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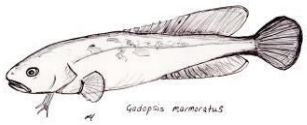

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Long Swamp Fish and Frog Baseline Survey 2012

A report to the Glenelg Hopkins CMA

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EXECUTIVE SUMMARY

Long Swamp is a large coastal wetland system that stretches behind the dunes of Discovery Bay from the Glenelg River estuary at Nelson (Victoria) for approximately 15 km to the south-east, through to Lake Mombeong. Although it is nationally recognised as a significant wetland and situated almost entirely within Discovery Bay Coastal Park, it has not been subjected to the same level of biological investigation as many other wetlands of equivalent conservation status. This report and the field work it summarises, in part, begins to address this limitation.

To summarise, this baseline fish and frog survey has identified that, in spite of a long-term drying trend and terrestrialisation of vegetation communities across Long Swamp, significant aquatic fauna communities continue to persist in a diversity of wetland habitats. The survey resulted in the detection of 12 native species of fish, from a range of functional groups, and five species of frog, including the nationally threatened growling grass frog. It is only the sixth record of this species from the Discovery Bay coastal landform, and just the second record from within the Long Swamp complex itself. Lake Mombeong is also a significant permanent freshwater habitat, and was found to support the greatest diversity of species during the fish survey. The results from this site, and the outlets at Noble Rocks and Eel Creek, indicate a degree of effective seasonal connectivity with the ocean.

Based on present conditions and trends, broader availability of aquatic habitat for nationally threatened fish and frog species would appear somewhat limited (in area) for a wetland system as large as Long Swamp, with the exception of the increase in aquatic habitat in the vicinity of White Sands, where the potential response of habitat to a reversal of the drying trend can be observed. The natural closure of an artificial cutting to the sea at White Sands (during the last drought, in approximately 2005) has now resulted in:

- the seasonal increase of water levels in the immediate vicinity of the former cutting;
- a shift in vegetation communities in response, a process that is continuing; and,
- the presence of what (during this survey) appeared to be a thriving assemblage of obligate freshwater fish species at the site, including two that are nationally threatened (Yarra Pygmy Perch and Dwarf Galaxias).

On the basis of these findings, future management objectives for Long Swamp might include:

- the enhancement of conditions for species dependent upon semi-permanent and permanent freshwater aquatic habitat;
- the maintenance of some form of oceanic connectivity for the system to conserve resident fish species diversity; and,
- building upon the results of this survey to increase the understanding of wetland values in response to any future environmental change.

1. Introduction

Long Swamp is a diverse freshwater ecosystem in south west Victoria and includes nationally important wetlands (Long Swamp and the Glenelg River estuary: ANCA 1996; GHCMA 2006), valuable recreation lakes (Lake Mombeong) and a range of ephemeral habitat. There is renewed interest in the hydrological management of this dynamic ecosystem, and an updated cataloguing of ecological assets (including fish and frog species) will better inform discussions regarding future management. The continued closure of the artificial outlet at White Sands since approximately 2005 (during the last drought) provides a new and somewhat unique opportunity to compare the aquatic fauna at this site (where wetland water levels are undergoing a recovery) and Nobles Rocks, where water from Long Swamp still freely drains to the ocean.

Aquasave Consultants - Nature Glenelg Trust were engaged to conduct a baseline aquatic fauna survey of Long Swamp to provide information that might inform a future review of management options. Specifically, the baseline survey aimed to collect the following key data to identify ecological assets in the Long Swamp -

(1) Native Fish:

a. **Species composition** - to assess presence of both native and introduced fish species and decapod crustaceans;
b. **Relative abundance** - to ascertain population health and provide data for comparison of trends;
c. **Length data** - to gain insight into demographic processes such as recruitment and survivorship; and,
d. **Movement** - to test for colonisation and successful passage between the wetland and the ocean.

(2) Frogs:

a. **Species composition –** to assess presence of frogs at key aquatic habitat sites.

2. Site Locations and Sampling Methods

2.1 Native Fish

A total of twelve research sites were sampled for fish in Long Swamp during August 2012 in accordance with relevant permits, including Victorian DPI WSI Animal Ethics Committee Permit 21.12, Victorian Fisheries (Fisheries Act 1995) Permit RP1097 and National Parks Victorian (National Parks Act 1975) Permit 10006425 (Figure 1 and Table 1 and see accompanying excel spreadsheet).

Sites were selected to provide good spatial representation across Long Swamp, with a focus on

areas of permanent water and key movement areas (e.g. outlets to the ocean). Sampling details for each site appear in Table 2, and included a combination of gear types as follows:

- Large fyke net: single 6m wing, D shaped entrance (0.7m wide x 0.7m high), 3 compartments and 6mm half mesh;
- Small fyke net: single 3m wing, D entrance, 2 compartments and 4mm stretch mesh;
- Double wing (directional) fyke net: double 3.5m wings, D entrance, and three compartments and 4mm stretch mesh;Bait trap: rectangular 0.5m long x 0.25m square, 60mm entrance and 1mm mesh; and,
- Dip net: 0.4 square monorail frame with 4mm stretch mesh.

Fyke nets were set with buoys (to provide air pocket for air breathing animals) and left overnight. Bait traps were baited with dried cat food pellets.

Table 2.1 Sampling site details and methods of fish survey of Long Swamp.

Site Code	Date	Waterway	Location	Easting	Northing
SW12-09	04-Sep-12	Long Swamp	White Sands (eastern side)	506968	5783893
SW12-10	04-Sep-12	Long Swamp	White Sands (old outlet)	506879	5783916
SW12-11	04-Sep-12	Long Swamp	White Sands (middle)	507008	5784035
SW12-13	05-Sep-12	Long Swamp	Adjacent Ewing property	508609	5783815
SW12-14	05-Sep-12	Noble Rocks outlet creek	at outlet	510498	5781764
SW12-15	05-Sep-12	Noble Rocks outlet creek	Road bridge (near outlet)	511891	5781950
SW12-16	06-Sep-12	Lake Mombeong	Southern side	516274	5779354
SW12-17	06-Sep-12	Lake Mombeong	Northern side	516084	5779643
SW12-18	06-Sep-12	Lake Mombeong	Eastern side	516450	5779426
SW12-19	07-Sep-12	Eel Creek	ds outlet culvert	501484	5787267
SW12-20	07-Sep-12	Eel Creek	us outlet culvert	501484	5787267
SW12-21	07-Sep-12	Eel Creek	Junction with Oxbow Lake	501162	5787453

All sampled fish were identified to species (Allen *et al.* 2002), counted and observed to obtain general biological information (size range, reproductive condition and external disease or parasites). Length-frequency information (as Total Length, TL) was gathered for certain components of catches, namely more sensitive freshwater and diadromous species. Threatened species were photographed at each site as identification vouchers. Records of other fauna sampled opportunistically were maintained. At each sampled site, environmental descriptors, covering differing aspects of underwater cover, edge vegetation, pool condition, flow and water quality were recorded to aid the interpretation of results and assist with broader wetland condition assessment (see appendix 1).

Figure 2.1 Map of fish sampling sites within Long Swamp.

Long Swamp - White Sands (middle) (SW12-11)

Noble Rocks outlet creek - at outlet (SW12-14)

Lake Mombeong - Northern side (SW12-17)

Eel Creek - ds outlet culvert (SW12-19)

2.2 Frogs

A total of eight audio recording sites were established for detecting the calls of frogs resident in Long Swamp. Placement of the recorders occurred in November and December 2012 in order to maximise the likelihood of detecting the nationally threatened growling grass frog - a species that is more likely to vocalise at semi-permanent wetland sites over the warmer months when climatic conditions are suitable. This is the only nationally threatened species of frog that occurs in the region, with a handful of past records from near Long Swamp, and hence was a priority for detection during the survey.

Being sensitive electronic devices, the audio recorders are protected from the elements in a rain-proof housing made of PVC pipe, with only the external microphone visible and mounted at the bottom of the housing where it is also shielded from the weather.

Table 2.2 Sampling site details of frog call audio detection survey of Long Swamp.

Site	Date In	Date Out	Site Name	Location	Easting	Northing
1	23-Nov-12	05-Dec-12	Eel Creek	Upstream (east) of culvert	501512	5787240
2	03-Nov-12	23-Nov-12	White Sands	SW edge near outlet	506870	5783928
3	03-Nov-12	23-Nov-12	White Sands	Southern edge near outlet	506927	5783910
4	03-Nov-12	23-Nov-12	White Sands	Southern edge east of campground	507037	5783795
5	23-Nov-12	05-Dec-12	Long Swamp	Adjacent Ewing property	508691	5783797
6	23-Nov-12	05-Dec-12	Noble Rocks	Swamp near entry road	511706	5782212
7	23-Nov-12	05-Dec-12	Lake Mombeong	Southern side near platform	516296	5779360
8	23-Nov-12	05-Dec-12	Mombeong Swamp	Small swamp to east of Lake	516535	5779317

Frog call audio recorder used in the survey (L), showing housing and mounted external microphone [and an incidental observation of the Brown Tree Frog at White Sands] (R)

The recorders, which save the audio in Windows Media Audio (WMA) format, were pre-programmed to record for three, 10-minute sessions per day – at dusk, midnight and pre-dawn. Importantly water was present at all sites, however it had receded greatly to the point that might limit frog calling at two sites: Eel creek (site 1) and the swamp near Noble Rocks (site 6). All other sites retained significant standing water and suitable aquatic habitat, likely to be conducive to frog activity. Incidental frog observations were also made during the earlier fish survey, and are presented in the results here.

Figure 2.1 Map of frog audio survey sites within Long Swamp.

3. Results

3.1 Native Fish

A total of 5039 fishes were recorded representing 13 fish species (and *Nannoperca* hybrid) across Long Swamp (Table 2 and see accompanying excel spreadsheet). Freshwater specialist species dominated the fish catch. Southern pygmy perch (*Nannoperca australis*) were collected from all sites, except the Eel Creek junction with Oxbow Lake (SW12-21) and were the most common species encountered, representing more than 80% of total catch. The majority of southern pygmy perch were in strong breeding condition. Dwarf Galaxias (*Galaxiella pusilla*) and Yarra pygmy perch (*Nannoperca obscura*), both considered threatened at national (*EPBC Act 1999*) or state (*FFG Act 1988*) level, were detected within the swamp. Encouragingly, strong populations of Yarra pygmy perch (showing signs of recent recruitment) were detected within the permanent freshwater habitats, namely Lake Mombeong (SW12-16, SW12-17, SW12-18), adjacent the Ewing property (SW12-13) and the inundated area below the recently closed White Sands outlet (SW12-09, SW12-10, SW12-11). River Blackfish (*Gadopsis marmoratus*) were recorded at both Lake Mombeong sites, as were the freshwater generalist species, Australian smelt (*Retropinna semoni*). The introduced *Gambusia holbrookii* was observed at the site adjacent the Ewing property (SW12-13) in small numbers however, their capacity to rapidly reproduce and expand their distribution means that their presence is some cause for concern. Diadromous species were recorded throughout Long Swamp with common galaxias (*Galaxias maculatus*) observed at eight of the sampled sites. Shortfinned eel (*Anguilla australis*) were also present (five sites) as were Tupong (*Pseudaphritis urvilli*), which was recorded from Eel Creek sites (SW12-19, SW12-21). The euryhaline, smallmouthed hardyhead (*Atherinosoma microstoma*) was collected at five sites (three of which were in Lake Mombeong) and the estuarine Tamar River goby (*Afurcagobius tamarensis*) and yelloweye mullet (*Aldrichetta forester*) were observed within the Eel Creek outlet. Gobies were also found in Lake Mombeong.

Table 2.1 Fish data for August 2012 baseline sampling of Long Swamp. The categories of fish catch was freshwater, specialist (Fs), freshwater, generalist (Fg), diadromous (D), Euryhaline (Eu) and Estuarine (Es) species. State threatened species in **bold** and introduced species in red.

		Fs				Fg			D			Eu	Es	
Site Code	Waterway	**Dwarf galaxias**	Southern pygmy perch	River blackfish	**Yarra pygmy perch**	Flathead gudgeon	Gambusia*	Australian Smelt	Common galaxias	Tupong (Congolli)	Shortfinned eel	Smallmouthed hardyhead	Tamar River Goby	Yelloweye mullet
SW12-09	Long Swamp	3	1190		22									
SW12-10	Long Swamp	2	1717		17				6					
SW12-11	Long Swamp		836		18									
SW12-13	Long Swamp	1	63		61		5				1	9		
SW12-14	Noble Rocks outlet creek		68						18					
SW12-15	Noble Rocks outlet creek		27											
SW12-16	Lake Mombeong		2	9	19			7	21		11	9	2	
SW12-17	Lake Mombeong		55	3	69			17	119		5	46	3	
SW12-18	Lake Mombeong		149		120			19	180		4	13	2	
SW12-19	Eel Creek		44						16	1	2			
SW12-20	Eel Creek		26						4					
SW12-21	Eel Creek					3			2	1			5	3

Fish species of Long Swamp: common galaxias (top left); river blackfish (top right); southern pygmy perch, top, Yarra pygmy perch, bottom (bottom left); and dwarf galaxias (bottom right).

3.2 Crustaceans

The baseline fish survey documented a range of crustaceans, including swamp yabby (*Geocherax sp.*) (Table 3 and see accompanying excel spreadsheet). Yabbies (*Cherax sp.*) were observed in the wetland area behind the closed White Sands outlet, whereas large permanent sections of Long Swamp (e.g. adjacent Ewing property, SW12-13) supported a more diverse crustacean (yabby and swamp yabby) community. Crustacean species - yabby (6 sites), freshwater shrimp (*Paratya australiensis*) (3 sites), swamp yabby (4 sites) and freshwater crabs (*Amarinus lacustris*) (2 sites) - were regularly collected across Long Swamp.

Crustaceans and other incidental fauna captures in Long Swamp: Swamp yabby, Geocharax sp. (top left); Long-necked turtle, Chelodina longicollis (top right); and freshwater crab, Amarinus lacustris (right).

Table 3.2 Crustaceans recorded in Long Swamp.

Site Code	Waterway	Crustaceans				Other animals
		Yabby (*Cherax*)	Freshwater shrimp (*Paratya*)	Swamp Yabby (*Geocharax*)	FW crab (*Amarinus lucustris*)	
SW12-09	Long Swamp					
SW12-10	Long Swamp	x				
SW12-11	Long Swamp	x				spider species
SW12-13	Long Swamp	x		x		
SW12-14	Noble Rocks outlet creek	x		x		
SW12-15	Noble Rocks outlet creek			x		Burrowing Crayfish (*Engaeus* sp.) burrow
SW12-16	Lake Mombeong		x			
SW12-17	Lake Mombeong	x	x			
SW12-18	Lake Mombeong			x	x	Long-necked turtle (*Chelodina longicollis*)
SW12-19	Eel Creek	x			x	
SW12-20	Eel Creek					
SW12-21	Eel Creek		x			

3.3 Frogs

The frog audio recording survey, and incidental records (including those obtained during the fish survey), resulted in the detection of five species of frog:

1. *Litoria raniformis* : southern bell frog/ growling grass frog
2. *Limnodynastes dumerilii* : eastern banjo frog/ pobblebonk
3. *Litoria ewingii* : brown tree frog
4. *Crinia signifera* : common froglet
5. *Limnodynastes peronii* : striped marsh frog

Striped marsh frog *Limnodynastes peronii* observed during the fish survey

One of these species, the growling grass frog, is of high conservation significance and listed as nationally vulnerable under the *EPBC Act 1999*.

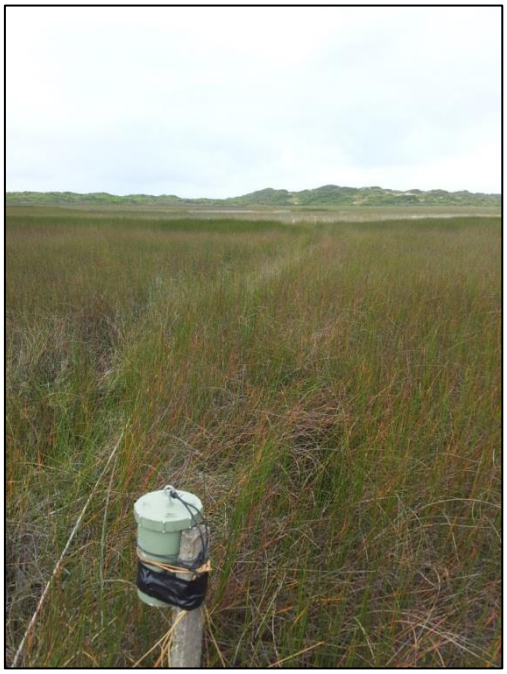
Table 3.3 Frogs recorded in Long Swamp [A = Audio recording, O = Observation during frog survey, F = Observation during fish survey]

Site	Site Name	Frogs (adults)					Other animals
		Growling grass frog	Banjo frog / pobblebonk	Brown tree frog	Common froglet	Striped marsh frog	
1	Eel Creek						tadpoles (100s) sighted during fish
2	White Sands		A	A	A, F		
3	White Sands			A, O	A, F	A	tadpoles (10s) sighted during fish
4	White Sands		A		A		
5	Long Swamp	A	A	F	A, F		
6	Noble Rocks						
7	Lake Mombeong				A	A	
8	Mombeong Swamp		A		A	A	

A search of historic database records, including Victorian museum specimens and DSE opportune records (DSE 2013) and the Atlas of Living Australia (2013) from within 5km of Long Swamp (including into Piccaninnie Ponds in nearby South Australia), indicates that on the basis of nearby records the following species are also potentially present in Long Swamp:

- *Limnodynastes tasmaniensis* : Spotted grass frog

- *Pseudophryne bibronii* : Bibron's toadlet
- *Pseudophryne semimarmorata* : Southern toadlet
- *Neobatrachus pictus* : Painted frog
- *Neobatrachus sudelli* : Sudell's frog
- *Geocrinia laevis* : Smooth frog



Site 5: Location where the growling grass frog was detected calling in the distance

The audio recording data has been presented here in its most simplistic form - namely in terms of presence/absence. However, a finer scale observation worth noting is that the growling grass frog was only heard calling on one occasion during the survey period (that is, throughout only one 10-minute session of the 30 recordings made over a 10 day period adjacent the Ewing property (Site 5)). This particular session was during the middle of the night, on a very still, warm and humid evening – conditions that past experience would indicate is favourable for the species to vocalise. It also demonstrates the difficulty of reliably detecting rarer species and the need for an extended survey period that covers a wide range of climatic conditions. The image to the right shows where the growling grass frog was heard calling in the distance, probably in the area of open water with emergent aquatic vegetation that can be seen distant in the image (reverse view below).

Site 5: Reverse (elevated) view of aquatic habitat present

As had been anticipated on the basis of site conditions when the recorders were set-up, the Eel Creek (Site 1) and Noble Rocks (Site 6) sites did not result in any frog calls being detected. It

is important to clarify that this does not mean that frogs are absent from these locations (as evidenced by tadpoles being observed in September during the fish survey at Eel Creek), but is indicative of the advanced state of drying that was underway at these sites by the time of the survey.

The growling grass frog audio recording is a significant result, particularly when one considers the context of past records from the general area, namely:

1. **1972** – Johnstone Creek (museum specimen)
2. **1979** –15km NW of Mt Richmond (location not clear) (museum specimen)
3. **1998** – Lake Mombeong (calling heard by Garry Peterson)
4. **1999** – Swan Lake (captured and released by Nick Clemann)
5. **2002** – Bridgewater Lakes (calling heard by Sharada Ramamurthy)
6. **2012** – Long Swamp (calling detected during fish and frog study)

Growling grass frog *Litoria raniformis* detected at Site 5 in the central portion of Long Swamp

Significantly, this is the first record of the growling grass frog in Long Swamp west of Lake Mombeong, and only the sixth record in the near-coastal land system along Discovery Bay (DSE 2013). The site adjacent the Ewing property (Site 5) was specifically selected for this survey because it is one of the best remaining examples of semi-permanent open water habitat with good emergent aquatic vegetation cover remaining in Long Swamp.

3.4 Environmental Descriptors

During the fish survey, environmental data was collected the same way at each site covering differing aspects of underwater cover, edge vegetation, pool condition, flow and water quality (see accompanying excel spreadsheet). Physical (0-18%), biological (<5-35%) and emergent (10-50%) aquatic habitat was variable, and edge vegetation excellent (>95%), across all sites. Water quality was excellent with all sites cool (10.1-13.0°C), fresh (1010-1566µScm^{-1}), well-oxygenated (>6.6ppm) and clear (transparency>0.5m).

4. Summary of aquatic ecological assets of Long Swamp

The baseline survey has helped to catalogue the ecological assets that are supported by the aquatic habitats within this wetland system. These ecological assets can be categorised as:

- **Rare or threatened obligate freshwater fishes**: southern pygmy perch, river blackfish and threatened Yarra pygmy perch & dwarf galaxias,
- **Diadromous fishes**: common galaxias, tupong, shortfinned eel.
- **Euryhaline & estuarine species**: smallmouthed hardyhead, Tamar River goby, yelloweye mullet.
- **Freshwater crayfish**: Swamp yabby, yabby.
- **Frogs**: Five species detected, including a significant new record of the nationally vulnerable growling grass frog, with a further six species possibly resident based on nearby records.

5. Discussion

5.1 Impact of Hydrological Trends on Aquatic Fauna

The influence of a long-term drying trend is generally observable throughout Long Swamp (through a corresponding vegetation change such as shrub encroachment and reduced open water throughout most areas). However in spite of this, at the key locations visited, the wetland system still retains a diversity of permanent and semi-permanent aquatic habitat and permanent lakes, as well as seasonal flowing creek/drain habitats (e.g. Eel Creek and Noble Rocks outlet).

The exception to the general drying trend is in the vicinity of White Sands, where a significant area of semi-permanent wetland habitat is recovering since the natural closure of this (apparently) artificial outlet in approximately 2005, and (unlike other parts of the system) is causing a shift in vegetation types that favours aquatic species.

Dune forming in front of the former White Sands Outlet – July 2012

The last few years of average to above average rainfall (Bureau of Meteorology, 2013), and lack of ocean outflows through the former outlet, are causing terrestrial species to be displaced, as shown below.

White Sands in August 2010

White Sands in November 2012 *(note the inundation in the foreground and browning-off of drowned terrestrial vegetation)*

White Sands in November 2012 – close-up of area shown in the far right of the image above

Wetland edge at White Sands July 2012 (note the death of terrestrial species around the wetland margin)

Importantly, this survey has then been able to identify the ecological assets which are favoured by an increase in aquatic habitat. For instance, the recovered wetland habitat at White Sands produced the highest captures of Southern Pygmy Perch during the survey, significant numbers of the Yarra Pygmy Perch and a limited number of captures of the Dwarf Galaxias – all species indicative of a healthy freshwater aquatic ecosystem. The latter two species are listed under the *EPBC Act 1999* and considered nationally threatened.

The other survey site in Long Swamp (SW12-13/Site 5 – see right) that retains a significant depth of water into the summer months (outside of the deeper waters of the permanent Lake Mombeong), was also found to support these nationally significant fish species, and produced the only record of the nationally threatened growling grass frog in the survey. Given the proximity of this site to the former outlet at White Sands, it is possible that the reduced water losses from White Sands may have a positive impact on the duration of inundation at this site.

It is also worth noting that the area of emergent aquatic vegetation developing at White Sands is now providing potential habitat for the growling grass frog (Hamer and Organ, 2006) within reasonable proximity of the site where the species was recorded at Site 5 (or SW12-13).

Recovery of potential breeding habitat for the growling grass frog at White Sands

In the context of this report, focussing specifically on the aquatic ecological assets of Long Swamp, it is worth noting that (given their similar hydrological requirements) any efforts to enhance habitats within the system for freshwater fish or frog species are likely to be mutually beneficial for species in each of these taxonomic groups.

The presence of the introduced *Gambusia holbrooki* at one of the more permanent sites (SW12-13) is worth noting. This species prefers the shallow, warm and still waters that are likely to prevail in semi-permanent or permanent habitats within Long Swamp over the spring and summer months. Monitoring the distribution, abundance and habitat use of this species within Long Swamp should be a key consideration in the design of any future survey work.

A recommended future objective of Long Swamp management is:

- the enhancement of conditions for native species dependent upon semi-permanent and permanent freshwater aquatic habitat;

5.2 Hydrological Connectivity

The diversity of species resident within Lake Mombeong is indicative of periods of connectivity with the ocean. Both the seasonal outlets to the sea, at Noble Rocks and Eel Creek via the Glenelg River mouth, were found to provide effective fish passage, with diadromous species recorded at these sites during the survey. Unlike the nearby Piccaninnie Ponds wetland system in South Australia where discharge to the sea is permanent, the flows from Long Swamp to the

sea are currently seasonal and therefore opportunities for migration by fish are restricted annually to the winter and spring. In 2012, the flows at Eel Creek ceased between the time of the September fish survey and the November 23rd frog survey, while the Noble Rocks flows ceased during November, sometime between the frog survey visits on the 3rd and 23rd of November.

It is also worth noting that there is the possibility that native fish have been inadvertently introduced to Lake Mombeong (with other non-native species) over a long history of being managed to create a destination for anglers. Efforts to stock Lake Mombeong (or Lake Bung Bung as it was then often referred to) began as early as the mid 1930's – as shown in the article opposite, from the Border Watch on the 6th of June 1935.

GLENELG RIVER ANGLING CLUB.

Stocking Lake Bung Bung Wtih Trout.

Nelson. Today.

After a thorough examination of the food supplies and an analysis of the water by the Victorian Piscatorial Council's expert on Freshwaters Fisheries (Mr. Kneebone) the committee of the Glenelg River Angling Club have decided to stock Lake Bung Bung with trout.

Lake Bung Bung is a fresh-water lake situated along the coast some ten miles east of Nelson, and about 13 miles from the Prince's Highway at Winnap. The lake, although not known to many people, is a fine stretch of water, having an area of about 350 acres, and is up to 40 feet in depth, the average being from 20 to 25 feet. The shores are sheltered by low banks on the north side, ti-tree on the west and east and a high sand drift on the south side, which is being planted with marram grass this winter. A stream which flows out of the west end of the lake will be fenced to prevent the trout escaping to the sea. The food supply in the lake is excellent, consisting of minnows, silver trout, shrimps, water beetles of various kinds, crabs, snails, flies, etc. There are no larger fish in the lake, and this no doubt accounts for such an abundance of food.

TWO SPECIES

The first consignment will consist of 36 cans, approximately 1,800 rainbow yearlings, from the Ballarat Hatcheries, 800 being allotted by the Victorian Fisheries Department free of cost to the Club. Two hundred brown trout yearlings, an experimental lot, for another lake near by, were also ordered, to find out which would thrive the better in the locality. This consignment is smaller than was ordered, owing to the shortage at the hatcheries this winter and the larger demand.

The fish arrived at the Winnap railway station at approximately 9 p.m. last night, and were met by supporters of the Club and transported to the lake and liberated the same night. An attendant accompanied the fish from Ballarat. Should the fish thrive in this lake it should prove a sportsman's paradise, there being sea fishing within half a mile of the lake, and plenty of good shooting grounds, and the Glenelg River only six miles away. Provided the Club gets the support of all interested further stocking will be carried out for next season.

Anyone wishing to assist the Club with a donation, however small, is asked to forward it as early as possible to the hon. secretary (Mr. Jas H McEachern) at Nelson.

A recommended future objective of Long Swamp management is:

- to maintain some form of oceanic connectivity for the system to maintain resident fish species diversity.

5.3 Future Work

Due to the project scope and available funding, this baseline investigation was limited to a 'one-off' snapshot of a small number of strategically selected sites. In spite of this limitation however, the findings now provide a significant foundation of knowledge that could:

1. provide the platform for an increased survey effort to better understand the distribution and habitat use of fish and frog species within Long Swamp (this may also be achieved through partnership with an academic institution);
2. provide the basis for regular long-term (e.g. annual) monitoring of the key locations now sampled;
3. be used to guide the future setting of management objectives for water management within Long Swamp and the Glenelg River estuary; and/or,
4. be used to provide “before” data, should any management changes be initiated in the future, noting that similar investigative work should also be repeated during and after any management changes that are initiated.

A recommended future objective of Long Swamp management is:

- to build upon the results of this survey to increase the understanding of wetland values in response to any future environmental change.

6. Conclusion

Long Swamp is a large coastal wetland system that stretches behind the dunes of Discovery Bay from the Glenelg River estuary at Nelson (Victoria) for approximately 15 km to the south-east, through to Lake Mombeong. Although it is nationally recognised as a significant wetland and situated almost entirely within Discovery Bay Coastal Park, it has not been subjected to the same level of biological investigation as many other wetlands of equivalent conservation status. This report and the field work it summarises, in part, begins to address this limitation.

To summarise, this baseline fish and frog survey has identified that, in spite of a long-term drying trend and terrestrialisation of vegetation communities across Long Swamp, significant aquatic fauna communities continue to persist in a diversity of wetland habitats. The survey resulted in the detection of 12 native species of fish, from a range of functional groups, and five species of frog, including the nationally threatened growling grass frog. It is only the sixth record of this species from the Discovery Bay coastal landform, and just the second record from within the Long Swamp complex itself. Lake Mombeong is also a significant permanent freshwater habitat, and was found to support the greatest diversity of species during the fish survey. The results from this site, and the outlets at Noble Rocks and Eel Creek, indicate a degree of effective seasonal connectivity with the ocean.

Based on present conditions and trends, broader availability of aquatic habitat for nationally threatened fish and frog species would appear somewhat limited (in area) for a wetland system as large as Long Swamp, with the exception of the increase in aquatic habitat in the vicinity of White Sands, where the potential response of habitat to a reversal of the drying trend can be observed. The natural closure of an artificial cutting to the sea at White Sands (during the last drought, in approximately 2005) has now resulted in:

- the seasonal increase of water levels in the immediate vicinity of the former cutting;
- a shift in vegetation communities in response, a process that is continuing; and,
- the presence of what (during this survey) appeared to be a thriving assemblage of obligate freshwater fish species at the site, including two that are nationally threatened (Yarra Pygmy Perch and Dwarf Galaxias).

On the basis of these findings, future management objectives for Long Swamp might include:

- the enhancement of conditions for species dependent upon semi-permanent and permanent freshwater aquatic habitat;
- the maintenance of some form of oceanic connectivity for the system to conserve resident fish species diversity; and,
- building upon the results of this survey to increase the understanding of wetland values in response to any future environmental change.

7. References

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Appendix 1: Environmental descriptors recorded

Location (description and GPS-WGS 84 datum, zone 54H), waterway, weather, land use, potential impacts and environmental characteristics were recorded for each sampling site to assist with the interpretation of results and future replication. Digital photos were taken of all sites. Environmental characteristics included details of aquatic and interlinked riparian condition under the following categories:

General descriptors:

- Habitat type (i.e. stream, wetland, instream dam).
- Pool size as an estimation of surface area.
- Bank slope (e.g. steep = 45º, vertical 90º).
- Depth (maximum and average).
- Substrate type (e.g. sand, gravel, mud).

Flow environment:

- A temporal measure of connectivity based on seasonal conditions and local landholder input (e.g. ephemeral, six months flow connection, or permanently connected), plus comments such as whether the area is spring fed.

Pool condition and flow:

A measure of water level in comparison to the normal bank level of a pool (e.g. concentrated, bank level, in flood) and recording of *Flow* at the time of sampling ranked relative to magnitude: low = <10 L/sec; medium 10-100 L/sec; high 100-200 L/sec; very high >200L/sec.

Contributions to cover (% of volume occupied and type):

- Submerged physical (e.g. snags, leaf litter, rock),
- Submerged biological (e.g. aquatic plants, *Chara*, other algae),
- Emergent (e.g. reeds, rushes and sedges, tea tree),
- Fringing vegetation within 2 metres of the waters edge (particular note of small amphibious species on the bank such as *Crassula*, *Centella*, *Ranunculus*).
- Canopy – measure of overhanging vegetation (shade),
- General surrounding terrestrial vegetation cover.

Water quality:

- TPS meters taken at 0.3m depth recording (a) temperature, (b) conductivity (k=10 probe, range 200-200,000µS = μScm^{-1}), (c) pH, and (d) dissolved oxygen.
- Water transparency measured in situ against a white object with comments on contributions to low values such as natural tannin, colloids or algae.