities.	**Commenced, ongoing.** NSW DPI maintains a database for sighting records of protected and threatened fish that covers the NSW north coast where Eastern Freshwater Cod occurs. NSW DPI encourages community reporting sightings of the species via the DPI website (http://www.dpi.nsw.gov.au/fisheries/species-protection/report-it). Since the adoption of the Eastern Freshwater Cod Recovery Plan additional procedures for reporting illegal activities have been introduced. In addition to an online reporting form members of the public who suspect illegal activities taking place can now also report the activity using a dedicated phone line (Fishers Watch Phone line). NSW DPI has also developed social media strategies for providing feedback on enforcement actions including Facebook and Twitter.
Promote responsible fishing practices in Eastern Freshwater Cod areas.	**Commenced, ongoing.** NSW DPI has a number of publications and advisory materials available promoting responsible fishing practices. Media releases are also regularly issued to advise of the seasonal fishing closure for Eastern Freshwater Cod. Direct contact with regional Fisheries Officers, DPI researchers in the field also aids in promoting responsible fishing practices in Eastern Freshwater Cod habitat and raise awareness of the threats to the species.

Assessment of Action Implementation

Overall, there has been a sustained and successful effort to implement the Eastern Freshwater Cod Recovery Plan and this is reflected in the large number of recovery actions that are either complete or have commenced and are ongoing. All of the recovery actions relating to "Minimising impacts from fish introductions" are 'commenced, ongoing' or 'complete'. Only two recovery actions relating to "Reducing impacts of fishing" have not commenced and only one "Research and Monitoring" action is yet to commence. All but one of the "Community awareness, involvement and support actions" has 'commenced'. In the recovery program area "Habitat Protection / Restoration" three recovery actions are 'complete', 15 have commenced and are ongoing, and 6 have not commenced. There are still some outstanding actions, however the overall implementation is well advanced and will continue to advance through the Priorities Action Statement (PAS – see below).

Although a significant proportion of recovery actions have been implemented since the adoption of the recovery plan, many of the recovery actions require ongoing work into the future to make a difference to the overall recovery status of the species. For example, the recovery action "Encourage land use activities in the upper catchment (e.g. agriculture, forestry, industry, mining, municipal) that minimise the risk of pollution, sedimentation and other adverse impacts on the Nymboida-Mann system" is not a 'one off' recovery action. It requires ongoing and sustained effort over time and in response to a wide range of varying issues. New issues will emerge over time and they will require addressing in order to assist with meeting the objectives of the recovery plan in the long term.

Achievement of Recovery Plan Objectives

Significant progress has been made over the 10 years of the Eastern Freshwater Cod Recovery Plan in improving the understanding of the size, distribution, ecological requirements, and historical and existing genetic status of Eastern Freshwater Cod. Some progress has also been achieved in maintaining and enhancing the aquatic habitat values of Eastern Freshwater Cod habitat and in coordinating and initiating community awareness and education programs.

In their annual reviews of the threatened species lists, the NSW Fisheries Scientific Committee (FSC) has identified the need to maintain protection of remnant Eastern Freshwater Cod populations by putting in place more effective fishing closures and by declaring critical habitat. The FSC has also prioritised more systematic and programmed monitoring of existing populations of Eastern Freshwater Cod in the Clarence and Richmond Rivers, which is currently only done on an opportunistic basis.

This review has also highlighted several areas where more work is required to assist with recovery including improving protection for Eastern Freshwater Cod habitat, and more strategic implementation and monitoring of the outcomes of recovery actions. The development and implementation of an ongoing program to monitor the status of Eastern Freshwater Cod is essential to assess the effectiveness of recovery actions, and prioritise implementation of future recovery efforts.

Other issues identified by this review and from consultation with Departmental managers, compliance officers and scientists, that may assist with the recovery of Eastern Freshwater Cod include:

- Addressing the diverse range of threats that occur in close proximity to Eastern Freshwater Cod habitat. These include but are not limited to managing the adverse effects of recreational activities such as camping and firewood collection, damage caused to riparian areas by grazing of domestic stock and wild horses, illegal dredging and reclamation activities and road maintenance activities adjacent to waterways.
- Reinstating the lapsed section 8 closure prohibiting the taking, possession, or release of live Murray Cod in North East NSW Catchments.
- Enhancing the enforcement capabilities of Fisheries Officers to better access the remote habitat of Eastern Freshwater Cod in wilderness areas to undertake compliance activities by the use of helicopter patrols and/or surveillance drones.
- Considering legislative amendments to improve legal protection for threatened species habitat and simplify enforcement of provisions related to the damaging of habitat of threatened fish.
- Investigating an expansion of the closed waters for Eastern Freshwater Cod to include additional areas of suitable or potentially suitable habitat (e.g. areas of the Sara, Mann, Boyd and Guy Fawkes River).

The recovery plan states that it will be judged a long-term success if it leads to the status of Eastern Freshwater Cod being revised from 'endangered' to 'vulnerable' and its eventual removal from lists under the *Fisheries Management Act* and the *Environment Protection and Biodiversity Conservation Act* schedules. Based on the limited information available and the latest review of the status of Eastern Freshwater Cod by the Fisheries Scientific Committee, it appears that populations have not increased to the point of downgrading or delisting the species. Further work is required to achieve this goal commencing with a focus on the areas identified by this review.

Since the adoption of the Eastern Freshwater Cod Recovery Plan legislative changes to the *Fisheries Management Act 1994* have required the development of a Priorities Action Statement (PAS). The PAS sets out all the actions required to recover threatened species, population, ecological communities and address key threatening processes listed in the *Fisheries Management Act 1994*. The recovery actions outlined in the Eastern Freshwater Cod Recovery Plan have been prioritised and included in the PAS (http://www.dpi.nsw.gov.au/fisheries/species-protection/priorities-action-statement2). Any future actions required to recovery Eastern Freshwater Cod will be outlined and included in future reviews of the PAS.

References

Butler, G.L., Mackay, B., Broderick, T., Rowland, S.J., Reinfelds, I. & Pease, B. (2014). Fishtrack: the effects of flow and barriers on the fish assemblages of the Clarence River, New South Wales, Australia. Interim report to Northern Rivers Local Land Services. NSW Department of Primary Industries, Grafton, NSW.

Butler, G.L., Mackay, B., Gilligan, D., St Vincent Welch, J. & Broderick, T. (2014). Relative condition of freshwater fish community in the Clarence Basin: Ecohealth North Coast New South Wales. Report to Northern Rivers Catchment Management Authority. NSW Department of Primary Industries, Grafton, NSW. Online: http://northern.cma.nsw.gov.au/publications/new-publications.html

Butler, G.L., Rowland, S.J., Baverstock, P.R. & Brooks, L. (2014). Movement patterns and habitat choice of the endangered eastern freshwater cod *Maccullochella ikei* in the Mann River, Australia. *Endangered Species Research*, 23, 35-49.

Butler, G.L. & Wooden, I. (2012). Dietary habits of a large, long-lived endangered Australian percichthyid, the eastern freshwater cod, *Maccullochella ikei*. *Endangered Species Research,* 16 (2), 199-209.

Butler, G.L., Rowland, S.J., Baverstock, P.R. & Morris S. (2012). Ontogenetic behaviour and swimming ability of the endangered eastern freshwater cod, *Maccullochella ikei*, with notes on growth and development. *Ecology of Freshwater Fish*, 21, 23-33.

Butler, G.L. & Rowland, S.J. (2009). Using underwater cameras to describe the reproductive behaviour of the endangered eastern freshwater cod *Maccullochella ikei*. *Ecology of Freshwater Fish*, 18, 337-349.

Butler, G.L. & Rowland, S.J. (2008). Using traditional age and growth techniques in endangered species management: eastern freshwater cod *Maccullochella ikei*. *Marine and Freshwater Research*, 59, 684-693.

Hall, K. C., Broadhurst, M. K. and Butcher, P. A. (2012), Post-release mortality of angled golden perch *Macquaria ambigua* and Murray cod *Maccullochella peelii*. *Fisheries Management and Ecology*, 19: 10–21.

Nock, C.J., Ovenden, J.R, Butler, G.L., Wooden, I, Moore, A.S. & Baverstock, P.R. (2011). Population structure, effective population size and adverse effects of stocking in the endangered Australian eastern freshwater cod, *Maccullochella ikei*. *Journal of Fish Biology*, 78, 303-321.

NSW DPI. (2005). *The NSW Freshwater Fish Stocking Fishery Management Strategy*. NSW Department of Primary Industries, Sydney, NSW.

NSW DPI. (2006). *Habitat rehabilitation for the endangered Eastern Freshwater (Maccullochella ikei) in the Richmond River Catchment, and Trout Cod (Maccullochella macquariensis) in the Murray Catchment, NSW.* Report to the New South Wales Environmental Trust. NSW Department of Primary Industries, Sydney, NSW.

Pollard, D.A. and Wooden, I. (2002). Interim results of surveys in the Clarence and Richmond river systems: supplement to eastern freshwater cod, *Maccullochella ikei,* recovery plan. New South Wales Fisheries: Nelson Bay.

Stuart, I.G. & Butler, G.L. (2013). Fish passage at Nymboida Weir: literature review and fish ecology. Report to Northern Rivers Catchment Management Authority. NSW Department of Primary Industries, Grafton, NSW. Online: http://northern.cma.nsw.gov.au/publications/new-publications.html

More information

NSW Department of Primary Industries

Threatened Species Unit

Email: fisheries.threatenedspecies@dpi.nsw.gov.au

Locked Bag 1

Nelson Bay NSW 2315

www.dpi.nsw.gov.au