Department of Sustainability and Environment

Hollands Creek Demonstration Reach: Annual Progress Report 2008/09.

Raymond, S., Hames, F., Lyon, J. and Tennant, W.

2009

Victoria
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Arthur Rylah Institute for Environmental Research Client Report

Hollands Creek Demonstration Reach: 2008/09. Summary document.

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For

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Front cover photo: Hollands Creek, Tatong (Scott Raymond).

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Summary

This report consists of six sections. The first section contains a general introduction to the Hollands Creek Demonstration Reach (HCDR) outlining the significance of the creek and the general aims of the project. The second section covers water quality and fish monitoring methodology. The third section presents the monitoring data and compares this data with the findings from the first monitoring program conducted in 2007/8 (Raymond *et al*., 2008). The fourth section focuses on the community. This section outlines discussion with local groups, government departments, landholders and other stakeholders. The fifth section discusses the findings from the monitoring program and provides an impetus to develop future works for the reach. The final section of the report outlines the rehabilitation works program for the HCDR. This program provides a comprehensive site specific in-stream rehabilitation plan.

This document is intended to be read in conjunction with the Hollands Creek Demonstration Reach: Background and Recommendations report (Raymond *et al*., 2007) and the Hollands Creek Demonstration Reach: 2007/08 Summary document (Raymond *et al*., 2008).

A Summary of the Key outcomes and findings of the 2009 monitoring program

Fish monitoring

- The proportion of native fish in the total catch declined from 78% in 2007 to 26% in 2009
- Macquarie Perch were restricted to site 1
- Numbers of Macquarie Perch captured declined by 55% from 2007 to 2009
- Macquarie Perch sizes ranged from 269-382mm in 2007 and 340-380mm in 2009 with no recruitment observed during these years
- Redfin accounted for 60% of the total catch, followed by River blackfish (23%) Gambusia (9%) and Brown trout (6%)
- A reduction in the distribution of *G. olidus* was observed from 4 to 2 sites (2007 and 2009, respectively)
- No gudgeon species were observed from the HCDR during the 2009 sampling event
- The distribution of Redfin and Brown trout was extended within the HCDR
- The abundance of all exotic fish species increased from 2007 levels and were found to occur in all 8 monitoring sites
- The wide size range of all exotic fish suggests regular recruitment
- **The decrease in distribution and abundance of most native fish species suggest that the health of the HCDR has deteriorated from 2007 to 2009**

Water quality monitoring

- Electrical conductivity was significantly higher in all sites compared with 2007 values
- Dissolved oxygen was significantly lower in 2009 compared with 2007 values (all sites)
- Turbidity was higher in 7 of 8 sites monitored in 2009 compared with 2007 values
- 2009 pH values were similar to 2007 values

Key outcomes and findings of the works program

- 11.2km of riparian fencing has been completed since January 2007
- 3.5km of riparian fencing has been completed in 2008/9
- 900 m of willows removed (2.3km of willows poisoned in 2008/9)
- 6.55km of weed control completed in 2008/9
- A detailed site specific works program established
- Consideration of proposed translocation of Macquarie Perch into the HCDR from the Yarra River (no formalised plans to date)

Planning

Input towards the Draft Flora and Fauna Guarantee Action Statement for Macquarie perch, *Macquaria australasica*

1 General introduction

The increasing use of Australian rivers for agricultural and industrial purposes has been a contributing factor in the degradation of river health. Estimates of native fish populations within the Murray Darling Basin (MDB) indicate that the abundance and distribution of fish species are approximately 10% of pre-European settlement levels (MDBC, 2004a). In an attempt to reverse this trend, the Murray Darling Basin Authority (MDBA) has developed a multi-disciplinary approach to river restoration through the Native Fish Strategy (NFS) (MDBC, 2004a). This approach employs the combined application of strategies targeted to a specific stretch or reach of river referred to as a 'Demonstration Reach'.

The purpose of a 'Demonstration Reach' is to show the community the cumulative benefits of rehabilitating in-stream and riparian habitat for improving river health (GBCMA, 2008). Hollands Creek was chosen as a demonstration reach as it is reported to have the 'most promising population of Macquarie Perch in the Broken Catchment' with successful breeding and recruitment of individuals recorded (MDBC, 2004a; Pritchard, 2006).

As fish are reported to be a good indicator of river health, an assessment of fish species and their distribution and abundances has been used to assess the effectiveness of the HCDR project.

Macquarie Perch are currently listed as nationally endangered under the Commonwealth EPBC Act, 1999 and endangered under the 2007 *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE, 2007).

The Hollands Creek Macquarie Perch population is restricted to a small stretch of creek in close proximity to the township of Tatong (Figures 1 and 2). This stretch of creek has significant habitat characteristics including flowing waters with > 30m of riparian vegetation overhanging the banks, emergent vegetation, snags and erosion retaining rock groynes (Pritchard, 2006). This 'significant' habitat abuts with farming land upstream of the Swanpool Bridge. The lack of good riparian vegetation above the bridge may account, in part, for the limited range of Macquarie Perch in this

section of the creek. The lack of water flow in the past may also significantly impact on the distribution of Macquarie Perch within the Demonstration Reach.

The GBCMA (2008) outlined a number of threats and their associated risks to the Hollands Creek Macquarie Perch population. Risk analysis was assessed on the probability of a threat causing any impact on the value asset (Macquarie Perch population), beyond current conditions. These threats include reduced food availability (very high risk), reduced water quality (substantial to high risk), loss of physical habitat (very high risk), insufficient flows (high to very high risk), exotic fish (substantial risk) and barriers to fish migration (low risk).

A number of sites were chosen to assess the impact of rehabilitation works on the local fish community. Monitoring was conducted at sites where works are to be undertaken as well as at control sites where no works are planned. Four control sites on Ryans Creek were surveyed in an effort to determine the impact of rehabilitation works from environmental perturbations. All sites were monitored for fish and water quality. This report outlines the data from monitoring conducted in January, 2009. This data will be used to compare the distribution and abundance of fish within the reach over consecutive years.

The HCDR is a joint venture between the GBCMA and the Department of Sustainability and Environment (DSE). This is the second of a series of reports that will be presented on an annual basis. Major works proposed for the HCDR shall be completed by 2010 with minor works ongoing. The monitoring program has been established until 2012 with a view toward future periodic sampling.

The primary aim of this report is to outline the status of the fish assemblage within the Hollands Creek Demonstration Reach in January, 2009. This data will be compared with the findings from the first round of monitoring conducted in November, 2007. Species, abundance and distribution of fish within the reach will provide information used to measure the effects rehabilitation works have on fish communities, and hence river health over the next 7 to 10 years.

2 Study Area and Monitoring

2.1 Location

Hollands Creek is located in north-central Victoria, 35 km south east of Benalla (Figure 1). The Demonstration Reach covers approximately 20 river kilometres and commences at the township of Tatong (Swanpool Bridge) upstream to the confluence of Hollands and Spring Creeks. Monitoring sites are outlined in Figure 2. The creek system is dominated by cobbled riffle/run stretches interspersed with deep pebble lined pools. The creek banks consist of rich organic sandy clay loam.

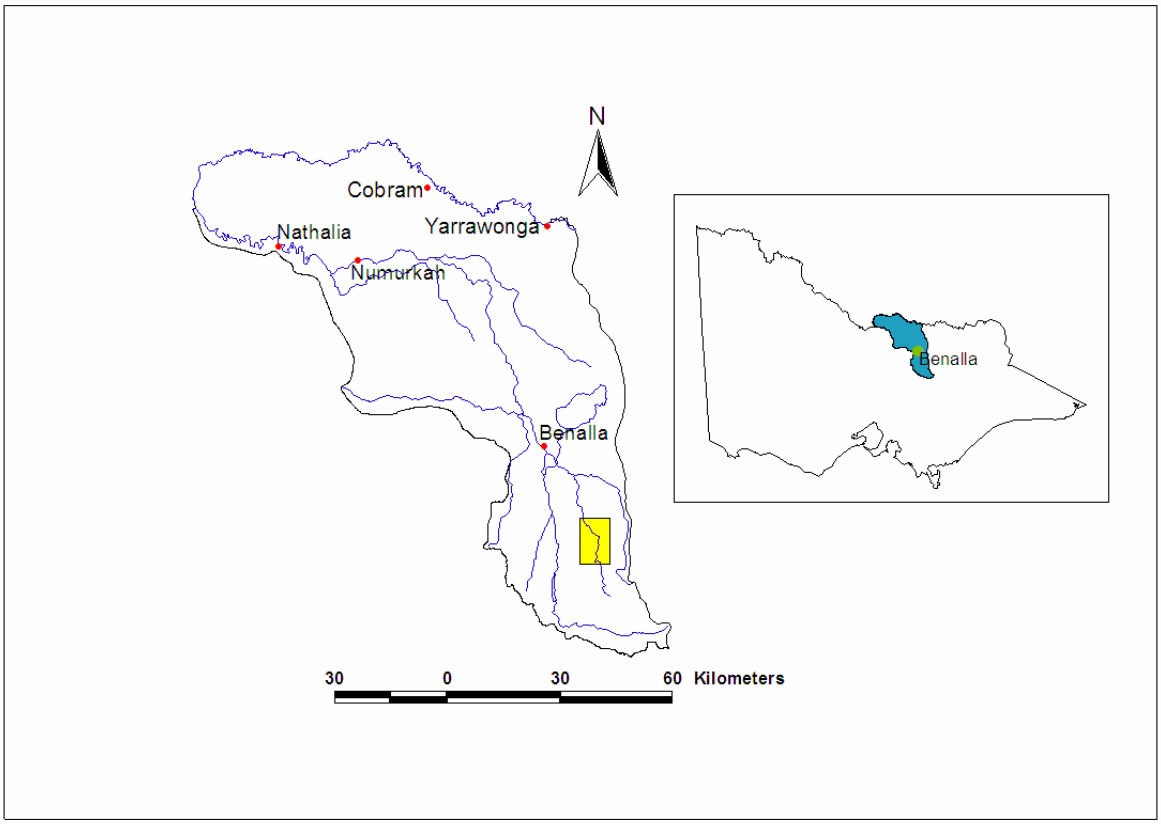

Figure 1. Location of the Hollands Creek Demonstration Reach

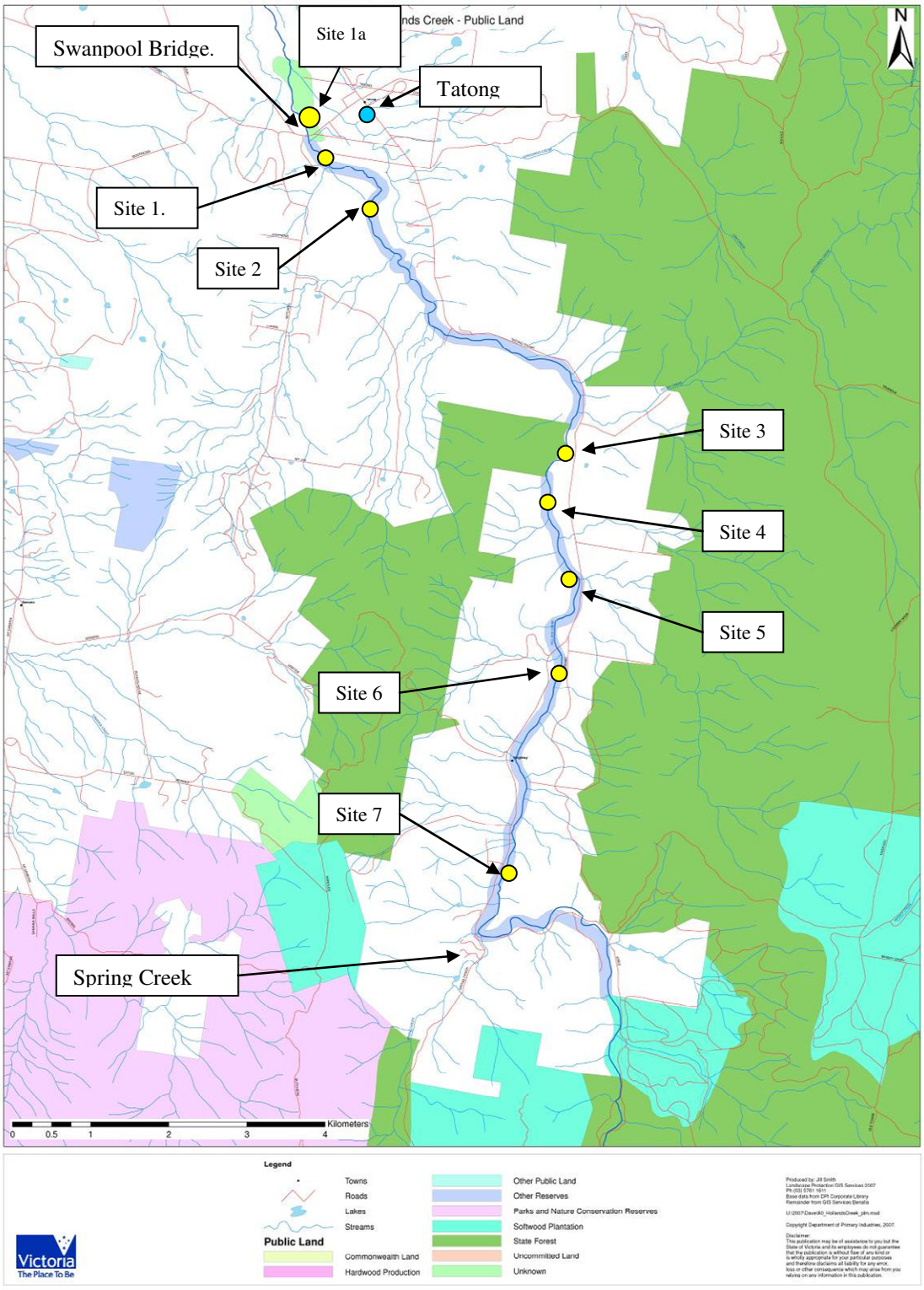

Figure 2. Monitoring sites within the Hollands Creek Demonstration Reach

2.2 Monitoring Methodology

Monitoring of water quality and the fish assemblage was carried out in January, 2009 as part of the 2008/9 monitoring program. The diversity and abundance of fish was measured at each of 8 sites on Hollands Creek and 4 control sites on Ryans Creek using the methodology outlined by the Sustainable Rivers Audit (SRA)(MDBC, 2004b). This data will be compared with the 2007/8 fish monitoring program conducted in November 2007. Fish monitoring provides a means to assess the long-term effect of adaptive management works on fish health within the HCDR. Monitoring data will also provide information used to suggest future site-specific restoration works within the HCDR. The four control sites on Ryans Creek were included to determine if future changes in the fish community within the HCDR are the result of works conducted within the reach or whether the observed changes are the result of environmental perturbations on a broader scale. Fish assemblage data for Ryans Creek are located in the Appendices (Appendix A).

2.2.1 Water quality

Water quality characteristics were recorded at eight treatment sites within Hollands Creek and at four control sites on Ryans Creek. Water quality was recorded using in-stream data loggers (HOBO ® Pendant Temperature data loggers, # UA-0020XX) and a single portable Conductivity, Temperature, Dissolved Oxygen, pH, and Turbidity meter (TPS-FLT logger). The diversity and abundance of fish were measured at each site using methodology outlined by the Sustainable Rivers Audit (SRA)(MDBC, 2004b). The monitoring methodology provides a means to assess the effect of adaptive management works on fish health within the HCDR. Monitoring data will also provide information used to suggest future site-specific restoration works within the HCDR.

2.2.2 Fish monitoring

Both active and passive fish collection techniques were used to monitor the fish assemblage within the HCDR. The active component included the use of a Smith Root ® model 12B backpack electro-fisher (set at 600 volts, 60 Hz, pulse DC) following SRA standard protocol (MDBC, 2004b). SRA standard protocol includes eight, 150 second shots for each fish monitoring site. The electro-fishing operator fished in an upstream direction, fishing all accessible habitats with an assistant following the operator to retrieve all stunned fish.

The passive collection of fish incorporated the use of fyke nets. Four fyke-nets were placed within each monitoring site (late afternoon) in an attempt to collect fish that moved at night. The nets were set in pairs: each pair consisted of one net facing downstream on a 45 degree angle and the other facing upstream on a 45 degree angle from the bank (Figure 3). Nets were set at the head and/or the tail of pools. All fish were identified to species level, measured to the nearest mm for total length (depending on species) and returned to the water.

Figure 3. Fyke nets at Riverview (site 3), HCDR, 2009

3 Results

3.1 Water quality

Water quality characteristics measured at each of the eight HCDR monitoring sites are reported in Table 1. These data will be compared with the 2007/8 findings. Water quality data for Ryans Creek are located in the Appendices (Appendix A).

In general, individual water quality characteristics between sites in the 2009 survey showed minimal variability with no clear trends observed. A number of differences in water quality were observed between 2007 and 2009 data. With the exception of site 7 (low turbidity), electrical conductivity (salinity) and turbidity were higher in the current investigation compared with 2007 values. In contrast, dissolved oxygen levels in the 2009 survey were significantly lower than 2007 values. Temperature levels were consistently higher in 2009 while pH values were similar in both years.

The downstream end of the HCDR lies at an altitude of 200m and consequently falls within the upland stream category (streams above 150m altitude, ANZECC, 2000). Turbidity values in both years (with the exception of site 6, 2009) are typical for upland rivers, which are generally between 2 and 25 NTU (ANZECC, 2000). The large pool of stagnant water at site 6 was significantly more turbid (70 NTU) compared with the remaining study sites.

A large section of the Hollands Creek Demonstration Reach (above Dodds Bridge to Swanpool Bridge) stopped flowing above ground in the second week of January 2009. Water continues to trickle into the top of the HCDR via Spring Creek. Local residents indicated that the creek has stopped flowing in the summer months for at least the past four years (Kevin Smith; pers. Comm. 2009) with 2009 water levels the most severe (lowest). Prior to 2005 there is no record that the stream had stopped flowing.

Water temperature data from the Hobo™ loggers are presented in Figures 4 and 5. The temperature graphs were constructed using hourly measurements from March 2008 to June 2009. The graphs indicate that temperature fluctuated from a low of approximately 7 ^{0}C in August 2008 to a high of approximately 30 ^{0}C in the end of January 2009. The general increase in water temperature from the end of September 2008 to the end of March coincide with the warmer months while the sharp rise in water temperature during the last week of January 2009 (site 3, Table 4) may have been the result of low/no flow conditions experienced from Mid-January to the first significant rains in early June 2009.

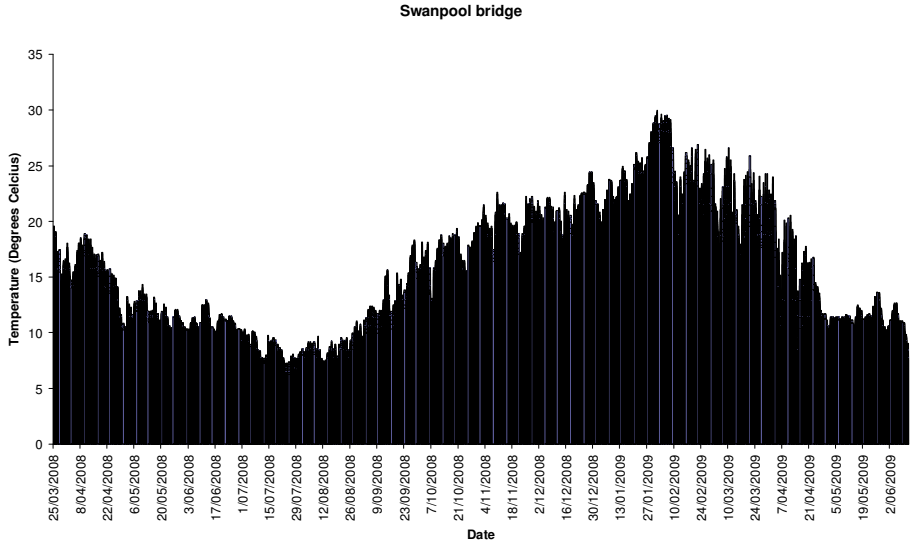

Figure 4. Temperature data for the HCDR (Swanpool bridge)

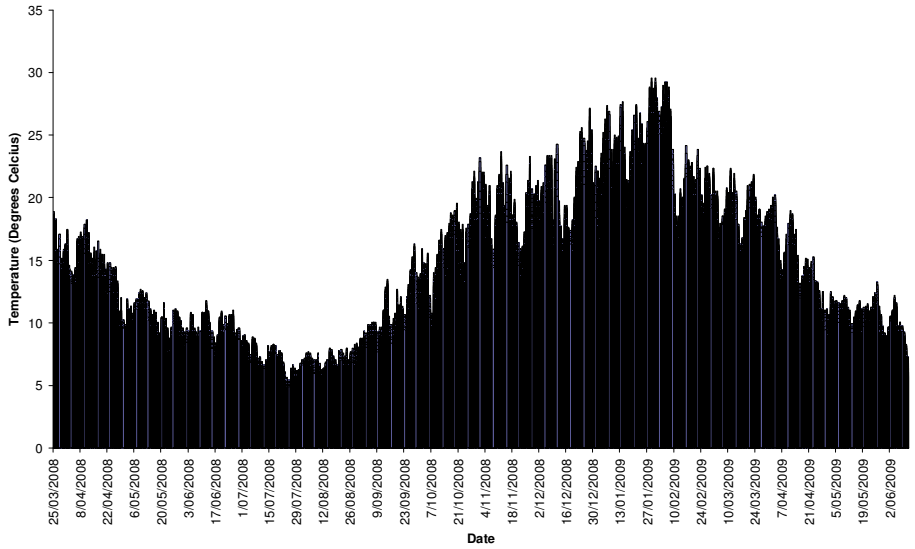

Figure 5. Temperature data for the HCDR (Site 7)

Table 1. Water quality characteristics measured at individual monitoring sites in Hollands Creek during 2007 and 2009.

Monitoring site number	Measured water quality characteristics									
	Electrical conductivity (µS/cm)		Temperature (^{o}C)		Dissolved Oxygen (mg/L)		Turbidity (NTU)		pH	
	2007	2009	2007	2009	2007	2009	2007	2009	2007	2009
1	91.7	211	26.3	24.3	17.1	3.3	3.5	15	8.6	8.2
1a	--	108	--	30.0	--	4.2	--	14	--	7.3
2	93.5	211	23.5	24.3	8.3	3.3	5.0	15	7.8	8.2
3	88.5	132	22.1	21.2	6.2	4.1	2.3	13	7.6	7.4
4	88.5	183	21.0	29.4	7.0	5.9	2.3	6.0	7.6	7.8
5	66.5	184	20.0	22.6	9.0	3.7	12.0	13	7.0	7.2
6	67.0	147	19.0	23.7	9.1	4.1	15.0	70	7.8	7.4
7	67.4	115	19.3	31.2	9.7	8.0	15.0	3.0	7.0	8.4

3.2 Fish surveys

3.2.1 Fish abundance

A total of 380 fish, from six species, were caught during the 2009 monitoring program (Figure 4, Table 2) with a further 299 individuals sighted. Thirteen turtles, 44 yabbies (C*herax destructor*) and two spiny crayfish (*Euastacus armatus*) were also captured from the HCDR monitoring sites. In excess of a thousand juvenile (< 30mm total body length) yabbies were observed during the study.

The total abundance of individual fish captured from the 2009 survey was more than twice that of the 2007 survey (Table 2). The significant increase in fish numbers was largely attributed to the increase in individual exotic fish from 2007 to 2009, (particularly redfin). The abundance of native fish was constant between the 2007 and 2009 surveys. However, their contribution to the total fish count fell from 78% to 26% from 2007 to 2009, respectively. Gudgeons were not recorded during the 2009 fish monitoring program.

Redfin, *Perca fluviatilis*, was the most abundant fish species recorded during the 2009 survey accounting for 60% of the total catch. River blackfish, Gambusia and Brown trout also significantly contributed to the total number of fish caught, with 89 (23%), 33 (9%) and 21 (6%) individuals captured, respectively. The remaining fish species contributed to less than 2% of the total fish catch (Table 2).

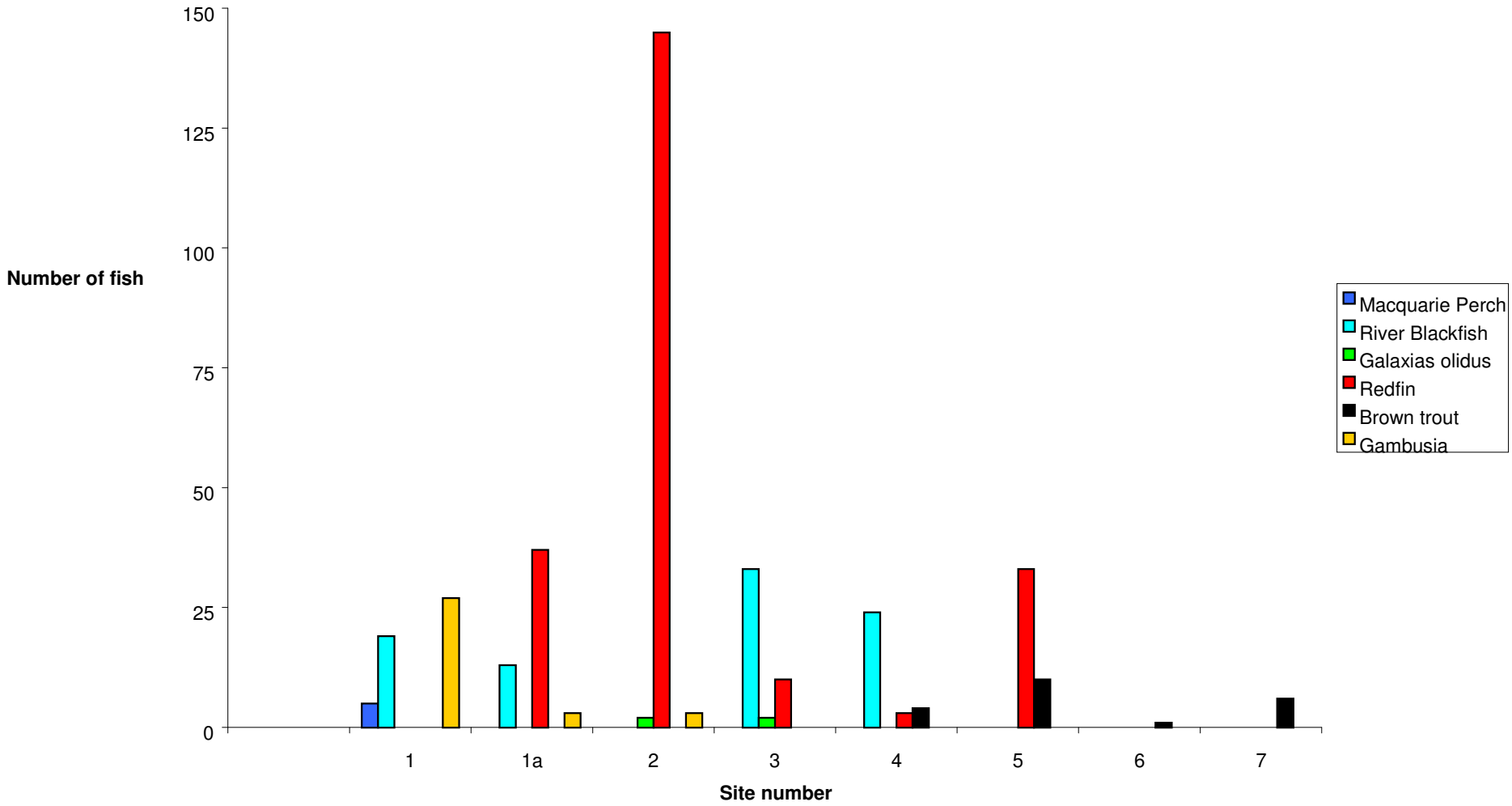

Figure 6. The total abundance and distribution of fish species recorded from the January 2009 monitoring survey of HCDR.

Table 2. Total number, mean length and range of fish captured from the 2007/8 and 2008/9 surveys of the HCDR.

Common name	Scientific name	No. captured		Mean length (mm)		Range (mm)	
		2007/8	**2008/9**	2007/8	**2008/9**	2007/8	**2008/9**
Macquarie Perch	*Macquaria australasica*	11	**5**	318	**357**	269-382	**340-380**
River blackfish	*Gadopsis marmoratus*	82	**89**	127	**130**	23-223	**28-240**
Mountain galaxias	*Galaxias olidus*	4	**4**	62	**59**	54-67	**40-68**
Gudgeon	*Hypseleotris sp.*	6	**0**	42	**0**	33-55	**0**
Gambusia*	*Gambusia Holbrooki*	1	**33**	24	**29**	24	**16-62**
Redfin*	*Perca fluviatilis*	24	**228**	129	**73**	84-282	**39-440**
Brown trout*	*Salmo trutta*	4	**21**	60	**222**	50-71	**30-294**
	TOTAL	**132**	**380**				

* denotes introduced fish species

Macquarie Perch numbers decreased from 11 to 5 individuals from 2007 to 2009 (Table 2, Figure 5). The 55% decrease in the Macquarie Perch population coincided with the first record of redfin in site 1. Macquarie Perch were the largest fish recorded from the HCDR with an average length of 357 mm; 39 mm longer than perch in the 2007 survey (Figure 6). Recruitment of Macquarie Perch was not observed during the 2009 survey.

The abundance and size of River blackfish was similar in the 2007 and 2009 surveys. However, their percentage of the total catch declined from 62 to 29 percent, respectively (Table 2, Figures 7 & 8).

Redfin were the most abundant (228 individuals) fish species recorded during the survey, accounting for 60% of the total catch (Table 2, Figure 9). This value is significantly higher than the 18% recorded for 2007. The dramatic increase in redfin numbers (9.5 fold increase) from 2007 to 2009 was skewed toward younger fish (< 80mm in total length) which accounted for 92% of the redfin population (Figure 10).

The Brown trout population was dominated by mature individuals (> 200mm), accounting for over 80% of the population. The presence of 30mm Brown trout indicates that either natural recruitment of this species is occurring (Figures 11 & 12) or that stocking of juvenile brown trout had taken place prior to the survey. The stocking of 1,000 Brown Trout into the HCDR at Dodds Bridge in April 2008 by the Tatong Angling Group (TAG) (pers. Comm. Franz Arndt [Hollands Creek Demonstration Reach Community Reference Group meeting, 8.4.2009]) makes it very difficult to assess changes in the trout population structure in time and space. Statistical analysis of the HCDR fish assemblage is also confounded by the continued addition of trout into the system.

The abundance of the small-bodied galaxid, *G. olidus,* remained constant between the 2007 and 2009 surveys (Figures 13 & 14) while the number of exotic small bodied Mosquitofish (*Gambusia holbrooki*) increased dramatically from 2007 to 2009 (Figure 15). The current population of Mosquitofish comprised both juvenile and adult fish, many of which were observed to be in breeding condition (Figure 16).

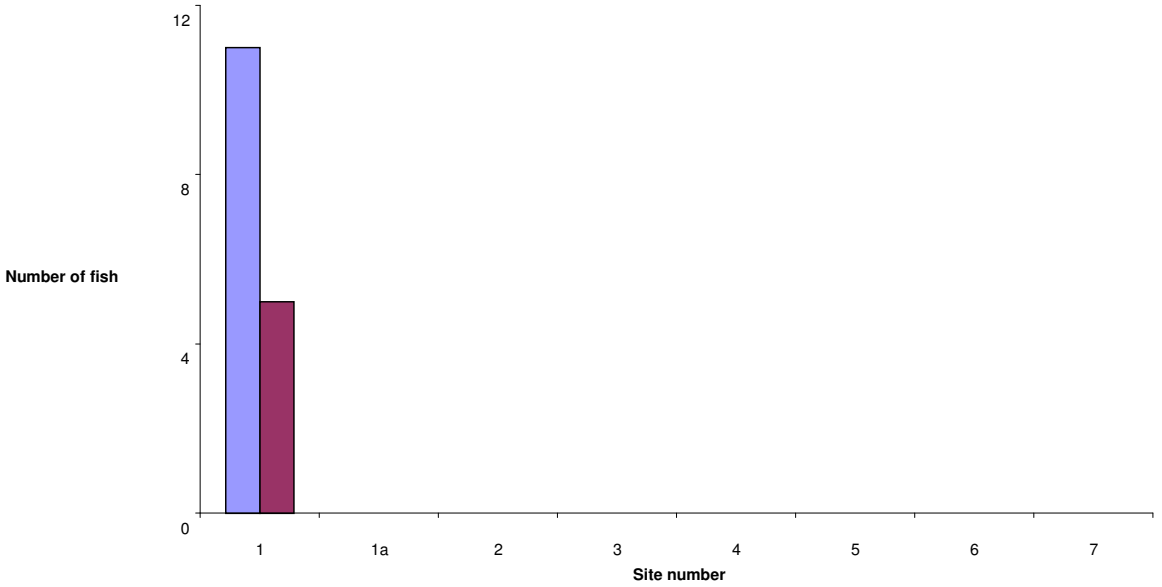

Figure 7. Comparative abundance and distribution of *Macquaria australasica* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

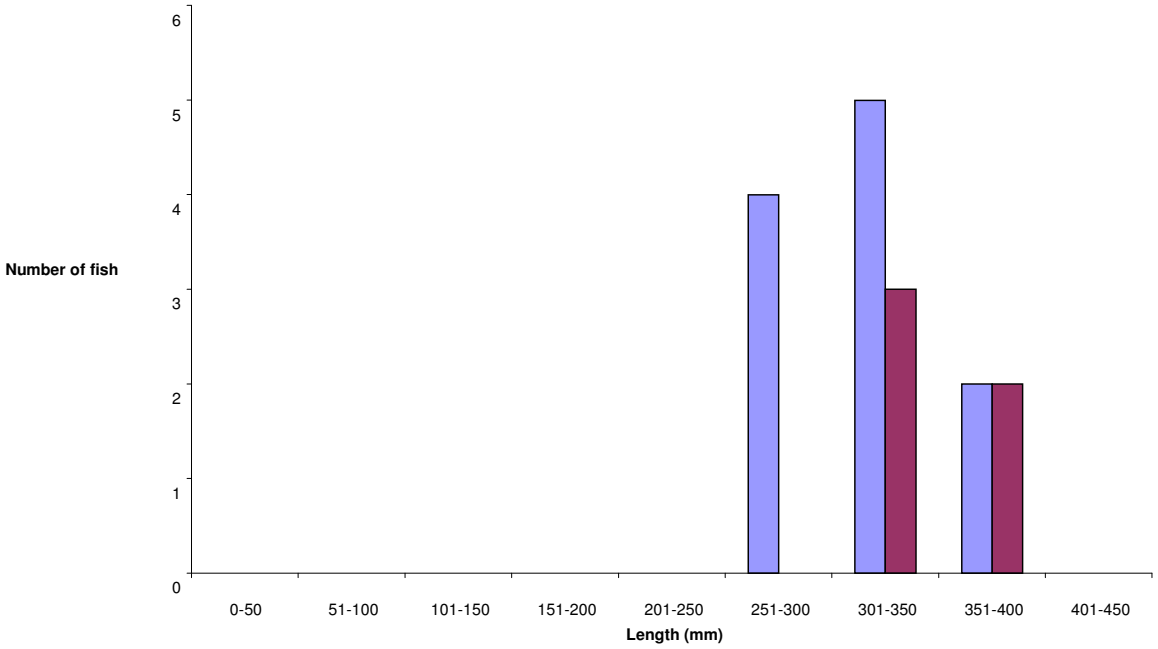

Figure 8. Comparison of length frequencies for *Macquaria australasica* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

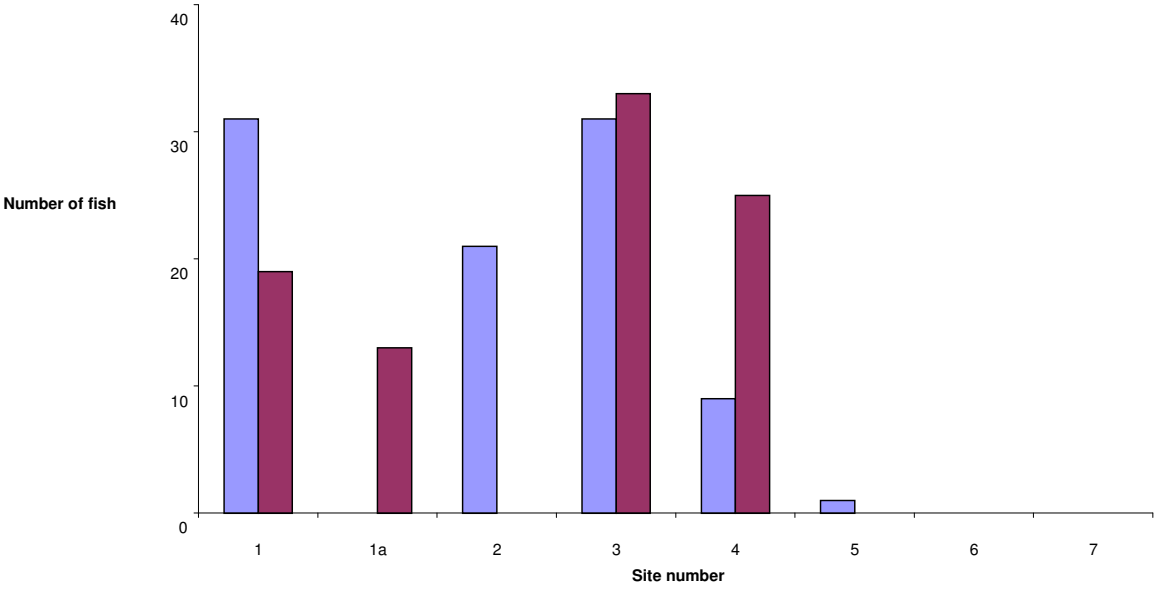

Figure 9. Comparative abundances and distribution of *Gadopsis marmoratus* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

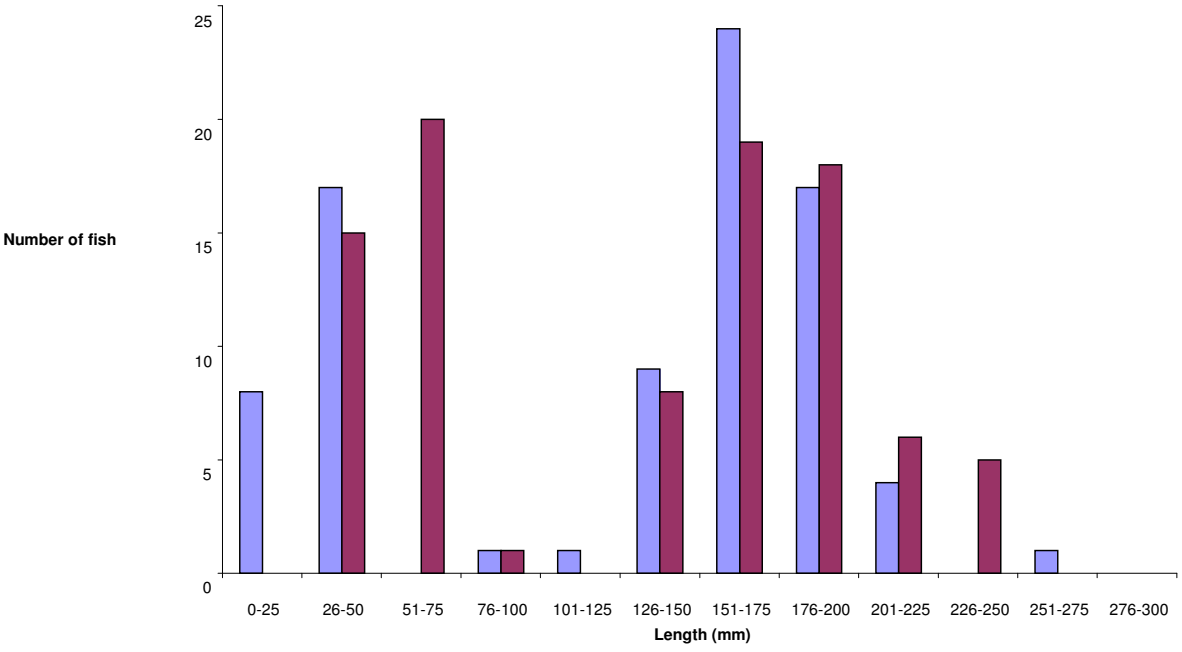

Figure 10. Comparison of length frequencies for *Gadopsis marmoratus* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

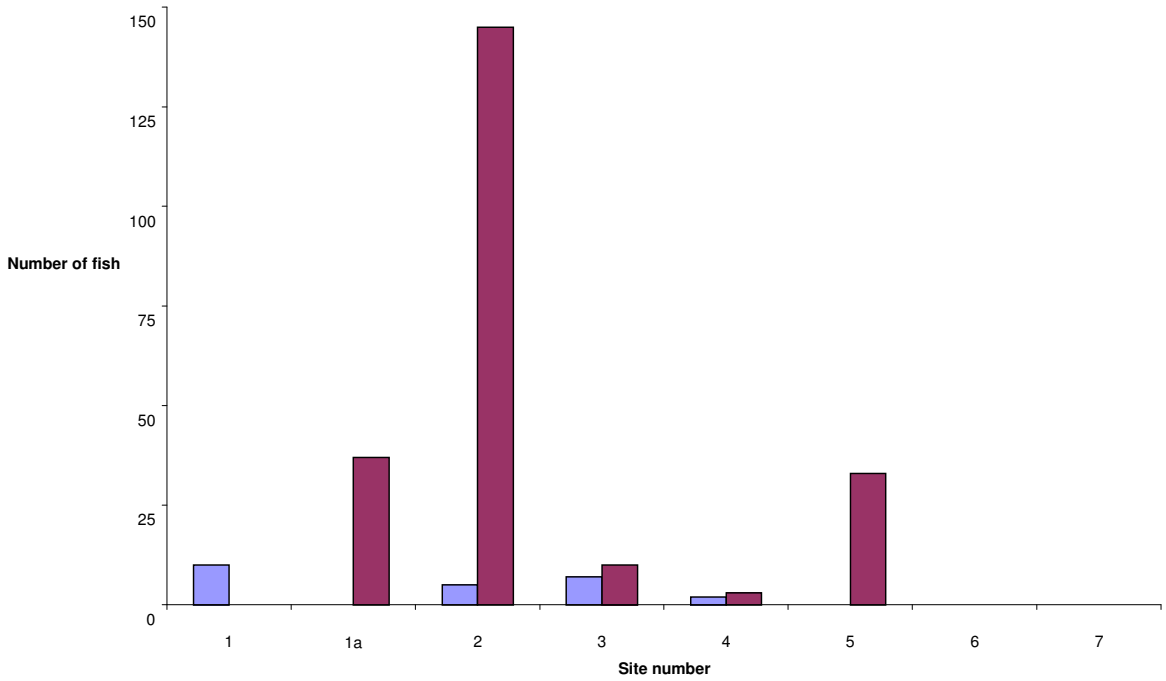

Figure 11. Comparative abundances and distribution of *Perca fluviatilis* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

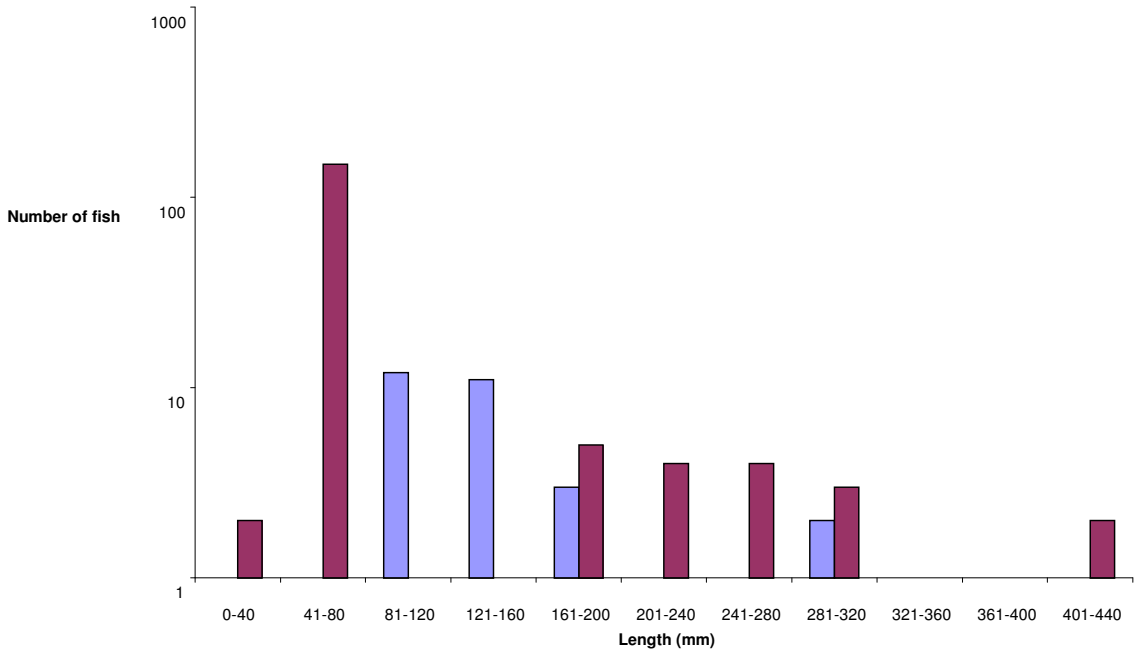

Figure 12. Comparison of length frequencies for *Perca fluviatilis* in Hollands Creek Data is presented on a $\log_{10}$ (x + 1) scale (Blue bars represent 2007 data, purple bars represent 2009 data).

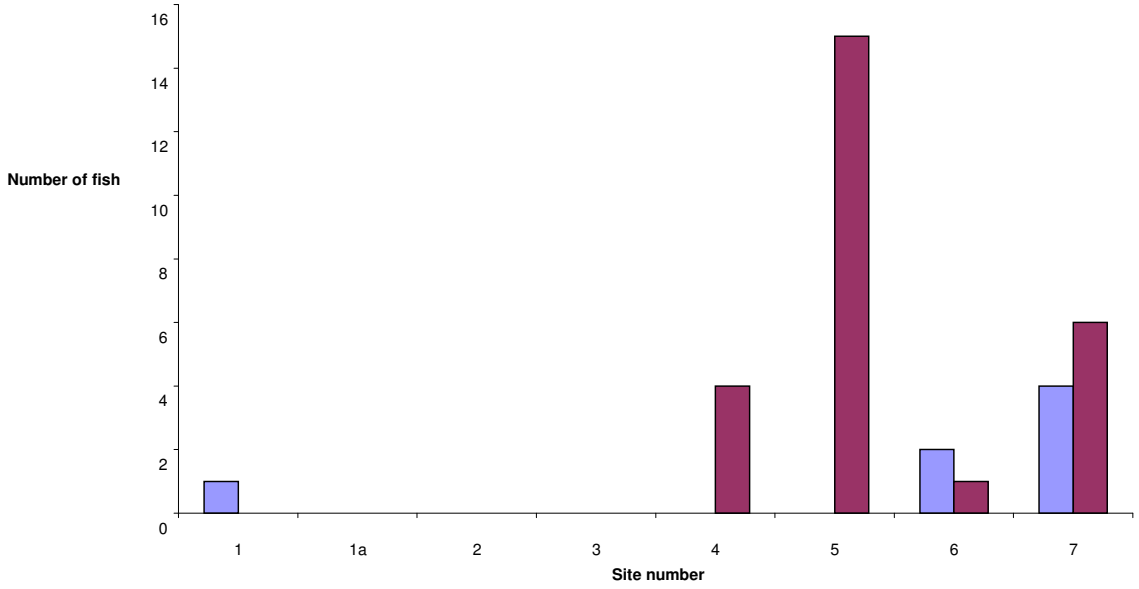

Figure 13. Comparative abundances and distribution of *Salmo trutta* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

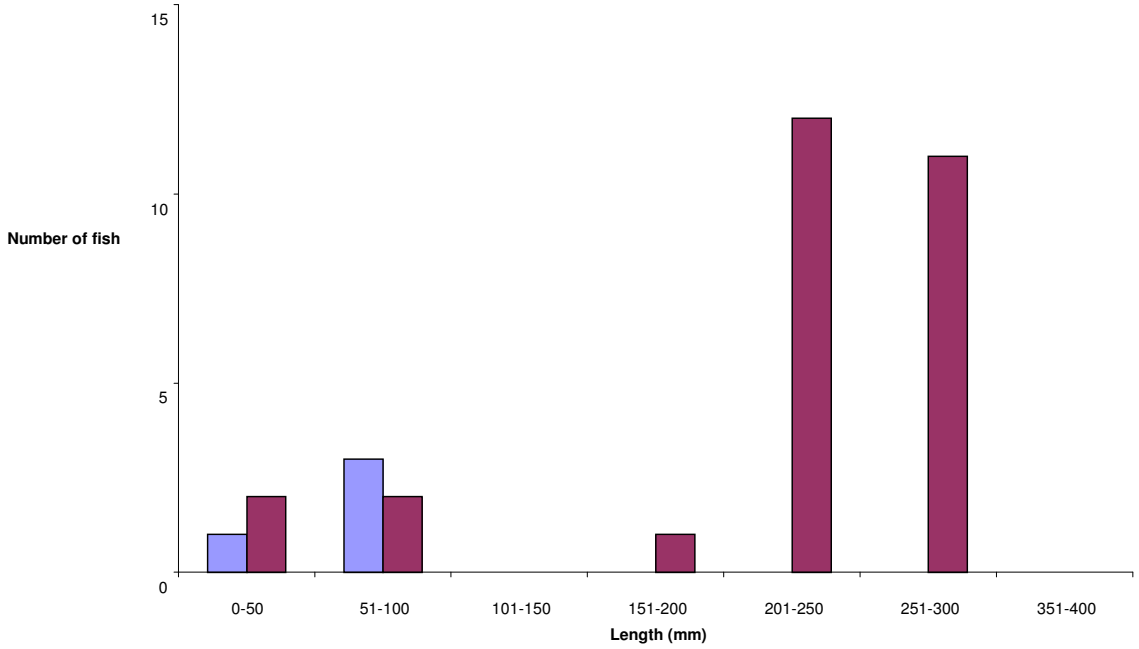

Figure 14. Comparison of length frequencies for *Salmo trutta* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

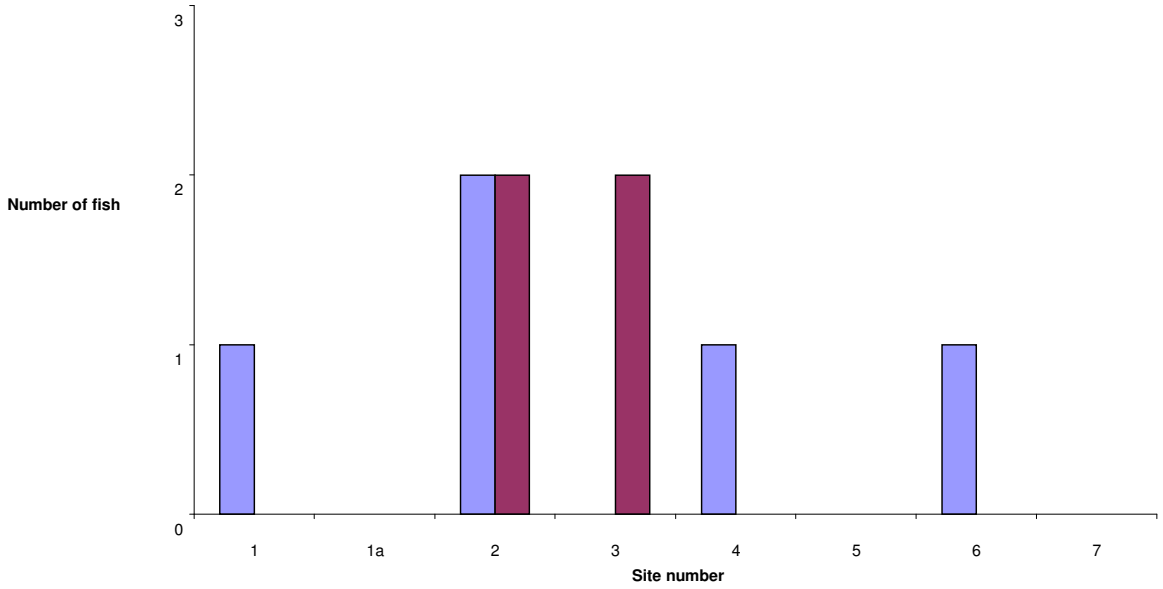

Figure 15. Comparative abundances and distribution of *Galaxias olidus* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

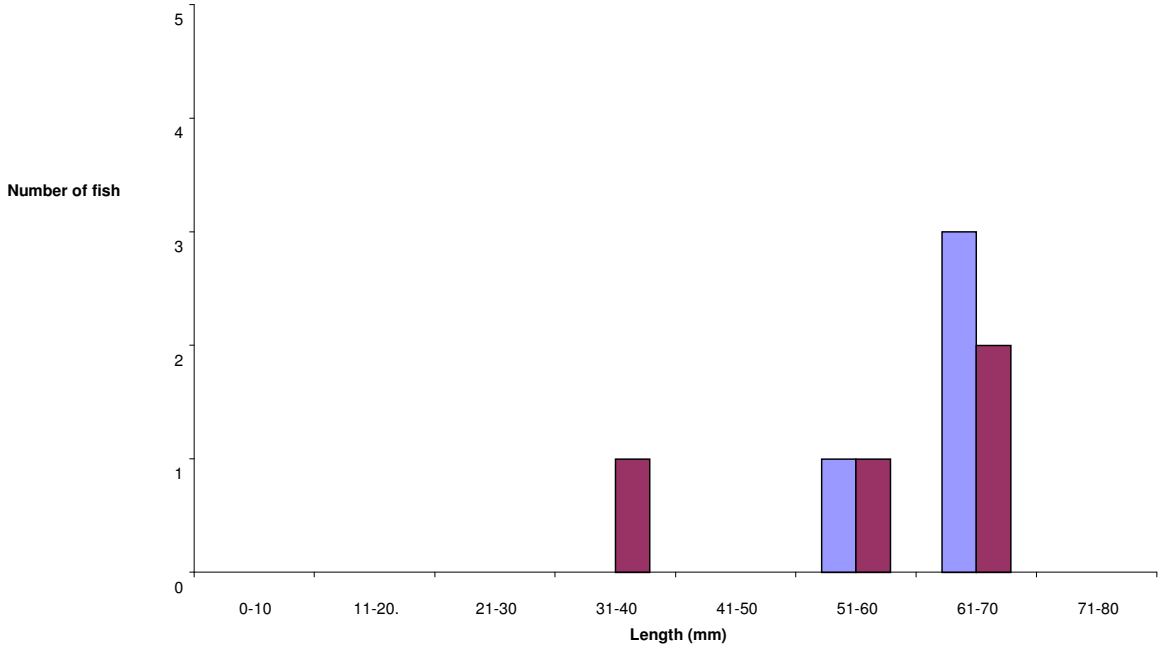

Figure 16. Comparison of length frequencies for *Galaxias olidus* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

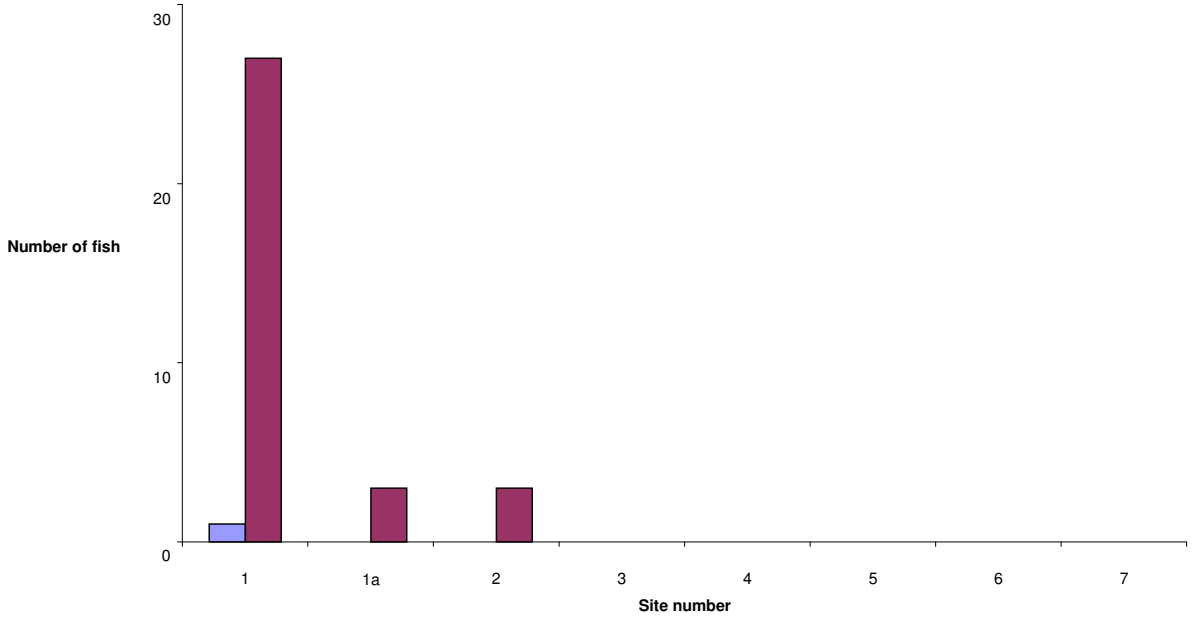

Figure 17. Comparative abundances and distribution of *Gambusia holbrooki* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

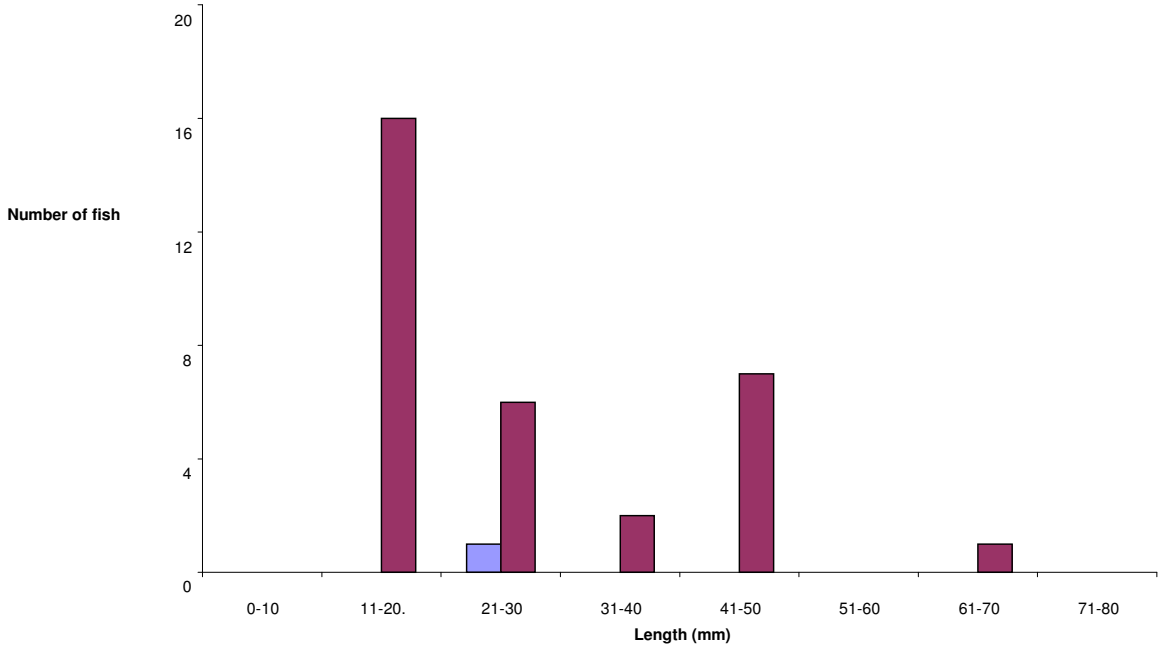

Figure 18. Comparison of length frequencies for *Gambusia holbrooki* in Hollands Creek (Blue bars represent 2007 data, purple bars represent 2009 data).

Distribution of fish

The majority (84%) of fish captured in the 2009 monitoring program were caught from monitoring sites 1 to 4. This value is lower than the 95% reported in the 2007 survey. The percentage increase in fish numbers from the top half of the demonstration reach is largely the result of the upstream colonisation of redfin and the increase in the upstream trout population. The presence of a 'rock shute' between sites 4 and 5 may act as a barrier to fish passage during times of low/no flow and may consequently prevent migratory species from moving upstream during these periods.

The high value species of the HCDR, Macquarie Perch, was only recorded from Site 1 during both the 2007 and 2009 fish surveys. This is consistent with the findings of Pritchard (2006) who failed to capture or sight individuals upstream of the bridge. While all Macquarie Perch were recorded from site 1, individuals of this species have previously been caught as far up as site 4 by anglers (pers. Comm., Max Campbell, Tatong Angling Club).

River blackfish were recorded from sites 1, 1a, 3 & 4 and were the dominant fish species recorded from sites 3 and 4 during the 2009 survey. The range of River blackfish has constricted over the last year due to their absence in site 5 which was previously represented by a single individual. River blackfish were absent from site 2 in the current survey where they existed in good numbers (21) in 2007. The loss of blackfish from site 2 corresponded with a 4-fold increase in redfin numbers within the same site.

Mountain galaxias were recorded from 4 sites during the 2007 survey and from 2 sites during the 2009 survey. Less than six galaxia were captured during each survey. No galaxia were recorded from sites inhabited by brown trout in the 2009 survey.

In contrast with the 2007 survey, gudgeons were not recorded from the 2009 fish survey of Hollands Creek. The absence of gudgeons in the current survey resulted in the loss of a native species compared with the 2007 fish survey.

Redfin were the numerically dominant fish species recorded from sites 1a, 2 and 5. While they were recorded from four sites in both surveys, their range has extended upstream to include site 5 where they were previously absent. Redfin have colonised site 5 in the past 14 months and share the site with good numbers of adult brown trout.

Brown trout were recorded from sites 4, 5, 6, and 7 (2009) extending their range by one site compared with the 2007 survey. The previous record of a single trout from site 1 was not repeated in the current survey; however, trout were recorded from 2 previously unrecorded sites (4 and 7).

Mosquitofish, *Gambusia holbrooki*, have extended their range upstream from site 1 in 2007 to include sites 2 and 3 in the current survey. The dramatic increase in number and distribution of the live-bearing Mosquito fish is consistent with the findings of Allen *et a*l. (2003) who found that mosquitofish 'can increase in number rapidly and are considered a pest in Australia. Current low flow conditions and relatively high temperatures are creating shallow, warm waters suitable for Gambusia.

4 Community engagement

The Hollands Creek Demonstration Reach has continued to partner the community and government agencies in planning and delivering works to support native fish. The Hollands Creek Demonstration Reach Community Reference Group continues to meet every second month and maintains a strong commitment to the project. The Group comprises landholders and representatives from the Tatong Anglers Group, Molyullah-Tatong Tree and Land Protection Group, Landcare, Tatong Village, the Goulburn-Broken Catchment Management Authority, Arthur Rylah Institute (DSE), Department of Primary Industries (DPI) and the Benalla City Council. Landholders have continued to welcome and be supportive of works on their properties.

A Field Day held on the 9th November, 2008 attracted 45 people and involved a Taungurung (indigenous group) Welcome to Country and storytelling, an electrofishing demonstration in the creek, children's activities, a Waterwatch display, heritage display and presentations by the MDBC Native Fish Strategy State Co-ordinator, Fern Hames, and stream ecologist Tim Doeg. The Tatong Anglers Group provided a barbeque lunch. Participants then inspected some of the works along the creek, including fencing and weed control, led by landholders and GBCMA staff (Figure 17).

The Hollands Creek Demonstration Reach Community Reference Group, with the local Heritage group, has secured funding to create a series of double-sided information shelters. Project stickers and Information Sheets have continued to be distributed and the webpage maintained on the GBCMA website (Appendix B). http://www.gbcma.vic.gov.au/Hollandscreek/

Figure 19. Hollands Creek Field Day 2008. Clockwise from top left; stream ecology talk (Tim Doeg), Taungurung storytelling (Uncle Larry Walsh), Waterwatch display (Danni Beischer), discussion of works on Fay Crowe's property (W Tennant and G Brennan) and kids playing the 'Fish Heads' game.

5 Works program for the HCDR

The current project commissioned the development of a works and activities plan for the rehabilitation and protection of sites within the Holland Creek Demonstration Reach. The original works plan (Appendix C) has been modified due to landholder consent issues. A revised works plan (Table 4) was created to enhance fish habitat throughout the reach with a focus on providing suitable habitat for future Macquarie perch translocation. The new works program begins at the Swanpool Road Bridge (Tatong) extending upstream to the confluence of Hollands and Spring Creeks (Figure 20). Prioritisation and recommended works have been based upon preserving and extending habitat continuity and potential range of Macquarie Perch.

This report prioritises sub-reaches for rehabilitation and protection based upon key criteria including:

- Proximity to known Macquarie Perch populations;
- Landowner and community involvement and support;
- Habitat quality and suitability for Macquarie Perch; and
- Potential for restoration.

Hollands Creek has been identified as a high priority reach within the Goulburn Broken Catchment under the GB Regional River Health Strategy (GBCMA, 2005). The presence of a remnant population of the critically endangered Macquarie Perch has been identified as a high value asset within the Hollands Creek Catchment. This document outlines targeted management actions developed to increase the abundance and distribution of native fish within the reach.

The works and activities plan conducted by the GBCMA (GBCMA, 2008) outlines a draft for the types of works required to improve the status of each monitoring site within the HCDR. The planned works are based on a combination of ISC, Habitat Hectares, Crown Frontage, Water quality and past records of the abundance and distribution of Macquarie Perch. The GBCMA have produced a detailed site specific action plan incorporating timelines, types of works, works/rehabilitation methods, works priorities, and costing for the HCDR project (GBCMA,

2008). A detailed in-stream works program has been developed for the HCDR in an effort to improve available fish habitat and enhance refugia for fish during times of no/low flow (Table 4).

A range of river rehabilitation techniques have be used to improve the health of the HCDR. These techniques include:

- fencing off stock access to the river
- the introduction of in-stream fish habitat (snags and rocks)
- the removal of riparian weeds
- promotion of fish passage
- re-vegetation of the riparian zone with local native plants and grasses
- installation of rock-bars
- rock-seeding to prevent bank collapse/erosion

A number of rehabilitation activities have taken place within the HCDR since the last report was completed (Slides 1 to 6). A summary of these rehabilitation works are outlined in Table 3. Replanting within the riparian zone will take place following suitable winter/spring rainfall. The benefits of these management works to river health and native fish communities have been well documented (Barrett & Ansell, 2003; Brooks & Lake, 2007). Table 4 outlines the revised in-stream works plan, detailing the activity undertaken at each of the nominated work sites, locations, progress and links between works and monitoring sites.

Table 3. Rehabilitation works conducted within the HCDR in 2008/9.

Work activity *	Length of stream (km)	Status
Fencing	3.5	Completed
Willow poisoning	2.3	Completed
Willow removal	2.3	Completed
Weed control	6.55	On-going
Re-snagging	5.2	Completed
Rock-seeding	0.75	Completed
Rock-bar	1.5	Completed

- **Data used in Table 3 was provided by Geoff Brennan, Works Manager, GBCMA**

Table 4. Summary of revised in-stream works plan for the HCDR 2008/9

Work site	Recommended activities*	Works progress	Location	Comment / Monitoring link
W1	Insertion of 8 snags	Completed	Within 100m up-stream of Swanpool Tatong Rd. bridge	• Habitat for proposed translocation of perch. • Below monitoring site 1 • Proposed monitoring site
W2	Installation of a rock bar across creek with vertical slots at one end to promote fish passage	On-going	100m up-stream of Swanpool Tatong Rd. bridge	• To raise water level in up-stream pools during low flows (refuge pools) • To increase connectivity between up-stream habitats • Below monitoring site 1
W3	Insertion of 10 snags	On-going	700m up-stream of Swanpool Tatong bridge GPS: Lat – S 36 73.877 Lon - E 146 10.472	• To increase fish habitat and habitat complexity • Within monitoring site 1
W4	Installation of retaining wall/groyne	On-going	GPS: Lat – S 36 75.025 Lon - E 146 11.462	• To maintain water flow in main channel for fish passage between pools
W5	Installation of a rock bar across creek with vertical slots at one end to promote fish passage	Completed	McCauleys Crossing GPS: Lat - S 36 75.828 Lon – E146 12.051	• To raise water level in up-stream pools during low flows (refuge pools) • To increase connectivity between up-stream habitats. • Proposed monitoring site. • Between monitoring sites 2 and 3

W6	Insertion of 20 snags	9 snags inserted	Monitoring site 4 GPS: Lat – S 36 77.323 Lon – E 146 13.531	• To increase fish habitat and habitat complexity • Snags placed within monitoring site 4
W7	Rock-beaching (60m)	On-going	Top of monitoring site 4	• To increase fish habitat and habitat complexity • To protect the RHS creek bank from further erosion and collapse
W8	Insertion of 9 snags	Completed	500m above monitoring site 4 GPS: 550422872 (E) 5929107 (N)	• Habitat for proposed translocation of perch • Between monitoring sites 4 and 5
W9	Insertion of 5 snags	Completed	Pool above W8	• Habitat for proposed translocation of perch • Between monitoring sites 4 and 5
W10	Insertion of 7 snags	Completed	Proposed stock crossing (FC) GPS: 550422308 (E) 5925226 (N)	• Habitat for proposed translocation of perch • Between monitoring sites 6 and 7
W11	Insertion of 5 snags	Completed	400m up-stream of W7 GPS: 550422267 (E) 5924829	• Habitat for proposed translocation of perch • Between monitoring sites 6 and 7
W12	Insertion of 3 snags Insertion of 5 rocks ($1m^3$)	3 snags inserted 1, $2m^3$ rock inserted	Pool 50m below Spring and Hollands Creeks confluence	• Habitat for proposed translocation of perch • Above monitoring site 7

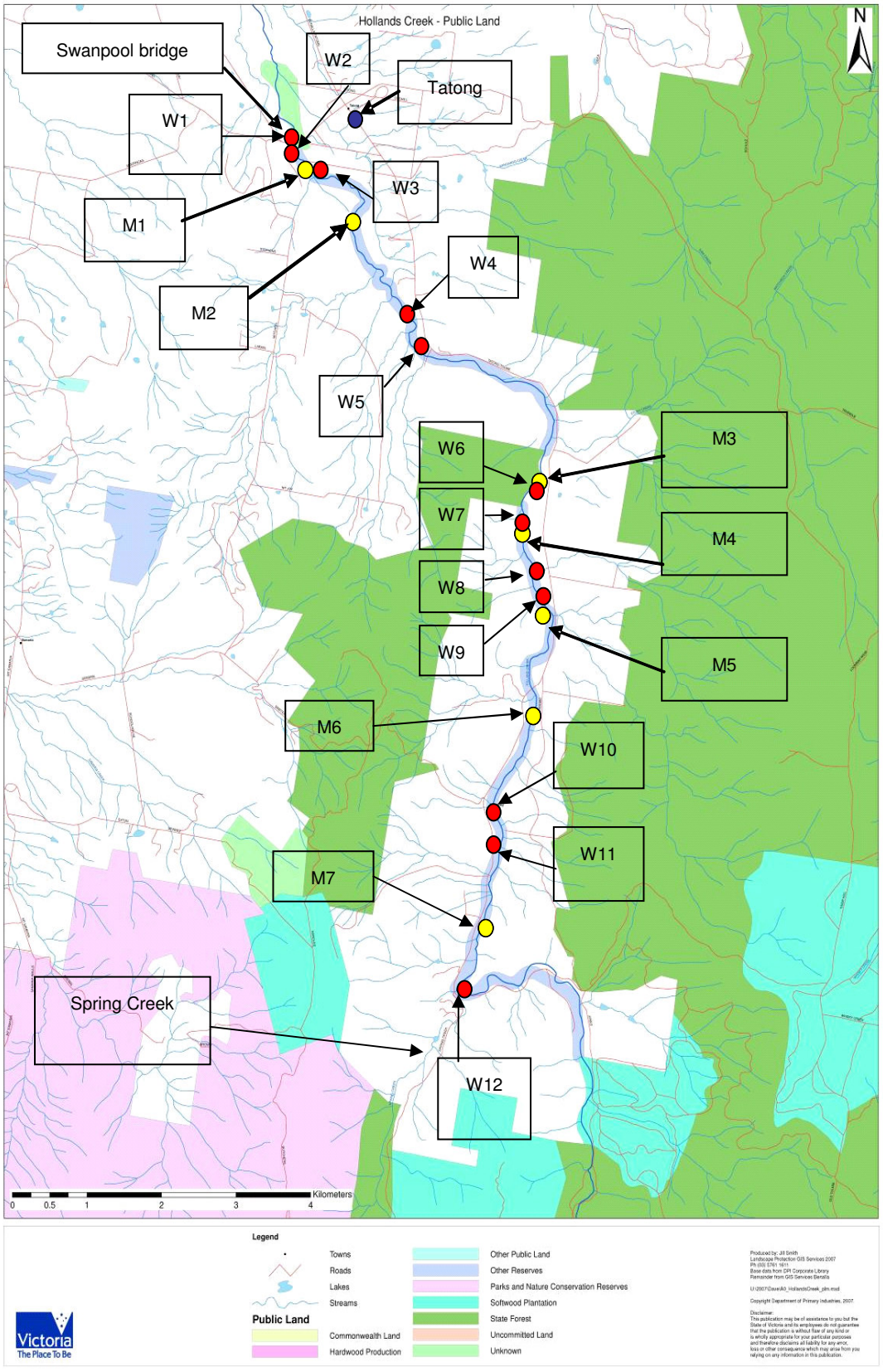

Figure 20. Map of the HCDR with monitoring (M 1-7, yellow circles) and in-stream work (W 1-12, red circles) sites

Slide 1. Re-vegetation works (monitoring site 6) carried out by landholder

Slide 2. Construction of fencing (monitoring sites 3 and 4)

Slide 3. Re-snagging (monitoring site 3)

Slide 4. Construction of rock-bar at McCauleys Crossing.

Slide 5. Willow removal (monitoring site 3)

Slide 6. Rock-seeding (monitoring site 3)

6 Discussion

Three native and three introduced fish species were recorded from the 2008/9 HCDR fish monitoring program, representing a loss of one native species (Gudgeon sp.) since 2007. A comparison of the 2009 fish assemblage and water quality parameters with 2007 results raised a number of issues. These issues include declining water quality, restricted distribution, size and abundance of Macquarie Perch, an increase in exotic species abundance and distribution, declining range of blackfish and the loss of gudgeons recorded from the creek.

Water quality declined from November 2007 to January 2009 within the HCDR. Tested water quality data showed that in general, salinity, turbidity and temperature increased across monitoring sites from 2007 to 2009 while DO levels fell. The fall in DO levels below 5mg/L in six of the eight monitoring sites indicate the fish community within the reach may be experiencing physiological stress (Koehn and O'Connor, 1990). The decline in water quality was largely attributed to seasonal variation and the on-going drought which resulted in a lack of flow during the 2009 monitoring program.

The drought has had a significant impact on the water quality of Hollands Creek. Drought conditions have led to the depletion of tanks, dams and off-stream watering systems. Stock are likely to be consuming water from 'fish refuge' holes, trampling vegetation, and increasing bank erosion leading to increased nutrient loads within the creek. This scenario contributes to increased turbidity and lower dissolved oxygen levels while ever decreasing water levels within stagnant pools lead to an increase in the concentration of salts in the water. These factors may in isolation and in combination significantly impact on the health of the fish within the creek. Sufficient winter rains and/or a breaking of the drought should ameliorate many of the current problems associated with declining water quality within the HCDR.

The current survey (2009) resulted in the capture of 380 fish: significantly more than the 2007 survey of 132 individuals. The three-fold increase in fish was largely a result of the increase in alien fish species, particularly redfin (10-fold increase), trout (from 3 to 24 individuals) and Mosquito fish (from 1 to 33 individuals). The observation that 92% of the redfin were less than 70mm in length suggests that they are a result of the 2007 spawning event as they usually attain a length of 40-70mm after their first year (Backhouse and Cadwallader, 1983). The stocking of

1,000 Brown trout in April 2008 may contribute to the total numbers of alien species in general. The lack of flow in the bottom half of the reach may account for the increase in Mosquito fish numbers.

The reduction in Macquarie Perch numbers from 11 to 5 individuals from a single pool within the HCDR is cause for concern. The average size of Macquarie Perch has increased annually with no recruitment evident. Recruitment of Macquarie Perch was last reported by Pritchard (2006) from a pool directly below the Swanpool Bridge which is currently dry. A site investigation carried out in April 2009 by ARI staff noted that no suitable Macquarie Perch habitat existed within the 2km section of creek below the Swanpool Bridge.

The absence of Macquarie Perch smaller than 270 mm may be the result of a number of factors. These factors may include; problems with egg/sperm production, fertilisation, hatching and/or recruitment of individuals. A number of other factors including siltation, predation, pollutants and/or the interruption of spawning cues may have contributed to the lack of smaller Macquarie Perch recorded. The factors responsible for the lack of smaller individuals within the Macquarie Perch population are not clear. It is clear that the continued inability to recruit smaller individuals will have a detrimental impact on the long-term survival of the critically endangered Macquarie Perch population within the HCDR. In light of this situation, we recommend that Macquarie Perch be translocated into the HCDR. Macquarie Perch may be sourced from the Yarra River in the short-term while a proposed breeding program at the Snobs Creek Centre may provide fish in the future. A number of locations for the translocation of Macquarie Perch have been investigated by ARI and GBCMA staff.

Redfin (English perch) may pose a significant threat to the Macquarie Perch population as well as populations of other native species as they are known hosts of the Epizootic Haematopoietic Necrosis Virus (EHNV). The virus has been linked with declining numbers of Macquarie Perch in recent decades (Whittington *et al*., 1999; Allen *et a*l., 2003). Native Australian fish are very susceptible to the virus which has been recorded to exterminate localised fish populations (Whittington *et al*., 1999). English perch may also compete with native fish for food and habitat. The four-fold increase in redfin numbers corresponded with the loss of blackfish and the Mountain galaxia in site 4 and the loss of blackfish after their recent movement into site 5.

The increased abundance of Brown trout in the upper reaches of the HCDR may affect native fish populations as a result of direct predation and competition for food and habitat. This concern is supported by the GBCMA who have recently listed trout as a 'species likely to have a negative impact on local native species within Hollands Creek' (GBCMA, 2008). The recent occurrence of trout captured within site four may explain the loss of gudgeons from this location as trout have been reported to prey on small-bodied native species resulting in their localised extinction (Saddlier and Raadik, 1995; Raadik, 2002). Brown trout may also significantly impact the blackfish and galaxia populations within the HCDR, as well as on smaller individuals of larger bodied fish within the HCDR.

The abundance of Mosquitofish within the lower part of the HCDR has dramatically increased over the last 14 months. Mosquitofish are listed as noxious in Victoria where they have had a detrimental impact on local native fish, amphibian and macro invertebrate populations. Mosquitofish have a preference for slow flowing or still waterbodies and are tolerant to poor water conditions (Allen *et al*., 2003). This may explain the increase in their numbers within the lower section of the Hollands Creek under current conditions. Many of the Hollands Creek Mosquitofish were noted to be in breeding condition. Their ability to reach plague proportions may further extend their distribution within the creek in the future.

While the overall abundance of blackfish within the HCDR remained constant between survey years, they were not recorded from two previously known locations (sites two and five) in 2009. The loss of blackfish from sites two and five coincides with a dramatic increase in redfin abundance and the capture of trout, respectively. The restricted home-range of river blackfish (within 20 – 30 m, [Allen *et al*., 2003]) indicates that the removal of blackfish from sites two and five may have long-term effects on their ability to re-colonise these sites. The range in size of blackfish from sites 1, 1a, 3 and 4 are indicative of a viable, self-sustaining fish population.

Community engagement has been an ongoing process from the inception of the 'Demonstration Reach' project. To date, local landowners have shown considerable interest and support for the project. Many of the landowners have actively removed weeds and installed off-stream watering points to remove the impact of stock from the creek bed and surrounding areas. The primary aim of community engagement was to gain support from and educate landowners and other stakeholders in the running of the program. Ultimately, it is expected that community groups shall take over the care

of the reach. The significant interest, support and active help from landowners and other local interest groups has led to the current strength of the HCDR project.

The works program outlined for the HCDR has commenced. The removal of weeds, fencing to restrict stock access, bank protection works, and a comprehensive, site-specific active works plan has been proposed. Works include the introduction of rock-bars, rocks and snags (Appendix C), further weed removal and re-vegetation for identified sites. The locations proposed for the translocation of Macquarie Perch have also been determined. The works have commenced and are proposed to be completed over the following two to three years. It is important to note the ongoing fluidity of the works plan to adapt to suggestions made in the annual DSE Summary document to ensure the long-term success of the project.

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Appendix A

Table 5. Fish species and abundances recorded from Ryans Creek, 2009

Site number	Fish species						
	Gadopsis marmoratus	*Galaxias olidus*	*Galaxias maculatus*	*Perca fluviatilis*	*Gambusia holbrooki*	*Salmo trutta*	*Carassius auratus*
1	3			2	20	1	
2	52	1		2	18		6
3	22				30		
4	7		12		9		
Totals	84	1	12	4	77	1	6

Table 6. Water quality data for Ryans Creek 2009

	Measured water quality characteristics				
Site number	Electrical conductivity (µS/cm)	Temperature (^{o}C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	pH
1	94.1	24.7	5.7	17	8.4
2	48.5	22.2	6.0	6.8	8.3
3	45.8	23.5	6.0	32	7.0
4	31.6	27.9	7.1	3.1	7.0

Appendix B

Hollands Creek Demonstration Reach

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Appendix C

Hollands Creek Demonstration Reach: ARI recommendations for the GBCMA 2009 Works Program.

This document outlines a number of site specific in-stream works aimed at increasing the abundance and distribution of native fish within the Hollands Creek Demonstration Reach (HCDR). These recommendations are in addition to other works co-ordinated under the existing GBCMA works program. As Macquarie Perch, *Macquaria australasica*, have been listed as a priority species within the HCDR our recommendations focus on increasing the abundance and distribution of this species.

Past fish surveys of the region (Pritchard, 2006; Raymond *et. al*., 2008) show that Macquarie Perch have been caught within pools below the Swanpool bridge on Tatong-Moorngag Rd, Tatong and from a single pool in the lower section of the HCDR (site one). No Macquarie Perch were recorded from pools in the top half of site one or from sites further upstream during the 2008 survey. Anecdotal evidence suggests that the fish were in greater numbers over a wider distribution than currently observed. The recommended works outlined in this report fall within two categories; the addition of in-stream habitat and the removal of barriers to fish movement.

In-stream habitat

The addition of in-stream habitat will be achieved by adding Large Woody Debris (LWD, snags) and/or rocks into pools devoid of suitable Macquarie Perch habitat. As Macquarie Perch have been associated with and captured from pools containing LWD and rocks, the increase in habitat complexity within pools should result in an increase in fish abundance within the HCDR. The improvement in habitat complexity will provide Macquarie Perch and other native fish with additional food resources and shelter. Much of the pre-existing LWD has been removed from within the Demonstration Reach (pers. Comm., Kevin Smith) for flood mitigation, creek access and fire wood. The addition of LWD at 11 sites and rocks at three sites (Table 1) within the HCDR is to provide refuge for Macquarie Perch during times of low/no flow and to increase the number of fish within the reach. Rocks shall also be used for bank shoring purposes with the indirect benefit of providing additional habitat.

Barriers to fish movement

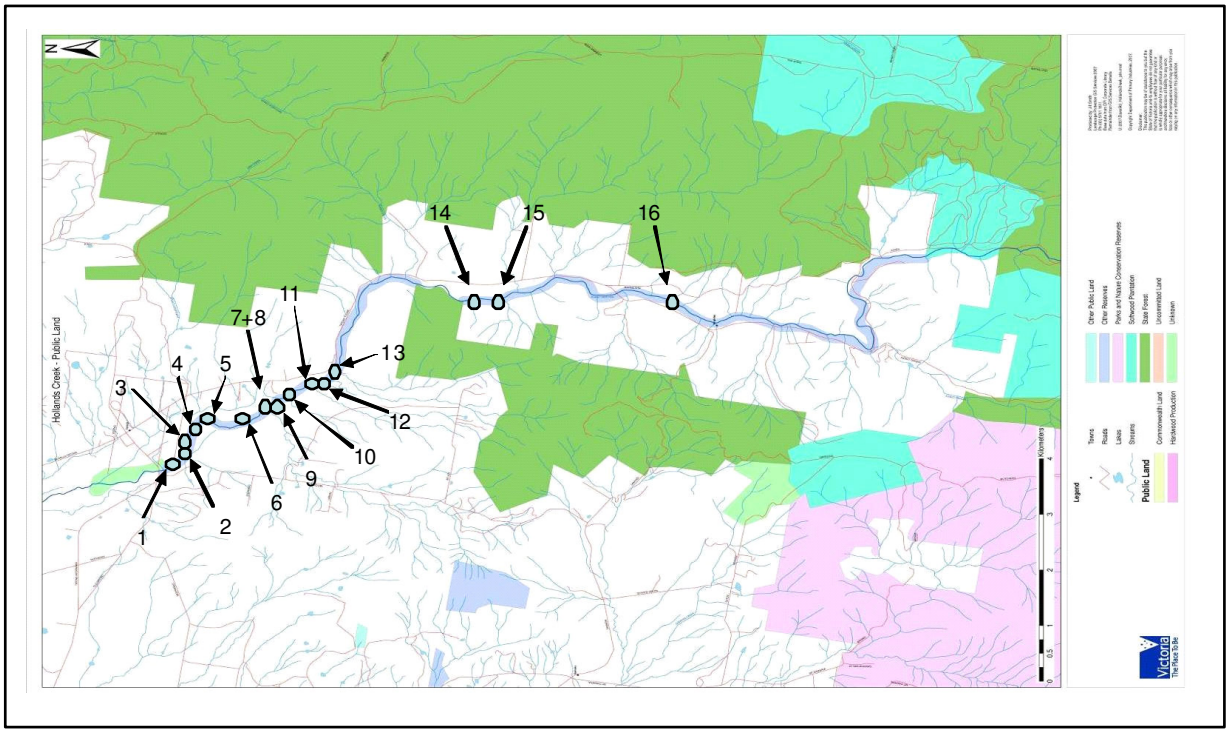
The removal of barriers to fish movement aims to improve connectivity between sites to promote the movement of fish within the reach. Currently, the existence of three Fords (Haupman property [top and bottom ford] and MacCauleys Crossing) act as potential barriers to the movement of fish within the reach. It is our aim to remove these barriers to fish. A number of strategies exist to overcome the problem of connectivity and fish movement created by the existing Fords. The use of rock-bars across the creek results in the creation of weir pools. These weir pools will result in higher up-stream water levels and consequently provide fish with improved access to these regions. Slots for fish passage will be incorporated into the design of the rock-bars. The introduction of in-stream habitat into the created weir pools would provide fish with refuge in times of low flow.

The increase in available habitat and connectivity between suitable habitats (as a result of in-stream works), is likely to result in an increase in native fish abundance and distribution with the Hollands Creek Demonstration Reach. The specifications for the works suggested in this report shall be determined by collaboration with the GBCMA.

Suggested specifications for LWD and rocks for in-stream habitat

- Use complex timber when possible (‘root-balls’ and regions with the highest branch counts).
- Use recently fallen timber as it is heavier than old timber (reduces the likelihood of downstream movement)
- The trunk circumference of the timber used for habitat should approximate 1 to 1.5m.
- The timber should be grouped together during installation to provide the greatest habitat complexity.
- It is preferable to have the largest timber on the bottom of the 'snag stack' with smaller timber over the top of the large snags.
- The trunks of the 'root balls' should face down stream while the trunks with complex branches should face up-stream to simulate natural conditions.
- The in-stream timber is preferably situated in the deep sections of the outer banks.
- ‘habitat’ rocks should approximate 1-2m^3 in size.

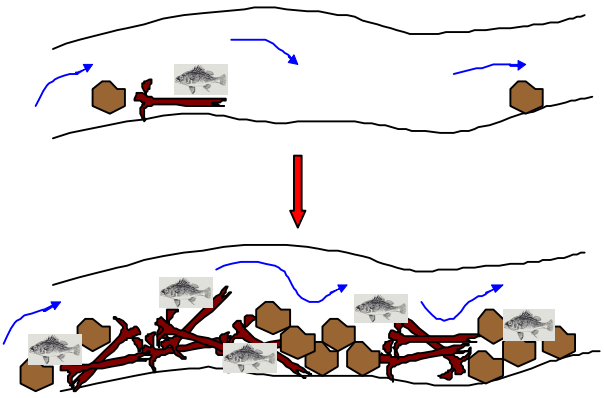
Figure 1. Map of the Holland's Creek Demonstration Reach outlining site locations for recommended works



Site 1

Pool below power lines
300m u/s of Swanpool bridge

Latitude: S 36° 73.836
Longitude: E 146° 10.353



Existing condition:

• lacking habitat

Proposed works:

• Introduction of 10 snags
• Introduction of rocks

Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

To be determined:

• Source of snags/rocks

Site 2

700m u/s of Swanpool bridge

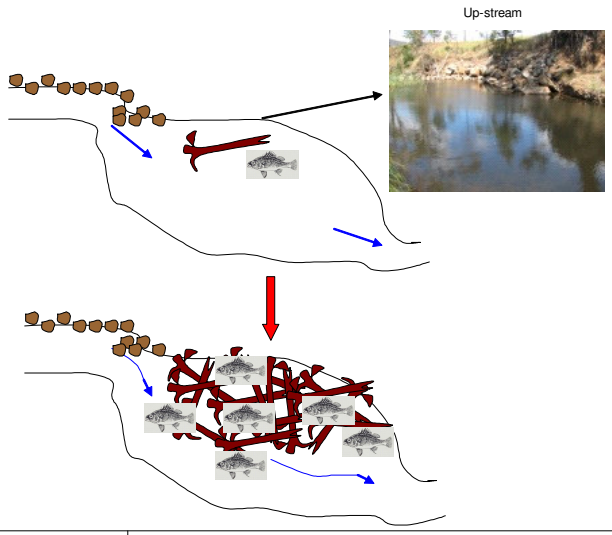
Latitude: S 36° 73.877
Longitude: E 146° 10.472

Existing condition:

• Lacking in-stream habitat

Proposed works:

• Introduction of 10 snags



Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

To be determined:

• Source of snags
• bank access for snag placement?

Site 3

900m u/s of Swanpool bridge

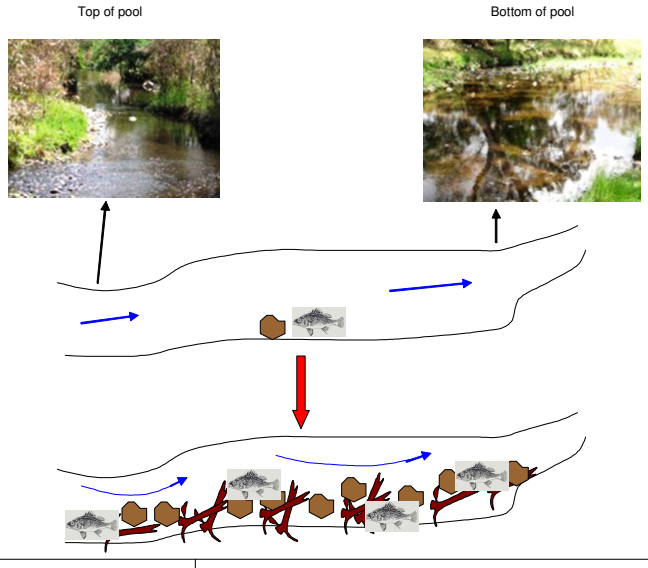
Latitude: S 36° 74.066
Longitude: E 146° 11.043

Existing condition:

• Lacking in-stream habitat

Proposed works:

• Introduction of 10 snags
• Introduction of 10 rocks



Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.
• to create scour pools through pool

To be determined:

• Source of snags and rocks
• bank access for snag placement?
• size of rocks

Site 4

Haupman bottom ford

(1km u/s of Swanpool bridge)

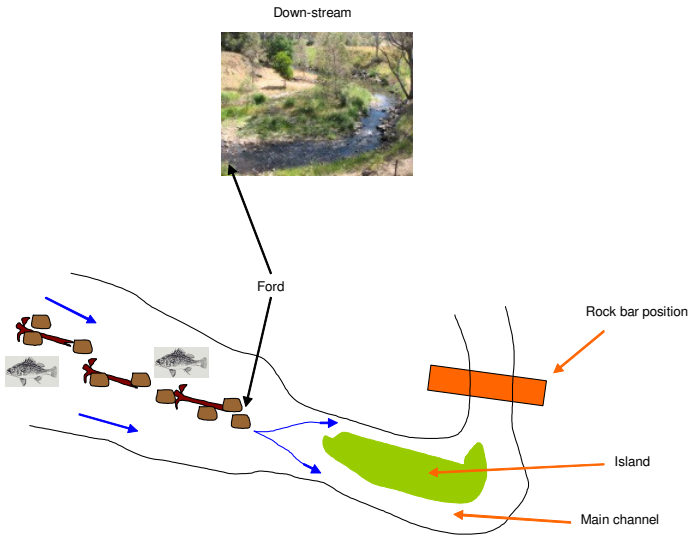
Latitude: S 36° 73.834
Longitude: E 146° 10.624

Existing condition:

- disconnected pools
- very shallow and wide section above riffle (ford)
- creek splits, reducing flow through main channel

Proposed works:

- installation of a rock bar across creek with vertical slots at one end to promote fish passage
- put 3 or 4 snags and some rock immediately above ford



Purpose of works:

- to create a weir pool above rock bar (increase water level above bar)
- to improve connectivity between pools
- to create 'refugia' for fish during low/no flow situations
- to improve fish passage and migration

To be determined:

- Engineering and design of rock bar (GBCMA)

Site 5

70m d/s of top Haupman Ford

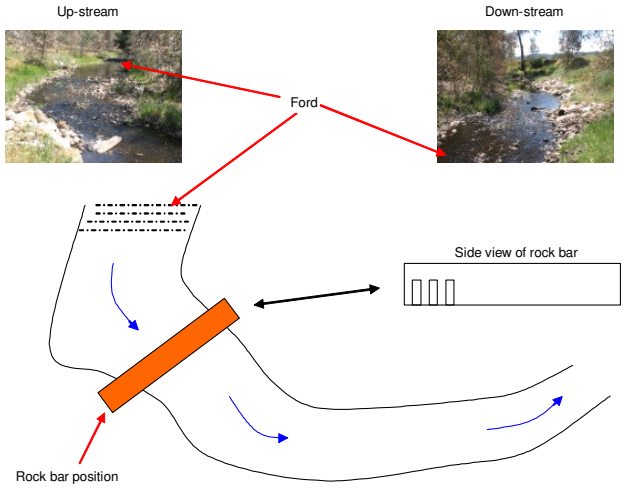
Latitude: S 36° 74.143
Longitude: E 146° 11.111

Existing condition:

- Long shallow riffle between pools
- very shallow and wide section above riffle (ford)

Proposed works:

- installation of a rock bar across creek with vertical slots at one end to promote fish passage



Purpose of works:

- to create a weir pool above rock bar (increase water level above bar)
- to improve connectivity between pools
- to create 'refugia' for fish during low/no flow situations
- to improve fish passage and migration

To be determined:

- Engineering and design of rock bar (GBCMA)

Site 6

Deep pool on Haupman property

Latitude: S 36º 74.203
Longitude: E 146º 11.035

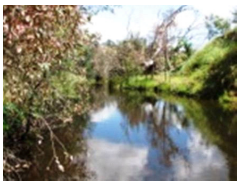
Existing condition:

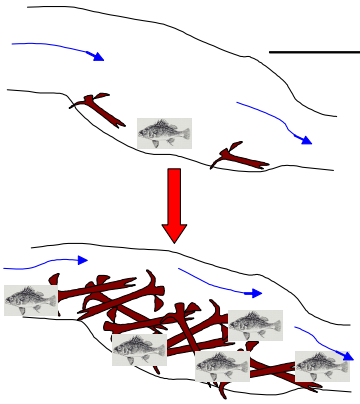
• Lacking habitat

Proposed works:

• introduction of 10 snags

Up-stream





Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

To be determined:

• Source of snags
• bank access for snag placement?

Site 7

Bottom of Deep pool on Haupman property

Latitude: S 36º 74.259
Longitude: E 146º 10.962

Up-stream

Main channel

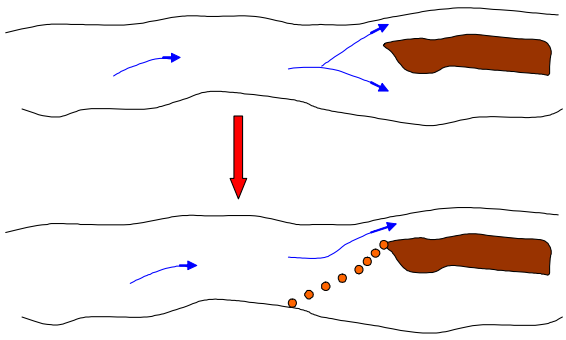
Down-stream

Existing condition:

• 20-30% of flow is over shallow, wide rocky section down LHB

Proposed works:

• install groynes, rocks to divert full flow down RHB



Purpose of works:

• to provide flow for fish movement between pools via deepening of channel

To be determined:

• groyne or rock structure used in works

Site 8

Top of Deep pool on Haupman property

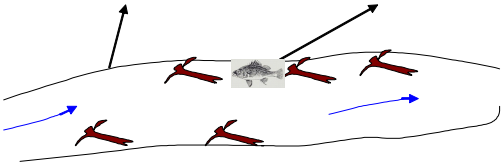
Latitude: S 36° 74.269
Longitude: E 146° 10.950

Downstream

Side view

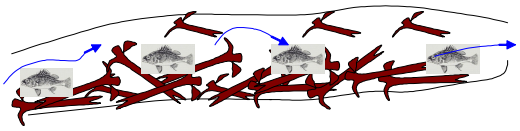
Existing condition:

• Lacking habitat



Proposed works:

• introduction of 10 snags



Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

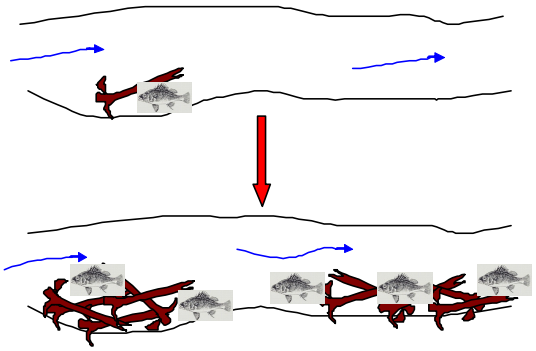
To be determined:

• Source of snags
• bank access for snag placement - LHB

Site 9

100m upstream of site 8

Latitude: S 36°74.299
Longitude: E 146°10.931



Existing condition:

• Lacking habitat

Proposed works:

• introduction of 10 snags (5 at head of pool and 5 at tail of pool)

Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

To be determined:

• Source of snags
• bank access for snag placement?

Site 10

200m upstream of site 9

Latitude: S 36° 74.603
Longitude: E 146° 10.976

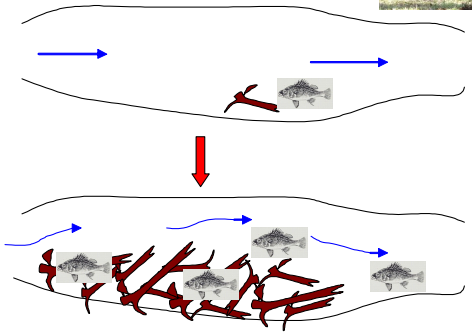
Side view

Existing condition:

• Lacking habitat

Proposed works:

• introduction of 10 snags



Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

To be determined:

• Source of snags
• bank access for snag placement - LHB

Site 11

500m d/s of Hakkeness home

Latitude: S 36° 74.686
Longitude: E 146° 11.070

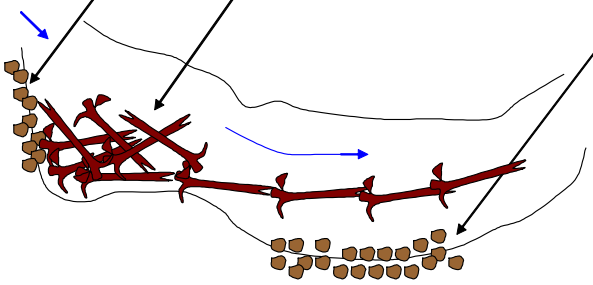
Down stream (top) | Up stream | Down stream (bottom)

Existing condition:

• Lacking habitat
• erosion/sedimentation occuring

Proposed works:

• introduction of 10 snags
• rocks for erosion control



Purpose of works:

• to provide habitat complexity for fish
• to promote fish refugia and movement through reach.

To be determined:

• Source of snags and rocks

Site 12

300m d/s of McCauley home

Latitude: S 36^0 75.025
Longitude: E 146^0 11.462

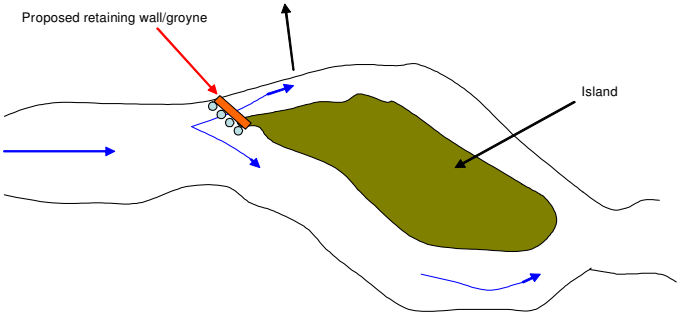
Existing condition:

• 30-40% of the water flow is diverted along the shallow RHB

Proposed works:

• Create a small (2 foot high) retaining wall/groynes to divert water away from RHB channel

Side view



Purpose of works:

• to divert water down the main creek channel along the LHB

• to maintain water height for fish passage and connectivity between pools

To be determined:

• material for retaining wall/ groynes (eg.timber, rock)

Site 13

McCauley's Crossing

Latitude: S 36° 75.828
Longitude: E 146° 12.051

Existing condition:

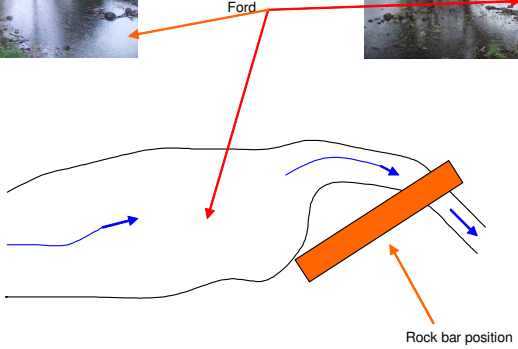
• Long shallow riffle between pools
• very shallow and wide section above riffle (ford)

Proposed works:

• installation of a rock bar across creek with vertical slots at one end to promote fish passage

Up-stream

Down-stream



Purpose of works:

• to create a weir pool above rock bar (increase water level above bar)
• to improve connectivity between pools
• to create 'refugia' for fish during low/no flow situations
• to improve fish passage and migration

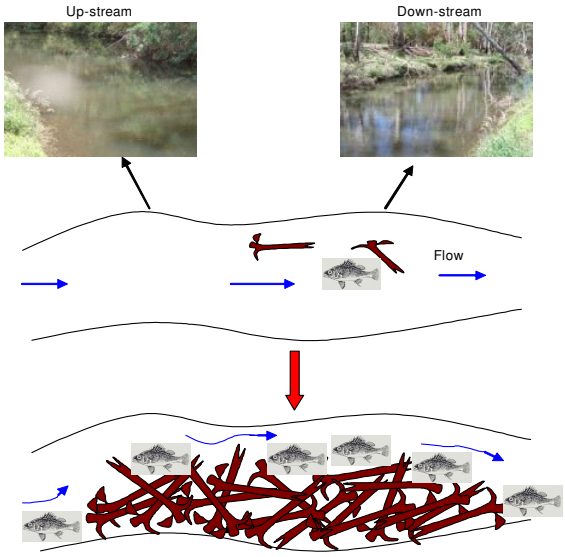
To be determined:

• Engineering and design of rock bar (GBCMA)

Site 14

400m d/s of KS property

Latitude: S 36^0 77.323
Longitude: E 146^0 13.531



Existing condition

- Lacking habitat
- uniform substrate

Proposed works:

- Introduction of 20 snags

Purpose of works:

- To provide habitat complexity for fish and to create scour pools
- To promote fish movement through reach.

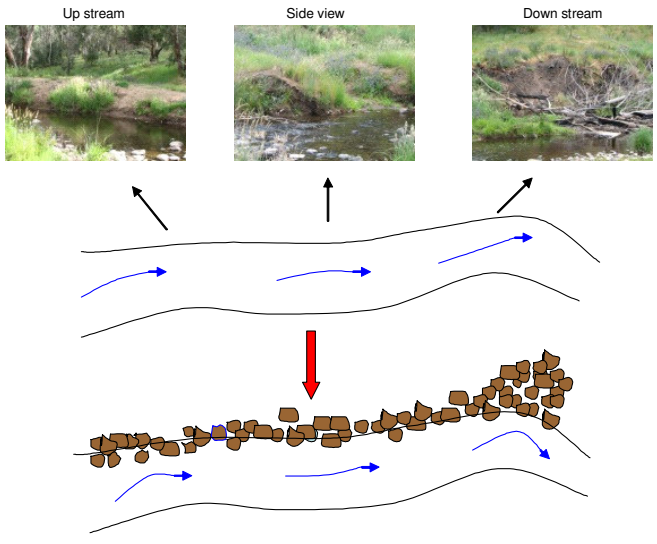
To be determined:

- source of snags

Site 15

50m d/s of KS property

Latitude: S 36^0 77.510
Longitude: E 146^0 13.444



Existing condition:

- Unprotected and eroding RHB

Proposed works:

- Rock beaching (approx. 60m)

Purpose of works:

- to provide bank support/ reduce erosion and sedimentation
- to improve habitat complexity
- to promote fish passage via channel incision
- improve connectivity between existing pools

To be determined:

- size and quantity of rocks
- pre-treatment of site

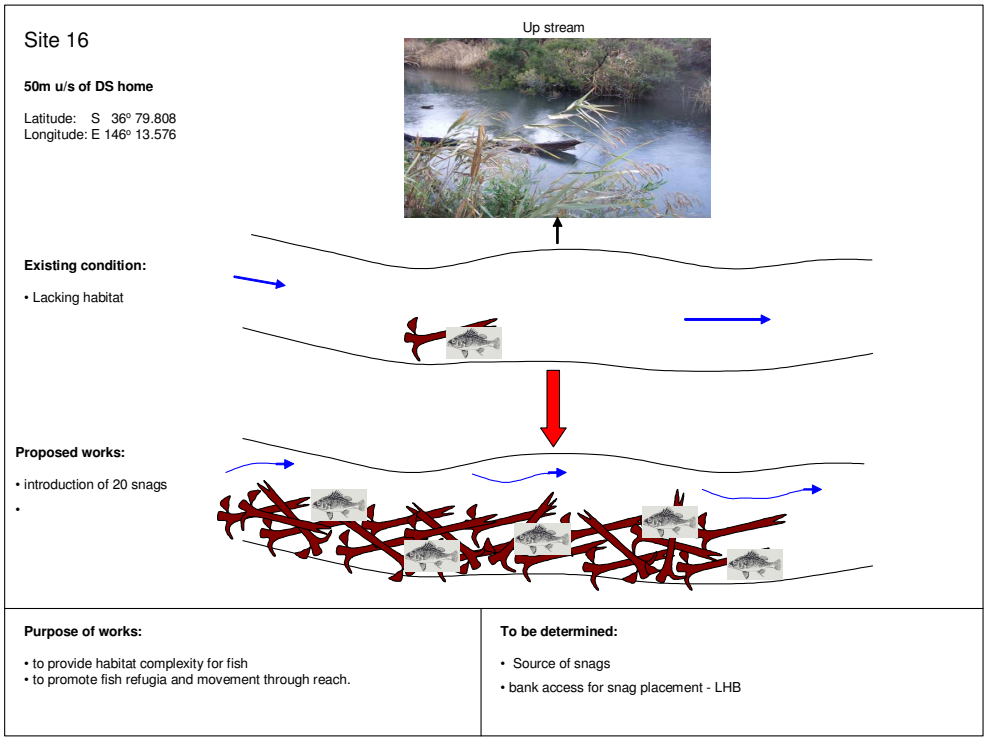


Table 1 Summary of the site specific recommendations for the HCDR works program, 2009

	Recommended works				
	Rocks			Woody debris	
Site number	In-stream habitat	Bank shoring	Rock-bar	In-stream habitat	Groynes
1	10			10	
2				10	
3	10			10	
4	6		1	4	
5			1		
6				10	
7					15
8				10	
9				10	
10				10	
11		20m3		10	
12					10
13			1		
14				20	
15		10m3			
16				20	
Totals	**26**	**30m3**	**3**	**124**	**25**