

Action statement No.259

Flora and Fauna Guarantee Act 1988

Australian Whitebait *Lovettia sealii*



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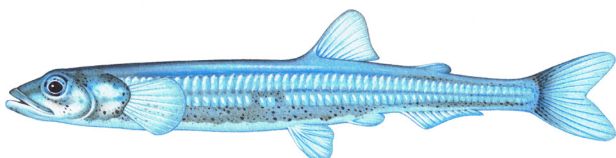
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Australian Whitebait *Lovettia sealii*

Description

First described in 1883, the Australian Whitebait (*Lovettia sealii*) is a small (maximum 77 mm caudal fork length (CFL); commonly to 65 mm CFL), slender and moderately laterally compressed, scaleless fusiiform fish with a long and slender head and snout (McCulloch 1915, McDowall 1996, Raadik 2008). It has a large silvery eye which is positioned high in the head, and a lower jaw which is conspicuous and protruding. The origin of the dorsal fin is above or just behind the pelvic fin origin and the dorsal fin is high. The caudal fin is forked with short, but distinct, peduncle flanges, and the anal fin is longer based than the dorsal fin, originating well posterior to the end of the dorsal fin base. Pectoral fins are long and narrow. Other distinguishing characteristics include a large, distinctive swim bladder located below the spine just forward of the mid-length of the fish, and an adipose fin located above the anal fin. Juveniles and marine adults are translucent, usually with the lateral line not distinguished by pigment. Fins are usually clear except for small black spots on the caudal fin, and adults have a silvery midlateral stripe. Dark pigmentation increases on adults in estuaries to almost completely black following spawning, with males typically darker than females at the same stage (Blackburn 1950); the underside of gravid females is yellowish (Raadik 2008).

Sexual dimorphism in mature adults is pronounced with obvious differences in external morphology. Males are distinguished from females by the presence of an anteriorly positioned urogenital papilla and anus located between the pectoral fins, and by enlarged, expanded opercular membranes



Australian Whitebait (DELWP)

which become covered in small papillae or tubercles. Females have larger pectoral and pelvic fins, and the urogenital papillae, positioned just anterior to the origin of the anal fin, is everted, large and spoon-shaped (Blackburn 1950, McDowall 1996, Raadik 2008).

This monotypic genus is endemic to south-eastern Australia. Until recently Australian Whitebait was placed in the family Aplochitonidae, along with a number of species endemic to the Patagonia region of South America (McDowall 1971). A recent genetic review, however, revealed a close relationship between the galaxiid fishes and the Aplochitonidae (Waters *et al.* 2000). As a result, Australian Whitebait is now considered part of the family Galaxiidae, though in a separate subfamily, the Aplochitoninae (McDowall 2006, Raadik 2008).

The presence of an adipose fin, forward position of the dorsal fin, and strong sexual dimorphism, separate Australian Whitebait from other galaxiid fishes in Australia (Raadik 2008). In addition, the lack of scales separates it from the closely related and morphologically similar Australian Smelt (*Retropinna semoni*) of the family Retropinnidae.

Distribution

This species was originally named the Tasmanian Whitebait due to it being historically only known from coastal regions in the north, west and south of Tasmania (Johnston 1883, McCulloch 1915, Lord and Scott 1924, Blackburn 1950, Fulton 1990). The discovery of a population in a coastal tributary on mainland Australia in 1993 led to the species being renamed the Australian Whitebait (Raadik 2008). In Victoria the species has been collected in the Tarwin



Distribution in Victoria (DELWP, 2015)

River from downstream of the bridge on the Tarwin Lower Road to Anderson Inlet (Raadik 2008, Schmidt *et al.* 2014). The total extent of range of Australian Whitebait in the Tarwin River has, however, not been fully investigated. The presence of the species in Anderson Inlet itself was reconfirmed in 2007 and 2014, indicating long-term persistence of the population. Despite intensive sampling of fish communities in estuaries and inlets across Victoria's coastal catchments, Anderson Inlet/Tarwin River remains the only known locality for the species in Victoria and on mainland Australia (Raadik 2008, Raadik, T., unpub. data, Koster, W. unpub. data).

No information is available on the historical distribution of this species on mainland Australia, prior to 1993.

Habitat

The habitat occupied by Australian Whitebait is poorly known, yet is suggested to be highly variable. Anecdotal sightings of Australian Whitebait schools several kilometres out to sea suggests adults principally inhabit shallow coastal waters, excluding times of spawning (Blackburn 1950). In Tasmania, the species has, nevertheless, been captured in estuaries (at salinities of < 0.1 – 2.1 ppt) from early August to December, and on main-land Australia, in Anderson Inlet/Tarwin River estuary, from April to September (Blackburn 1950, Fulton and Pavuk 1989, Schmidt *et al.* 2014, Raadik, T., unpub. Data, Koster, W., unpub. data). As residence in freshwater reaches of rivers (salinity < 0.01 ppt) does not appear to occur during the lifecycle of the species, Australian Whitebait appears to be unique among the Galaxiidae (Schmidt *et al.* 2014).

Life history and ecology

In Tasmania, mature adult Australian Whitebait enter estuaries and migrate upstream to just below the upper tidal limit, where spawning occurs over successive days from August to December (Blackburn 1950, Fulton and Pavuk 1988). Following spawning at approximately one year of age, nearly all individuals die, with less than 1% living to two years old and spawning for a second time (Blackburn 1950). Adults do not die immediately, but gradually loose condition and deteriorate (Fulton and Pavuk 1988). Schools of spent Australian Whitebait have been recorded upstream of estuaries in Tasmania, suggesting adults that survive the first spawning may remain within river systems (Blackburn 1950). Recent otolith microchemistry analysis suggests that Australian Whitebait are a semi-anadromous, or an estuarine dependant marine species, as residence in

pure freshwater does not appear to occur during the lifecycle (Schmidt *et al.* 2014).

The sex ratio of populations is variable, however, populations are most commonly dominated by males (Blackburn 1950). Fecundity of mature females is positively correlated with fish length, ranging from 128 – 206 oocytes (maximum 350) for fish 40 – 54 mm in length (Blackburn 1950, Fulton and Pavuk 1988). Unshed mature oocytes are approximately 1.0 mm in diameter (Blackburn 1950), while extruded eggs are adhesive and generally found attached to submerged substrates, such as logs, branches, sticks, stones and other vegetation-free surfaces below low water level, in areas with strong current flow and aeration (Blackburn 1950, Fulton and Pavuk 1988). The site of spawning and egg deposition in estuaries is likely to be determined to some extent by river discharge and the effect of flow on water salinity. It is unclear if fertilisation occurs before or after deposition (Blackburn 1950). Eggs hatch in about 14 – 23 days (Blackburn 1950, Fulton and Pavuk 1988), however, hatching time can be delayed by low temperatures and possibly low salinity (Fulton and Pavuk 1988).

Newly hatched larvae are approximately 6 mm in length, have a yolk sac, mouth, a median fin fold which is continuous and lacks fin rays, rudimentary pectoral fins, a caudal fin which is diphycceral, pigmented eyes, and a narrow band of melanophores in the mid-ventral line between the head and anus (Blackburn 1950). Slightly older larvae sampled drifting in the water column in late October were 7 mm long, lacked a yolk sac, possessed developing caudal and pectoral fin rays, and melanophores along the mid-lateral line were more developed (Blackburn 1950).

Larvae wash downstream to more saline areas where development and growth is completed (Blackburn 1950, Raadik 2008). Whether all larvae enter the open ocean, or grow and develop close to shore or in marine inlets, has not been verified. At least a portion of the larvae are, however, suggested to remain within estuaries and inlets (Fulton and Pavuk 1988, Schmidt *et al.* 2014). Natal homing (the return of fish to the river in which they hatched) although unknown (McDowall 2003, IFS 2006), is strongly suggested, with the only mainland population appearing to be confined to Anderson Inlet/Tarwin River. This limited distribution may, however, be due to the entire life cycle of individuals in the Anderson Inlet/Tarwin River population being confined within the system.

Diet of the Australian Whitebait is poorly known; the little information which exists has been gathered

from the examination of upstream migrating mature or spent fish. The stomachs of these fish contained zooplankton, amphipods, insects (including nymphs, larvae and pupae), cannibalised eggs and fry (Blackburn 1950, IFS 2006). Predators of Australian Whitebait are also poorly known, with existing knowledge based on incidental observations: Barracouta (*Thyrsites atun*), Rock Cod (*Physiculus barbatus*), Australian Salmon (*Arripis* spp.), School Shark (*Notogaleus rhinophanes*), Yellow-eye Mullet (*Aldrichetta forsteri*), Eels (*Anguilla* spp.), the alien Brown Trout (*Salmo trutta*) and birds (Blackburn 1950). The species likely forms a component of the diet of many other fish species found in inlets and estuaries, in particular the native piscivore Estuary Perch (*Macquarie colonorum*) in Anderson Inlet/Tarwin River.

Australian Whitebait have also been found to be infected with internal trematode and nematode parasites, subdermal trematode cysts, and the immature stage of a parasitic amphipod on pelvic and anal fins (Crowcroft 1947).

Conservation status

National conservation status

Australian Whitebait is not listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Victorian conservation status

Australian Whitebait has been listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act).

Australian Whitebait is considered Critically Endangered in Victoria according to the Department of Environment, Land, Water and Planning (DELWP)'s *Advisory List of Threatened Vertebrate Fauna in Victoria – 2013* (DSE 2013).

Threats

Australian Whitebait has suffered a major decline in abundance in Tasmania, due to over-

harvesting of mature fish which are yet to spawn (Blackburn 1950, Fulton and Pavuk 1988, IFS 2006). In Tasmania, the species formed part of the commercial whitebait fishery from 1941, catches from which peaked in 1946 (672,000 lb.; Blackburn 1950). Despite the viability of the commercial fishing venture questioned as early as 1949 (due to declines in catch), the fishery was not closed until 1974 in response to collapse of stock (Blackburn 1950, Fulton 2000, Raadik 2008). The fishery was reopened in 1990 for recreational purposes only under limited licences and seasonal operation (Fulton 2000, IFS 2006). No commercial or recreational fishing for Australian Whitebait has occurred within Victoria.

Despite the historical abundance of the species in Tasmania, and its commercial and recreational importance, only one major study of aspects of the species' biology and ecology has been undertaken (Blackburn 1950). Similarly, little is known of the mainland population in Victoria.

Although only limited knowledge exists of the species, there are a range of threats likely to impact it including predation of all life history stages by alien species, instream barriers in tidal reaches of coastal streams, deteriorating water quality and waterborne pollution, altered flow regimes into estuaries, altered hydrology within estuaries/inlets, reduction or removal of spawning/egg deposition sites and spawning substrates, alteration to larval/juvenile and adult habitat and food sources.

Aspects of the biology of the species which make it particularly susceptible to threats are its short lifecycle, low fecundity, and requirement to migrate upstream into lower tidal reaches of coastal streams to complete its lifecycle. Thus, the presence of a single, apparently restricted Victorian population, genetically isolated from the Tasmanian populations, dramatically increases the risk of extinction of the mainland population.

Details of major threats to Australian Whitebait are outlined in the following table.

Standard threat	Source of threat	Explanation
Genetic decline Recruitment	Genetic decline – inbreeding depression	As the Anderson Inlet/Tarwin River population of Australian Whitebait is genetically isolated from the populations in Tasmania, it is at risk of genetic decline due to loss of evolutionary fitness through loss of diversity and inbreeding depression, particularly if there is a major decline in the abundance of individuals due to a lack of recruitment.

Limited biological knowledge	Lack of knowledge	Inadequate knowledge of key aspects of the biology and ecology of Australian Whitebait is a major limiting factor for conservation management. Little is known of the life history before or following spawning. Lack of information for the mainland population includes knowledge of the current status of populations, extent of spawning period, spawning/egg deposition sites, spawning substrates, fate and movement of post-spawning adults, egg incubation time, conditions required for hatching and larval development, larval and juvenile development and habitat, habitat use of all life stages within and outside of Anderson Inlet, aspects of diet and physico-chemical tolerances. There is also a lack of knowledge of the significance of negative interactions (predation/competition) with alien species.
Surface water – quantity/ regime	Waterways – instream barriers Water – level/ flow changes	Instream barriers located in the lower tidal reaches of coastal streams can prevent the upstream migration of mature fish ready to spawn, preventing access to spawning sites, constraining the movement of deteriorating post-spawning adults which may lead to fewer individuals surviving to spawn in their second year, or stranding individuals during low flows leading to mortality. Low flow events can be exacerbated during dry times by over-extraction of water in the mid to upper catchment.
Taking by humans	Recreational/ commercial fishing Collection/ harvesting of target species	Exploitation of mature adult fish in Tasmania has been shown to cause major decline in population abundance due to the low number of eggs and single age class structure in this species. This is a particularly high risk in a small population which cannot be supplemented by recruitment of individuals from adjacent populations. Harvesting of glass eel resources in the upper estuarine reaches of coastal Victorian rivers can impact on mature fish during spawning as they can be a major component of bycatch (Gooley <i>et al.</i> 1999).
Carnivory	Introduction of species to areas outside their range	The alien piscivore species, Brown Trout, is known to prey on migrating Australian Whitebait. Other alien species, such as Eastern Gambusia (<i>Gambusia holbrooki</i>) may also prey on larvae or juveniles. A high level of predation on this annual species, additional to levels of natural predation by native species, can reduce abundances of individuals of all life stages. This is a particularly high risk in a small population which cannot be supplemented by recruitment of individuals from adjacent populations. Trout have caused the decline of a number of native species, particularly within the Galaxiidae (McDowall 2006) of which Australian Whitebait is a member.
Surface water quality Pollution/toxins	Agricultural chemicals/ effluent Chemical - oil spills Water-nutrients and chemicals	Water pollution from chemicals is likely to be a threat to all life history stages of Australian Whitebait, which are present within the tidal reaches of rivers. Chemicals, such as pesticides and herbicides, can be derived from poor application or land management practices in the mid to upper catchment.

Competition	Introduction of species to areas outside their range	Alien species which compete for resources or display aggressive behaviour have potential to reduce abundances of individuals of Australian Whitebait of all life stages. As an example, Eastern Gambusia is known to be aggressive toward native species, to compete for food resources and habitat, and is implicated in the decline of more than 30 fish species worldwide (Allan <i>et al.</i> 2003, Lintermans 2007, Macdonald and Tonkin 2008). This alien species is present in the Tarwin River, and, being tolerant of high water salinity levels, may be negatively impacting on Australian Whitebait in the lower Tarwin River and parts of Anderson Inlet.
Habitat damage or loss Loss of important habitat features Human disturbance	Waterways – sedimentation or siltation Water – turbidity Soil erosion	Deteriorating water quality through increased sedimentation/siltation may be a major threat to the health of Australian Whitebait populations. Siltation can cause increased water turbidity and changes to water chemistry such as increased temperature and lower dissolved oxygen levels. Poor water quality may lead to fish mortality, and the smothering of spawning substrates or eggs, leading to reduced hatching and larval survival. Sedimentation can be derived from poor land management practices in the upstream catchment, or by stock trampling or excavation of the river banks/riparian zones in coastal reaches.
Soil disturbance (physical)	Construction – marinas, breakwaters, piers, other port constructions Land use changes – residential/commercial development Dredging Coasts - impairment of tidal movements	The estuarine spawning sites and egg deposition substrates in the upper tidal portion of rivers, including key larval and juvenile habitats within inlets, can be damaged, reduced or eliminated by development which physically alters habitat, flow and tidal regimes and alters or eliminates natural spawning cues. This is a particularly high risk in a small isolated population which cannot be supplemented by recruitment of individuals from adjacent populations.
	Waterways – removal of wood debris/snags	Eggs are laid onto hard, vegetation-free submerged substances such as timber debris (logs, branches, sticks). Therefore, the removal of timber debris from the lower tidal reaches of waterways may impact on the success of spawning by reducing the amount of spawning substrate available or, if undertaken during the spawning season, lead to egg mortality.

Important populations

Catchment	Location name	Land manager	Bioregion
WEST GIPPSLAND	Anderson Inlet/lower Tarwin River	DELWP	Gippsland Plain

Past management actions

Action	Result explanation
Undertake periodic surveillance monitoring of populations	Species confirmed as still present and undertaking spawning migration in Andersons Inlet/Tarwin River in August 2007 and September 2014 (Raadik, T. unpub. data, Koster, W. unpub. data).
Conduct survey to locate additional populations	No targeted sampling undertaken, but no additional populations located in estuarine sampling conducted in coastal Victoria from 2002–2010. The majority of these surveys were, however, conducted outside of the spawning period for Australian Whitebait.
Genetic assessment	Recent investigations by Schmidt <i>et al.</i> (2013), indicates three well differentiated genetic lineages, with the Tarwin River population (and only mainland population) separate from two lineages in Tasmania.
Develop Protocol for the Translocation of Fish in Victorian Inland Public Waters	All aquatic organisms that are stocked in Victorian inland waters must comply with the <i>Protocol for the Translocation of Fish in Victorian Inland Public Waters</i> . The Protocol specifically considers potential impacts to native species when stocking of non-native species is being considered. For example, 1.3. Waters (or a section of a waterway if barriers exist to prevent movement of fish) will not be stocked when any one of the following applies: Where there is reasonable evidence the released fish species may constitute an unacceptable risk to a threatened species or community (e.g. listed under FFG Act, EPBC Act).

Conservation objectives

Long term objective

To ensure that the Australian Whitebait can survive, flourish and retain its potential for evolutionary development in the wild.

Objectives of this Action Statement

- To increase populations of the Australian Whitebait
- To secure populations or habitat from potentially incompatible land use or catastrophic loss

Intended management actions

The actions in this action statement have been developed taking into consideration relevant social and economic matters, as required under the FFG Act.

These actions are designed to support the conservation, management or control of flora and fauna and the management of potentially threatening processes, which will assist in mitigating any impact of climate change on Australian Whitebait, and will have no impact on greenhouse gas emissions.

The intended management actions listed below are further elaborated in DELWP'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.

Standard objective	Objective explanation	
To increase knowledge of the Australian Whitebait	To increase knowledge of biology, ecology and management requirements to better achieve conservation goals.	
Standard action	Details	Responsible agents
Conduct survey to locate additional populations	Conduct targeted surveys for Australian Whitebait in inlets/estuaries within and nearby to Anderson Inlet during the spawning period (August to October).	DELWP
Acquire baseline population data	Collect population data over a number of years on length/weight of juveniles and adults.	DELWP
Undertake genetic research	Undertake an assessment of genetic diversity for all populations to determine genetic 'health' or evolutionary fitness of Victorian populations (e.g. genetic diversity, inbreeding depression, outbreeding depression, connectivity), and to inform knowledge of localised connectivity between populations.	DELWP
Undertake periodic surveillance monitoring of populations	Monitor populations annually to assess trends in distribution and abundance. This information should be entered into appropriate information systems (i.e. Victorian Biodiversity Atlas) to ensure that it can be used by the Fish Translocation expert panel in its consideration of stocking applications.	DELWP
Undertake research to determine habitat	Determine specific habitats (freshwater/estuarine/marine embayment/open ocean) occupied by larvae, juveniles and adults, including period of occupancy, to identify areas which need to be protected from impacts to support the entire life-cycle.	DELWP
Conduct priority research projects as specified	Undertake research to gather key information important for the effective management of populations of Australian Whitebait (e.g. key spawning areas/habitat/requirements; spawning period; key egg deposition sites, etc.).	DELWP
Develop detailed population monitoring protocols	Provide a detailed survey standard for the detection of Australian Whitebait adults and recruitment of juveniles, which addresses the issue of poor detectability and provides an acceptable level of confidence for zero catches in embayments/inlets and tidal reaches of rivers/streams.	DELWP

Ensure records of species, communities and locations are documented on relevant databases	Ensure that DELWP information systems contain up to date information, including reporting all species records and progress on actions.	DELWP
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Standard objective		Objective explanation
To secure populations or habitat from potentially incompatible land use or catastrophic loss		Secure populations or habitat of Australian Whitebait from potentially incompatible land use or catastrophic loss to improve conservation outcomes.
Standard action	Details	Responsible agents
Assess threats	For each Victorian population, undertake an assessment of key threats to larvae, juveniles and adults, ranking threats according to degree of impact (probability of extinction) identifying likely sources of threats, and potential mitigation actions.	DELWP, West Gippsland CMA
Construct/maintain information boards	Create interpretive signage to delineate the area of spawning and egg deposition in the lower reaches of rivers (including the period of spawning / egg incubation), and to describe threats and mitigation actions used to enhance protection of these areas.	DELWP, West Gippsland CMA
Incorporate actions to protect item into planning processes	Provide key biological/ecological information important to avoid or mitigate threats to known populations (for incorporation into appropriate planning processes).	DELWP, West Gippsland CMA
Incorporate actions to protect and/or manage item into Regional Catchment Investment Plan/Regional Catchment Strategy	Provide key biological/ecological information important to avoid or mitigate threats to protect known populations into Regional Catchment Strategy, and incorporate key habitat protection actions into RCIP process.	West Gippsland CMA
Develop and amend planning scheme overlays and schedules	Provide key biological/ecological information, important to avoid or mitigate threats to protect known populations, to local government to use in planning scheme overlays and schedules.	DELWP
Develop, provide input to or implement park, reserve or land management plan	Provide key biological/ecological information, important to avoid or mitigate threats to protect known populations, into appropriate land management plans.	DELWP, West Gippsland CMA
Manage the impact of commercial fishing	Consider measures to minimise bycatch of Australian Whitebait as part of commercial glass eel collection where the collection could have a significant impact on Australian Whitebait populations.	Department of Economic Development, Jobs, Transport and Resources

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