Department of Sustainability and Environment

Action Statement

Flora and Fauna Guarantee Act 1988 No. 203

Freshwater Herring *Potamalosa richmondia* Empire Gudgeon *Hypseleotris compressa*

Preamble

The Freshwater Herring and the Empire Gudgeon are considered together in this Action Statement as in Victoria:

- the river systems in which they are found discharge to Mallacoota Inlet and both are likely to use the estuary for part of their life cycle;
- land use surrounding the rivers where they have been located is generally similar;
- they both appear to be at the southern edge of their distribution; and;
- there is likely to be no negative impact on one species for management actions carried out for the other.

Description and distribution

The Freshwater Herring Potamalosa richmondia MacLeay 1879 is a smallish, silver, back slightly iridescent green, coloured fish that has a reported lifespan of at least 11 years (McDowall 1996, Pigeon 1989). Slender and elongated, with sharp ridges dividing both its back and belly, the adult length is commonly 140 – 160 mm, but has been described at up to 320 mm (McDowall 1996). Large, silvery eyes lie slightly above and to the side of a small upturned mouth with protruding lower jaw on its longish snout (McDowall 1996). It has a scaleless head, but quite large scales cover the rest of its body. Small, colourless fins (although sometimes darkening along the rays) are typically angular, with the tail fin strongly forked.

The Empire Gudgeon *Hypseleotris compressa* Krefft 1864, like the Freshwater Herring, is slender and elongated, although smaller, attaining a length of up to 100 mm.

Adult Freshwater Herring.
Photo by Rudie Kuiter ©

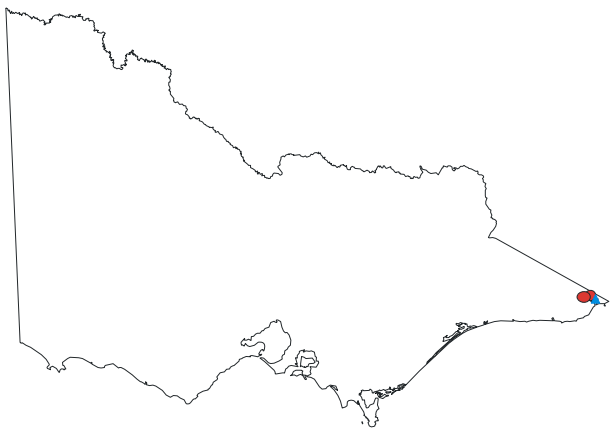
Adult male Empire Gudgeon.
Photo by Rudie Kuiter ©

Adult female Empire Gudgeon.
Photo by Rudie Kuiter ©

The species has a fawn to light golden brown (sometimes almost chocolate brown) head and body and a lighter coloured red belly. The adult males are differentiated from the females and juveniles by distinctly banded belly and back fins, the number of bands depending on the position of the fin. Bands can be brownish, bright orange red, black and pearly white. White spots are present on the dusky coloured tail fin, while the pectoral and pelvic fins are generally clear. While colouring is the most distinguished feature of the fish, it can vary widely. Each fish also has the ability to swiftly change to a lighter or darker shade. When breeding, the colours of the male intensify "giving the impression that the fish is glowing from the inside" (McDowall 1996).

More detailed information on the distinguishing features and other characteristics of both fish can be found in McDowall 1996. In Victoria, a Freshwater Herring was located at one site in the Little River (Teal Creek) river system in 1976 (McCarraher 1986, Raadik 1992). The Empire Gudgeon has been found at two sites in the Genoa River system of far East Gippsland. One fish was found in the Genoa branch in 1991 and two fish were found during a survey of the Wallagaraugh branch of the Genoa River system in 1994 (Raadik unpublished data). All sites are within Mallacoota Inlet, east Victoria.

Reports of Freshwater Herring at Lakes Entrance and elsewhere in Victoria have not been substantiated (Raadik 1992, Raadik pers. comm.). The Freshwater Herring is also found in coastal streams in New South Wales, where it is less common in the southern part of its range, appearing to be more abundant north of the Hawkesbury River, although low and fluctuating abundance in many streams has led to concern for the species (Pidgeon 1989, Morris *et al.* 2000). The Empire Gudgeon is also found in New South Wales, Queensland, the Northern Territory, north-western Western Australia and southern New Guinea.



Victorian Distribution: Freshwater Herring (blue triangle); Empire Gudgeon (red circle) (original source: *Victorian Fauna Display*, NRE 2002)

The Australian Grayling (*Prototroctes maraena*), Cox's *Gudgeon (Gobiomorphus coxii*) and Eastern Freshwater Shrimp (*Australatya striolata*), all Victorian FFG Listed aquatic species, have also been found in the Genoa River System. Both river systems have high fish diversity (LCC 1989).

Habitat

Depending on the life stage of both species, aquatic habitat preferences can vary. Typically, adults inhabit freshwater while larvae and juveniles live in estuaries or possibly the ocean (Koehn and O'Connor 1990). Adult Gudgeon have also been known to live in estuaries (Raadik pers. comm.).

Habitat preferences of both the Freshwater Herring and the Empire Gudgeon, while in the estuary or the ocean are unknown. The Mallacoota Inlet provides a range of possible habitats for both species. Estuarine habitats found within it include seagrass, intertidal flats, salt marsh/salt flats, rock reefs and open water (Gippsland Coastal Board 2001). Estuaries provide important nursery grounds for fish (Beck *et al.*, 2001). A number of species, freshwater, marine and estuarine spawn or move into the estuary as eggs, fry or larvae where they grow to the sub-adult stage before moving into adult habitats (based on Beck *et al.*, 2001). Estuaries are known to have high primary and secondary productivity (Beck *et al.*, 2001) providing a good source of plant and animal food for the young fish.

As adults, the two species are likely to prefer the lower reaches of freshwater streams, although both are also known to move far upstream (Merrick and Schmida 1984, McDowall, 1996, McGlashan and Hughes, 2001, Allen *et al.* 2002). Both fish can be found in still water such as lakes or the backwaters of creeks, and flowing waters (McDowall, 1996, Allen *et al.* 2002).

The Freshwater Herring can tolerate moderately fast flowing waters but prefers clear or slightly turbid waters (McDowall, 1996). The species has been shown to be sensitive to management that possibly reduces the range of flow habitats available for its use. For example, reduction in abundance was associated with loss of flowing sections following the deepening of pools by sediment extraction in the upper Nepean River (Erskine and Green, 2000).

The Empire Gudgeon is commonly found amongst aquatic plants and fallen tree branches in flowing waters and uses rock 'caves' (Merrick and Schmida 1984, Allen et al. 2002). They may be tolerant of salinities as high as that of sea water, water

temperatures as high as 35ºC and slightly acidic to alkaline waters pH 5 to 9.1. Empire Gudgeon has been shown to be less abundant where there has been nutrient enrichment caused by the input of treated sewage effluent and urban run-off to the river or where the stream is surrounded by degraded riparian vegetation (Growns *et al.* 1998).

Life history and ecology

Freshwater Herring eggs probably hatch in an estuary or possibly the ocean (Koehn and O'Connor, 1990). More specific details on age, fecundity and where and how the species lays its eggs are not known. The fish will live in an estuary as larvae, fry and juveniles until approximately six months of age when they move into freshwater (Pidgeon, 1989).

Spawning is believed to occur during the colder months, July and August (Koehn and O'Connor, 1990). Several cues may be responsible for spawning at this time including temperature, salinity, turbidity, flow increases or decreases (Koehn and O'Connor, 1990). Several reasons have been suggested for estuaries being valuable pre-adult habitat at this time. A winter spawning may ensure that eggs are ready to hatch during a time when there is increased food supply as water temperatures increase. During this period estuaries may become flushed with freshwater from rivers resulting in reduced salinity levels. There may be a reduction in predation and/or competition for food in the estuary as marine fish move to remaining high salinity waters as happens in the Swan-Canning Estuary in Western Australia (Kanandjembo *et al.* 2001). Bird predation may also be minimised during that period. For example, the piscivorous predator, the Great Comerant, although with permanent populations inhabiting the coast, may become much more prevalent as ephemeral inland lakes dry up (Reside and Costin 2001).

From six months to up to at least 11 years of age it lives primarily in freshwater, although it may move into the estuary during the breeding season. Worms, water fleas, prawns and insects make up its diet (Merrick and Schmida 1984). It is also known to be a surface feeder at dusk (Pidgeon, 1989). The Freshwater Herring is a schooling fish. Schooling may be used by species to confuse predators, particularly when habitat is open and devoid of refuges in which to hide in comparison to the local population size of the species (Rangeley and Kramer, 1998). The Freshwater Herring is sensitive to disturbance, suffering "a very high mortality rate after even gentle handling during capture, such as angling with barb-less hooks" (Pigeon, 1989).

Empire Gudgeon eggs hatch during the warmer months, most likely in freshwater close to the estuary. Larvae move or are washed into the estuary. Juveniles live for up to about a year in the estuary before moving into freshwater during spring. Rainfall has been suggested as a cue for juveniles to move into freshwater (McGlashan and Hughes 2001).

Living amongst rock, woody debris and aquatic plants, the Empire Gudgeon are believed to be mid-column feeders with a diet consisting of small crustacea, predominantly water fleas, larvae of insects such as mosquitos, algae and detritus (McDowall, 1996). Water fleas also thrive in still or only slightly flowing water amongst aquatic plants (Williams, 1980).

While the breeding age has not been determined, it is known that breeding occurs from early spring through to autumn when adult Empire Gudgeon probably return close to the estuary. Males use bright colours and behavioural displays to attract females and fight over territory during this period (Auty, 1978). Rock caves or crevices, aquatic plants and woody debris are fought for in, probably, open water and used for protection during territorial disputes and acquisitions (Auty, 1978). While gaining the most prized territory did not guarantee enhanced breeding chances (Auty 1978), lack of territory could lead to loss of spawning colouration, effectively curtailing breeding possiblilities. Colouration can be regained if a new territory becomes available (Auty 1978).

Under artificial conditions, an estimated 40 000, 0.3 mm diameter eggs could be laid during approximately 20 spawning sessions by a female within one breeding season (Auty, 1978). Eggs are laid in rows that adhere to rocks, aquatic plants or sand where they are fertilised by sperm lines deposited by males. The male fish guards the eggs until they hatch 10-14 days later (Auty, 1978).

The Empire Gudgeon and the Freshwater Herring are possibly dispersive species, spreading into other river systems by travelling through the ocean and back into freshwater. Empire Gudgeons throughout their Queensland distribution show a marked similarity in genetic characteristics, in contrast to that likely of freshwater species, suggesting an intermixing of fish from different catchments (McGlashan and Hughes 2001). The Freshwater Herring has been described as possibly catadromous (Allen *et al.* 2002). While perhaps a small possibility, new species can develop from a dispersive species if a group of fish become separated from the rest of their population and are acted upon by different biological and physical processes (McDowall 2001). Any genetic changes

to a species make up are likely to occur over a long time period.

Conservation status

Freshwater Herring

Victorian conservation status: Data Deficient (NRE 2000)

The Freshwater Herring has been listed as threatened under the **Flora and Fauna Guarantee Act 1988**.

Empire Gudgeon

Victorian conservation status: Vulnerable (NRE 2000)

The Empire Gudgeon has been listed as threatened under the **Flora and Fauna Guarantee Act 1988**.

Threats

Mallacoota Inlet has been evaluated as a "near pristine" estuary in the National Land and Water Audit Ozestuaries database (Commonwealth of Australia 2001). It has been qualitatively judged to have relatively minimal human impacts in relation to its hydrology, tidal regime, floodplain and estuarine ecology and catchment vegetation. However, there are a number of potentially threatening processes that could still effect the species distribution and abundances and lead to a reduction of the "near pristine" value of the estuary. The Index of Stream Condition (Victoria, Department of Sustainability and Environment, 1999) indicates that reaches in the Genoa River system, although ranging from excellent to marginal, are typically of marginal condition. It should be noted that the calculations to determine total condition are based on estimated values for both water quality and aquatic life. Poor physical form and/or streamside zone condition for each reach has reduced the condition of the Genoa River system. More specifically, one or more of the following may have been compromised: streambed and bank condition; the presence and access to physical habitat; and/or; the quality and quantity of riparian vegetation. No recent information is available about the condition of the Little River system. Details on the individual threats to these fish species, including barriers, increases in sediment and negative changes to other water quality parameters - particularly nutrients, degradation of riparian vegetation and instream habitat and changes to streamflow are discussed below.

Barriers to Movement

Fragmentation and loss of habitat can occur when obstructions prevent movement of species to necessary parts of the river system to fulfil their life cycle. Obstructions can be physical barriers such as weirs, dams, barrages and culverts or can be caused by changes to water quality and/or flow levels (McGuckin and Bennett 1999). Both the Freshwater Herring and Empire Gudgeon appear to seek particular parts of the river system to reproduce. Larvae and juveniles live in estuaries prior to moving into freshwater where they typically spend their adult life. They are both known to travel upstream although triggers and reasons why are unknown.

Changes in instream and estuarine sediment levels

An increase in sediment may reduce or eliminate the reproductive success of the Empire Gudgeon due to abrasion, destruction or blanketing of its adhesive eggs (Boulton and Brock 1999). Territories may also become filled or covered by sediment, reducing the number of male fish involved in reproduction. The Freshwater Herring prefers clear to slightly turbid water.

Changes to instream and estuarine sediment patterns result from both historic and current management activities that have either impacted directly on the instream and floodplain environment or indirectly through soil and hydrological disturbance in the landscape.

Channel incision, channel widening, instream works for river regulation and extractive industries impact directly on sediment levels (Boulton and Brock 1999). Other possible impacts include dredging for boat passage (Burchmore 1992). For instance, sand and gravel extraction has been shown to have detrimental impacts on rivers (see, for example, Boulton and Brock 1999 and Brizga and Finlayson 2000). Covering of habitat and eggs, loss of habitat and restrictions to movement may occur if extraction leads to increases in sediment or changes to sediment movement in the reach, changes to the shape of bed and banks, and/or floodplain stripping and avulsions during flooding.

Agriculture, forestry, grazing, the extractive industries and urbanisation have generally indirect impacts on sediment levels (Boulton and Brock, 1999). Specific precursors of increased erosion from landscape activities include exposure of soil through vegetation clearing, loss of soil cohesion through loss of root binding, loss of soil fauna, soil compaction, changes to hydrologic patterns resulting in increased groundwater, soil water and surface run-off (Boulton and Brock 1999, Rees 2000).

Associated land management techniques such as fire management include activities which may also lead to soil disturbance and hence sedimentation. While fire itself can lead to increased

sedimentation (Hall 1994), activities such as wildfire preparedness and wildfire suppression may also increase the risk of sedimentation. Maintaining key roads and tracks, conducting fuel management by burning, constructing control lines and back-burning can expose the soil, increase loose soil particles, and increase run-off.

Associated infrastructure such as stormwater drainage systems and roads and tracks create further disturbance to soil and hydrology and also provide pathways for eroded soil to directly enter water bodies. For instance, roads and tracks and associated culverts and run-offs have been shown to be a primary sediment source, and provide pathways for eroded soil to enter rivers in forest (Croke *et al.* 1999). Increased sediment arises from compaction, caused by heavy machinery or livestock trampling, which has been shown to increase the proportion of dust on tracks and decrease water infiltration leading to increased run-off (Langford and O'Shaughnessy, 1980, Boulton and Brock, 1999).

Brookes *et al.* 2001 have indicated that most of these processes or activities have been implicated in increased sediment levels in the Genoa River System.

Soils of the Little River System and the Victorian portion of the Genoa River System are generally highly susceptible to water erosion and have a moderate susceptibility to compaction (Rees 2000). Brookes *et al.* 2001 reviewed sand erosion issues in the Genoa River System through the evaluation of previous research and examination of sand sources and sinks. They recommended "integrated management of the entire Genoa River catchment (i.e. river system), with the focus on minimising all sources of sand and maximising the effectiveness of all sand sinks". All actions recommended would be of benefit to the Empire Gudgeon, particularly:

- Stock exclusion from riparian zones
- Native vegetation regeneration of riparian zone coupled with weed management
- Annual assessments and reviews of proposed forestry activities in the upper river system.

Increases in nutrient levels

Empire Gudgeon abundance has been shown to be lower where there has been nutrient enrichment caused by the input of treated sewage effluent and urban run-off to a river (Growns *et al.* 1998). There are several ways in which nutrient enrichment can decrease fish abundance. Nutrients can alter plant distribution and abundance leading to changes in the fishes' habitat structure, habitat quality and food sources. It can promote the growth of toxic-producing algae (eg. blue green algae) and cyanobacteria. Habitat structure may change by encouraging increased numbers of large aquatic plants that may hinder fish passage (ANZECC and ARMCANZ, 2000). Habitat quality can be decreased by reducing the penetration of sunlight into the stream, by decreasing the amount of oxygen available or promoting algal growth on the bed of the stream (ANZECC and ARMCANZ, 2000). Changes in plant composition may also lead to changes in invertebrate type and availability, potentially reducing food supply of the fish. Death is a possibility following exposure to large amounts of some nutrients. Excessive amounts of nitrate, a common nutrient, can leave an animal vulnerable to disease or directly cause its death as has been shown to happen to the early life stages of prawns (ANZECC and ARMCANZ, 2000).

The sources of excessive nutrients found in a river system are not always clear. Boulton and Brock (1999) write that while sewage and fertiliser are generally considered to be the main sources of phosphorus, this is not always the case. A study of nutrient input sources to the Murrumbidgee River found that these two sources contributed less than 8% of the total nutrient load of the river. There appears to be no quantitative data available to elucidate nutrient sources or levels in the Mallacoota Inlet or its tributaries. Potential sources of nutrients are sewage effluent from houses and from recreational and commercial boats, agricultural establishments, waste from fish cleaning, sediment carried by urban stormwater and released during fire and fire management.

Sewerage treatment works and a sewerage pumping station were built in 1987 to service the township of Mallacoota (John Hutchinson, *pers. comm.*). The township is likely to have had its sewerage scheme operating since about 1988, although a few large properties on the outskirts remain on septic tanks. Secondarily treated water is used for purposes such as irrigated pasture and a eucalypt plantation. Sewerage treatment ponds are not located in the catchment of the Mallacoota Inlet. Sewerage overflow has been identified as a problem in public sewerage systems, particularly as the system ages (Hadden 1991). Sewerage overflow can result from a lack of capacity, pipe blockages and breaks, electrical or mechanical equipment failure, or stormwater leakages into the sewerage systems (Hadden 1991).

Currently, raw sewage from recreational and commercial boats is released into the water. Sewerage pump out sites can be provided for boats, as is being done for Gippsland Lakes. Fish cleaning can involve the release of nutrients into the system when unwanted parts of the fish are left or wash into the water. This may cause a problem when a large amount of waste is concentrated in a small area such as at jetties.

Fertiliser and erosion are generally considered to be the main sources of nutrients from agricultural production (Boulton and Brock, 1999). Reducing the amount of fertiliser reaching the river can be achieved by regulating fertiliser application and using less water-soluble fertiliser. (Boulton and Brock, 1999). Riparian vegetation consisting of dense ground cover can trap sediments and nutrients before they reach the stream (Boulton and Brock, 1999). Erosion rates are increased by soil disturbance through the clearing of vegetation and compaction by livestock and heavy machinery (Boulton and Brock, 1999). Careful attention should be placed on farming techniques that cause minimal disturbance to the soil including stocking rates and machinery use. Protecting and restoring riparian vegetation is an important strategy in reducing sediment and nutrients from reaching the stream.

Fire and fire management can increase nutrient availability (Hall 1994). Nutrients can be released from roads and tracks and conducting fuel management by either burning or other methods, such as slashing, constructing control lines, back-burning and bombing with phosphorus-containing fire retardant chemicals.

Loss of riparian vegetation

Empire Gudgeon abundance has been shown to be greater where banks had a good coverage of treed riparian vegetation compared to physically degraded sites. Riparian vegetation has been cleared along the lower reaches of the Genoa River catchment where agricultural practices are being undertaken. Woody debris and snags that originated from falling trees were also high in those areas with good riparian cover. Woody debris can provide protection and cover for Empire Gudgeon during the breeding season. There were no significant differences in the abundances of the Freshwater Herring when comparing the physically degraded bank to the vegetated bank (Growns *et al.* 1998). This does not mean that having a good coverage of riparian vegetation isn't important for Freshwater Herring but may indicate that there is one or more other significant factors that effect the fishes abundance.

Other water quality changes

Oil and petrochemical spills vary in their impact on fish depending on the type and amount spilt, the flow and sediment patterns of the receiving water, and characteristics of the instream biota (Lytle and Peckarsky, 2001). Some impacts that have been recorded are:

A 92% reduction in fish abundance following a spill of 26 500 l of diesel fuel into a small United States stream. Fish killed included Rainbow trout (*Oncorhyncus mykiss*), a species which has been stocked into Australian waters (Lytle and Peckarsky, 2001). Possible changes to, or loss of, fish food supply following a 90% drop in invertebrate density and 50% decrease in species richness for up to 5 km downstream of the spill site during the same diesel fuel spill as above. Invertebrate recovery took about a year except for immediately downstream of the site where recovery had still not occurred after fifteen months (Lytle and Peckarsky, 2001). Secondary pollution may also occur caused by decomposing oil-killed species (Law and Hellou, 1999).

Oil and petrochemical spills can occur during transportation, storage and use on both land and water. Accidents and deliberate releases can occur during inland transportation, industrial and agricultural activity and seepage from land-fill sites (Parks, Flora and Fauna Division 2001). In Victoria, 40% of reported oil spills occurred from known and unknown vessels, 25% occurred inland and 29% were of unknown origin (Marine Safety Victoria, 2002). Only 3 of these oil spills were reported in the Gippsland Region during the period July 2001 to February 2002 (Marine Board Victoria 2002).

Very little base information is available on fish kills resulting from spills. No conclusions could be reached on spills and their impact on the Freshwater Herring and Empire Gudgeon.

Changes to streamflow

Streamflow changes may result in decreases in native fish spawning success (Boulton and Brock 1999), changes to food supply and habitat, predation and increased competition for food and space, and loss of movement (Gordon *et al.*1992). While many of the effects of changes to streamflow levels and patterns on the Freshwater Herring and Empire Gudgeon do not appear to have been documented, the reduction in Freshwater Herring abundance following the loss of flowing sections in a river indicates the sensitivity of this species to streamflow changes (Erskine and Green, 2000). The Index of Stream Condition indicates that the hydrological condition of reaches within the Genoa River system, as measured by flow volume and seasonality, is presently considered high (Victoria, Department of Sustainability and Environment, 1999).

Exotic species, disease and parasites

Exotic species can compete for food and habitat, or prey on, native fish. They are also possible carriers of disease and parasites. Low abundance and limited distribution in the East Gippsland river systems make the Freshwater Herring and Empire Gudgeon vulnerable to exotic species or possible

pests and diseases they carry. While there appears to be no reported incidences directly effecting either of these fish, there are examples of the potential risk of the problem. For example, the Asian fish tapeworm (*Bothriocephalus acheilognathi*) has been detected in the native Western Carp Gudgeon (*Hypseleotris klunzingeri*), a member of the same family, Eleotridae, as the Empire Gudgeon. It has shown that it is capable of crossing over to different species, for example, from carp to Western Carp Gudgeon, and has been found in other eleotrid fish species elsewhere. It is believed that the tapeworm entered Australia, as a parasite on imported cyprinid fishes eg. carp, although possibly on Gambusia (*Gambusia holbrooki*) (Dove *et al.* 1997). The tapeworm can cause bleeding in the intestinal system and closure of the gut lumen and can lead to high death rates in young fish (Dove *et al.* 1997).

Exotic fish reach Victorian waters via accidental escape or deliberate release following importation or breeding for the aquarium trade or other recreational purposes (Dove 1998). While some don't survive there are those species that are "weedy". Dove (1998) characterises these fish as having a generalist nature, efficient users of resources, high fecundity, and tolerant of a wide variety of physico-chemical conditions.

Closing/Opening of Mallacoota Inlet mouth

Mallacoota Inlet is a wave-dominated estuary in which a barrier forms across the estuary entrance by wave deposited beach sand (Roy *et al.* 2001). River-discharge is generally able to keep the estuary open to the ocean, however, during low river discharge a build up of sand can cause the barrier to completely close (Roy *et al.* 2001). Entrance closure of Mallacoota Inlet appears to have been infrequent although may have increased over the last 15 years. Parks Victoria records indicate that it closed in 1988, 1995 and is now (2004) closed (Riekhelt, *pers. comm.*). Local recollections place the 1988 closure as only the 2nd occurrence in that century (Riekhelt, *pers. comm.*). An increase in barrier closures at this time may be part of the natural pattern of the Mallacoota Inlet estuary mouth. Roy *et al.* 2001 writes that smaller estuaries with entrances that were predominantly open for several decades could switch to predominantly closed during the following decades due to climatic fluctuations on decadal time scales prior to European settlement. Estuarine waters may become decreasingly saline with the closure of the mouth (Young *et al.* 1997). Unblocking of the mouth occurred naturally with increased discharge resulting in either high water levels in the estuary and/or storm waves that were able to breach the bar in 1998 but in 1995 it was mechanically opened. Sediment disturbance by mechanical methods may impact on the reproductive success of the fish. Physical structures placed to prevent closing may cause changes to the hydrology, salinity and fauna of the estuary (Roy *et al.* 2001). Ecological changes by the use of training walls at estuary mouths have not been documented (Roy *et al.* 2001).

Existing conservation measures

- The main trunk of the Genoa River System from the New South Wales border downstream to the Creek junction adjacent to the Coopracambra National Park and to 200 m to either side of each bank has been classified under the Heritage Rivers Act 1992 as a Heritage River Area. Construction of impoundments, artificial barriers or structures that impede aquatic fauna passage is not permitted in this Heritage River Area. Water diversions and timber harvesting are also prohibited.
- The Conservation Guideline for fish in the East Gippsland Forest Management Plan states that "a Linear Reserve zone should be placed around a site of extant population of Freshwater Herring". The linear reserve should cover an area of 1 km either side of the site and 100 m from each bank of the watercourse (Victoria. Department of Conservation and Natural Resources (1995).
- A tributary of the Genoa River has been classified as a natural catchment area under the Heritage Rivers Act 1992. Activities that are not permitted in this natural catchment area include: clearing of indigenous flora, timber harvesting, mining, the introduction of non-indigenous fauna and the use of powered water craft.
- The Croajingalong National Park, of which the Little River is wholly topographically contained within and which the Mallacoota Inlet is mostly surrounded by, is part of a UNESCO Biosphere Reserve.
- A range of physical barriers and their locations have been identified through the State Fishway program (McGuckin and Bennett 1999). This program identified a tidal barrage stream gauging station and one culvert or ford on the Genoa River as barriers. However, the identification of culverts and fords proved a problem because their locations were not always included on topographic maps. Many roads and tracks crisscross both river systems. Culverts and fords used on these roads and tracks need to be identified for their potential as fish barriers and be submitted for prioritisation for removal or reconstruction to lessen the risk of prevention of fish passage. A new publication "Why do fish need to cross the road? Fish Passage Requirements for Waterway

Crossings" could be used to assist agencies and authorities to start planning for management of likely problem culverts and crossings. More detailed guidelines will become available later this year (Tim O'Brien, *pers. comm.*)

- Guidelines and manuals to minimise erosion off roads and tracks and construction sites are available including a general guide that includes managing erosion off roads (EPA 1991); and detailed design guidelines such as Garvin *et al.* 1979. The East Gippsland Shire Council is developing a Code of Practice for Roadside Management which details minimum acceptable standards for works on land managed by the Shire Council (Kelly & Associates, 2002). While these publications are not specifically written for the fish of concern they provide a basis to reduce sediment reaching streams. Erosion is a natural process and continued exposure of the soil and alteration to the hydrological balance of an area will continue an area's susceptibility to erosion. Maintenance of the road drainage network is critical to preventing erosion and Garvin *et al.* 1979 recommends that "ineffective drainage should be noted at every opportunity, especially during wet weather, and corrected promptly".
- 10 km of electrified fencing was installed along the lower reaches of the Genoa River to prevent stock access to the River in 1990. Planting of indigenous trees and shrubs took place in Kikuyu pasture in 1991 to 1993 to start the process. Following this natural regeneration has been allowed to take place with management focussed on control of competition from stock, vermin and weeds and to planting where regeneration will be restricted or slow. The "Long stem planting" method has been used to restore riparian and instream vegetation of the Genoa River over the last few years to increase (Reg Morrison, Manager Operations, East Gippsland Catchment Management Authority, *pers. comm.*) This method allows plants to be dug in deeper initially so that they are more likely to survive high flow events. The planting of vegetation instream helps to increase habitat diversity.
- Large woody debris has been placed in the Genoa River to enhance instream habitat diversity (Reg Morrison, Manager Operations, East Gippsland Catchment Management Authority, *pers. comm.*).

Conservation objectives

Long term objective

That land and water management is conducted in a way such as to ensure that the Freshwater Herring and Empire Gudgeon distribution and abundance is maintained in as naturally occurring a pattern as possible by continually reducing or eliminating threats to the species or its habitat.

Objectives of this Action Statement

1. Integrate conservation of the Freshwater Herring and Empire Gudgeon into local and regional planning processes.
2. Identify barriers to fish passage and mitigate their impact.
3. Reduce risk of excess sedimentation, nutrients or pollutants entering Mallacoota Inlet or its tributaries.
4. Protect, enhance and restore riparian vegetation and instream habitat in all tributaries to Mallacoota Inlet.
5. Raise community awareness of the conservation of Empire Gudgeon and Freshwater Herring.
6. Improve knowledge of distribution, abundance, habitat, biology and threats.

Intended management actions

The intended management actions listed below are further elaborated in DSE's Actions for Biodiversity Conservation (ABC) system. Detailed information about the actions and locations, including priorities, is held in this system and will be provided annually to land managers and other authorities.

Objective 1. Integrate conservation of the Freshwater Herring and Empire Gudgeon into local and regional planning processes.

1. Provide information and advice to land managers and planning authorities regarding Freshwater Herring and Empire Gudgeon conservation requirements.

Target: all relevant land managers and planning authorities provided with advice

Responsibility: DSE Gippsland Region

2. Incorporate measures to protect Freshwater Herring and Empire Gudgeon in relevant planning documents, including the East Gippsland Forest Management Plan, Regional Fire Management Plan, Parks Victoria Park and Reserve Management Plans, along with relevant plans of the East Gippsland Shire Council, Gippsland Coastal Board, Gippsland Port Authority, East Gippsland Water Authority

Target: all relevant plans refer to Freshwater Herring and Empire Gudgeon

Responsibility: East Gippsland Catchment Management Authority, East Gippsland Shire Council, Parks Victoria, DSE Gippsland Region, East Gippsland Water Authority, Gippsland Coastal

Board, Gippsland Port Authority Priority: High Timelines: ongoing

3. Consider and act on, if necessary, the impact of mechanically opening the Mallacoota Inlet on the Empire Gudgeon and Freshwater Herring when developing the Coastal Action Plan for Estuaries

Target: Coastal Action Plan for Estuaries addresses Freshwater Herring and Empire Gudgeon

Responsibility: Gippsland Coastal Board

Objective 2. Identify barriers to fish passage and mitigate their impact.

4. Enhance or maintain fish passage in the Genoa and Little River systems by following fish passage guidelines (Fish Passage Requirements for Waterway Crossings Engineering Guidelines – CD-ROM) where new stream crossings are required or where existing crossings need to be replaced. In these cases, provide details (type of crossing and dimensions) to the Waterways Manager (or equivalent) of the East Gippsland Catchment Management Authority.

Target: highest priority barriers identified;modifications made to highest priority barriers to enhance fish passage

Responsibility: East Gippsland Catchment Management Authority, East Gippsland Shire Council, Parks Victoria, Department of Sustainability and Environment (Water Sector Group, Gippsland Region)

Objective 3. Reduce risk of excess sedimentation, nutrients or pollutants entering Mallacoota Inlet or its tributaries.

5. Ensure no excess nutrients enter the Mallacoota Inlet and associated rivers systems by continuing good maintenance program of sewerage system to ensure minimisation of sewerage blockages as system ages.

Target: water quality monitoring program established; no significant sewage discharges detected

Responsibility: East Gippsland Water

6. Encourage reduction of fish cleaning waste and hence nutrient entering waters during peak usage time through activities such as provision of bins.

Target: bins provided and maintained; demonstrable reduction in fish cleaning waste entering waters

Responsibility: East Gippsland Shire Council

7. Encourage reduction of fish cleaning waste entering waters by placing sign at main fish cleaning site at Mallacoota Inlet advising community not to throw waste back into waters at fish cleaning sites, if physically feasible. Advise people fishing that throwing fish cleaning waste back into waters may lead to nutrient problems that may impact on the survival of the Empire Gudgeon.

Target: signs erected and maintained; advice provided to anglers

Responsibility: East Gippsland Shire Council (signage), Department of Primary Industries (Fisheries Victoria).(advice to anglers)

8. Continue to work towards reducing nutrient input into estuary, for example, support extension of the sewage pump-out program to Mallacoota.

Target: feasibility of extending sewage pump-out to Mallacoota assessed and undertaken if feasible

Responsibility: Gippsland Coastal Board

9. Identify the location of nutrient sources to the aquatic environment and include in storm-flow management planning. Works should be prioritised to reduce nutrient enrichment of the Empire Gudgeons habitat. The East Gippsland Shire Council is currently developing a stormwater management plan and the construction of a sediment trap at the stormwater outlet to Mallacoota Inlet is being considered. Threatened fish species requirements should be taken into account during prioritisation of construction works.

Target: key nutrient sources identified and managed; demonstrable decline in nutrient input

Responsibility: East Gippsland Shire Council

10. Avoid, wherever possible, dredging in Mallacoota Inlet around jetties during the breeding seasons of the two threatened fish.

Target: no dredging during breeding season

Responsibility: Gippsland Port Authority

11. Ensure drainage from carparks minimises sediment input into river systems, particularly at Gypsy Point.

Target: sediment input risks assessed and mitigation measures applied to high risk sites

Responsibility: DSE Gippsland Region, East Gippsland Shire Council, Parks Victoria

12. Sand extraction from the Genoa River System should be avoided and must be excluded from the reproductive habitat of the Empire Gudgeon and any feasibility studies which are carried out must take into consideration and act upon the possible impacts on the Empire Gudgeon and Freshwater Herring

Target: no sand extraction from Genoe River system

Responsibility: East Gippsland Catchment Management Authority

Objective 4. Protect, enhance and restore riparian vegetation and instream habitat in all tributaries to Mallacoota Inlet.

13. Continue existing riparian vegetation programs in Genoa River System, including planning for succession using indigenous species.

Target: 10 km of river frontage restored using indigenous species

Responsibility: East Gippsland Catchment Management Authority

14. Continue increasing existing instream habitat diversity where habitat diversity has decreased since European settlement to maximise reproductive chances of the Empire Gudgeon.

Target: key sites for works identified; works undertaken

Responsibility: East Gippsland CMA

15. Continue support for complementary river restoration programs in the Genoa and Wallagaraugh catchments in NSW.

Target: cross border contact maintained

Responsibility: East Gippsland Catchment Management Authority

Objective 5. Raise community awareness of the conservation of Empire Gudgeon and Freshwater Herring.

16. Use existing community education programs to raise awareness of threatened fish in the area, including the Empire Gudgeon and Freshwater Herring, and of the potential negative impacts of exotic fish release, oil spills, barriers, excess nutrients, fish cleaning and other potentially threatening processes into the waters of the Genoa and Little River systems.

Target: community education material developed and incorporated into existing programs

Responsibility: East Gippsland Catchment Management Authority, East Gippsland Shire Council, Department of Primary Industries(Fisheries Victoria), DSE (Public Land Policy Division)

17. Ensure that recreational fishers fishing locally are aware that Empire Gudgeon and Freshwater Herring are protected species and must not be taken or kept.

Target: no anglers encountered by Fisheries Enforcement staff taking or possessing Empire Gudgeon and Freshwater Herring

Responsibility: Department of Primary Industries (Fisheries Victoria)

Objective 6. Improve knowledge of distribution, abundance, habitat, biology and threats.

18. Encourage research to be undertaken regarding the abundance, distribution, habitat and habitat requirements, life cycle requirements and/or threatening processes and genetics, particularly of Freshwater Herring in southern populations in NSW.

Target: key research questions identified and documented; research completed, subject to resource constraints

Responsibility: East Gippsland Catchment Management Authority, DSE (Biodiversity & Natural Resources Division)

19. Periodically survey to establish abundance and distribution of the Empire Gudgeon. No monitoring should be conducted for the Freshwater Herring unless survey methods are shown to be harmless to this fish.

Target: surveys designed and implemented

Responsibility: DSE

20. Implement protocols in response to all significant fish kills, including prompt collections of samples, appropriate pathology testing and investigation of causes.

Target: all significant kish kills promptly investigated

Responsibility: Gippsland Port Authority, East Gippsland Catchment Management Authority, DPI (Catchment and Agricultural Services, East Gippsland), EPA, DSE/DPI (Gippsland Region), East Gippsland Water, Museum Victoria

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