

# Woolgoolga to Ballina Pacific Highway Upgrade

## Threatened Fish Monitoring Program Annual Report 2022

Year 2 Operational Phase Report





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Woolgoolga to Ballina Pacific  
Highway Upgrade  
Threatened Fish Monitoring Program Annual  
Report 2022

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# Introduction

The following report summarises the methods and results from the second year of threatened fish monitoring undertaken during the operational phase of the Woolgoolga to Ballina Pacific Highway upgrade (W2B Upgrade).

## 1.1 Background

As part of the conditions of approvals required for construction of the W2B Upgrade Transport for NSW (TfNSW) are monitoring a range of environmental factors prior to, during, and after construction, including threatened species. Formal environmental assessments undertaken during the planning phase of the W2B Upgrade revealed that a variety of threatened species listed under state and federal environmental legislation occur, or have the potential to occur, at various locations within or near the construction footprint. One species of threatened fish, Oxleyan Pygmy Perch (OPP) (*Nannoperca oxleyana*), was identified during the project EIS. As a result, a Threatened Fish Management Plan (Roads and Maritime 2015) was prepared to inform monitoring and adaptive management actions for this species during all stages of the project. This report documents the results of the second year of monitoring conducted during the operational phase, with the combined operational phase data being assessed against results from three pre-construction surveys and seven construction phase surveys.

## 1.2 Objectives

The Threatened Fish Management Plan (Roads and Maritime 2015) states that monitoring will be conducted during construction and operation where known Oxleyan Pygmy Perch populations may be impacted, and for a period until such time as the mitigation measures have been proven to be effective over three consecutive annual monitoring periods.

Monitoring will provide information such that sound conclusions can be drawn in relation to management of threatened species. The overall monitoring objectives include:

- Evaluate the success of mitigation measures (including erosion and sediment control and pollution control measures).
- Determine the extent of secondary impacts of the project on Oxleyan Pygmy Perch populations and identify any additional mitigation measures that may minimise these impacts such as connectivity, stream mitigation, water quality and restoration of habitat.
- Determine the effectiveness of bridge design and bank rehabilitation in the management of Oxleyan Pygmy Perch.

## 1.3 Species Profile

### 1.3.1 Oxleyan Pygmy Perch (OPP)

In NSW OPP are known to occur in Banksia-dominated coastal heath (wallum) ecosystems and coastal lakes as far south as Tick Gate Swamp (just south of Woolli). The systems where they are



usually found are dystrophic, acidic and freshwater (Knight & Arthington 2008) in addition to being shallow, slow flowing and narrow. They are mostly found over sandy and sometimes muddy benthos with high proportions of riparian cover, leaf litter and emergent aquatic plants. Typically, water depths are around 50 cm but OPP have been collected from depths of up to 130 cm. Water velocities are almost always below 0.4 m/sec, limiting occurrence to backwaters and small tributaries (Pusey, Kennard & Arthington 2004).

The predicted natural range of OPP in NSW is from the Queensland border south as far as the Manning River. In recent years, OPP have mostly been collected from the area around Evans Head NSW. OPP are known to be particularly sensitive to capture by nets. In particular, surveys using seine nets have resulted in significant mortality. The methods suggested for OPP surveys are electrofishing and setting unbaited standard fish traps (DSEWPaC 2011). To minimise disturbances to breeding, surveys should be avoided between October and April inclusive.

**Table 1.1 Summary of water quality information from NSW sites where OPP have been collected.**

<i>Measure</i>	<i>Range</i>	<i>Mean ± SE</i>
Temp (°C)	10.9 – 28.3	16.1 ± 0.34
DO (mg/L)	2.15 – 10.02	6.42 ± 0.189
pH	3.32 – 6.9	4.47 ± 0.087
Cond (µS/cm)	68 - 2148	186 ± 22.7
Turbidity (NTU)	0 – 80	14 ± 3.6

From Knight & Arthington (2008)



**Plate 1.1 OPP captured at site C5 during the September 2022 survey.**

## Methods

### 2.1 Study Area and Monitoring Sites

The study area is located within Sections 6 – 9 of the W2B Upgrade corridor.

In the first year of construction phase threatened fish monitoring 27 and 28 sites were sampled in May 2017 and September 2017 respectively. In the second year of monitoring a reduced number of sites were sampled due to landholder restrictions upon access to sites 11b, 13e and 26b. In the third year of monitoring 7 sites, previously monitored as part of the Devils Pulpit Pacific Highway upgrade threatened fish monitoring (GeoLINK 2015), were added to the survey, but landholder restrictions upon access have continued to impact monitoring at sites 13e, 26b and OPP4.

The waterways monitored include backwaters on flood-prone land, ephemeral swamps, farm drainage lines, natural creeks, dams and excavations. Of the total sites currently monitored eleven are control sites.

The study area and location of sampling sites are displayed in **Illustrations 2.1, 2.2, 2.3 and 2.4**. A list of sampling locations is presented in **Table 2.1**.

Due to the potential for construction impacts to extend along waterways, and the location of suitable habitat for the target species, some sites were located outside of the immediate W2B upgrade corridor. In most cases, the maximum distance from the highway corridor of individual impact sites was 200 m. For the same reason control sites were mostly located at a larger distance from the W2B upgrade corridor.

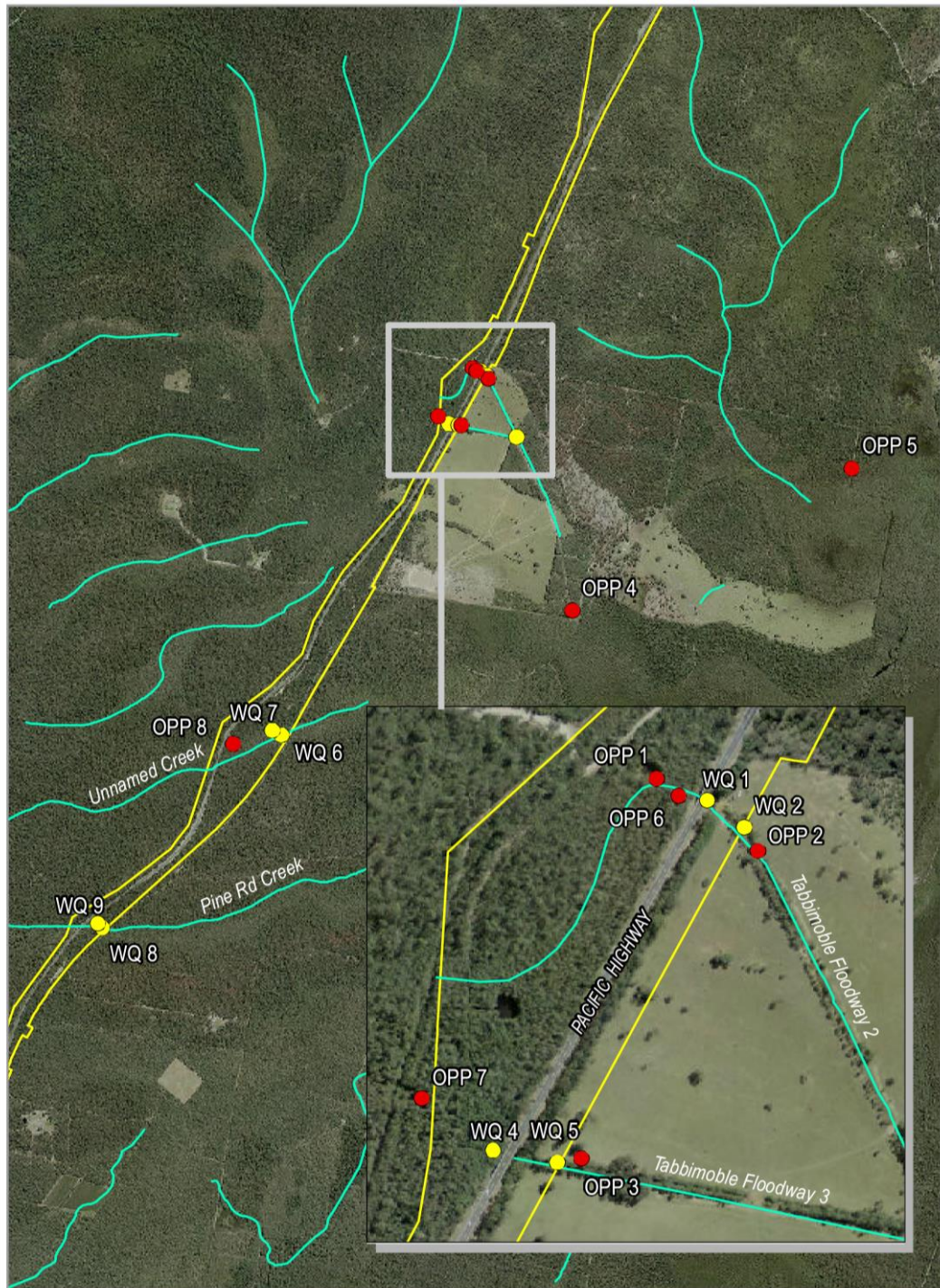
**Table 2.1 A brief description of the significant waterways sampled during the survey.**

<i>Section</i>	<i>Waterway</i>	<i>Sites</i>	<i>Chainage</i>	<i>Notes</i>
DP	Tabbimoble 3 Channel	OPP3, OPP7	110500	Constructed channel that drains floodwaters from the west of the Pacific Highway. Confluence with Tabbimoble 2 Channel 300m downstream of the highway. Permanent <b>Class 1</b> stream with intermittent areas and an offstream dam. OPP previously identified. <b>2 sites</b> , one upstream and one at the impact. The upstream site (OPP7) frequently dries out.
DP	Tabbimoble 2 Channel	OPP1, OPP2, OPP4, OPP6	110800	Constructed channel that drains floodwaters from the west of the Pacific Highway. Permanent <b>Class 1</b> stream with intermittent areas and an offstream dam. OPP previously identified. <b>4 sites</b> , two upstream, one at the impact and one reference site far downstream. One of the upstream sites (OPP6) frequently dries out.
7	Unnamed waterway south of Serendipity Rd	2a, 2b, 2c	114000	Drains from headwaters approximately 1km upstream. Intermittent <b>Class 1</b> stream. OPP previously identified. <b>3 sites</b> , upstream, impact and downstream. The impact and downstream site frequently dry out.

<b>Section</b>	<b>Waterway</b>	<b>Sites</b>	<b>Chainage</b>	<b>Notes</b>
7	Tabbimoble floodway no. 1	3a	115300	Drains from headwaters approximately 1.5km upstream. Intermittent <b>Class 1</b> stream. OPP previously identified. <b>1 site</b> at impact.
8	Unnamed waterway south of MacDonalds Ck	10b, 10c	134600	<b>Class 1</b> waterway, draining flood prone land connecting with Broadwater NP. OPP previously identified. <b>2 sites</b> , impact and downstream. The downstream site frequently dries out. The upstream site has a constructed drought refuge pool.
8	MacDonalds Ck tributary	11b, 11d	135200, 135530, 136450	Manmade drains connecting cane fields and flood prone land in Broadwater NP with a small natural <b>Class 1</b> waterway. OPP previously identified. <b>2 sites</b> , impact and downstream.
8	MacDonalds Ck	12a	136600	<b>Class 1</b> waterway draining flood prone land connecting with Broadwater NP. OPP previously identified. <b>1 site</b> , at impact.
8	Various dams south of Broadwater National Park	22b, 22c	136700 - 137900	Two manmade dams and excavations on private property. OPP previously identified. Each individual waterbody sampled at <b>1 site</b> only. Both located E (downstream) of impact.
9	Broadwater NP Swampland	16a, 16b, 27b, 27e	139000 - 140500	Series of wetland pools throughout protected wallum country. <b>Class 1</b> stream. OPP previously identified. <b>4 sites</b> one impact, three to the east.
9	Various dams north of Broadwater National Park	26d	140900 - 142300	Manmade dam/excavation on private property. OPP previously identified. Located E (downstream) of impact.
9	Montis Gully tributary 1	13b, 13c, 13e	141180, 141850	Series of <b>Class 1</b> waterways and canals draining agricultural land and flood prone land. OPP previously identified. <b>3 sites</b> , 1 slightly upstream, 2 at the impact.
N/A	Bundjalung National Park Swampland	OPP5, C13, C14	N/A	Large coastal wetland complex. <b>Class 1</b> intermittent wetland area with a variety of natural depressions, natural drainage lines, constructed drainage lines and flooded trails. OPP previously identified. <b>3 reference sites</b> , 2 intermittent, 1 permanent.
N/A	Broadwater National Park Swampland	C1, C2, C3, C5, C8, C11, C12	N/A	Large coastal wetland complex. <b>Class 1</b> intermittent wetland area with a variety of natural depressions, natural drainage lines, constructed drainage lines and flooded trails. OPP previously identified. <b>7 reference sites</b> , 4 intermittent, 3 permanent.

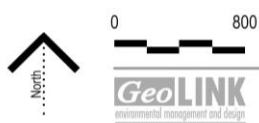
A control site was monitored for each of the locations with a confirmed population of OPP. Control sites were selected according to the methods set out in the *Threatened Fish Management Plan* (Roads and Maritime 2015) for the W2B Upgrade. The locations of all impact and control sites are presented in **Illustrations 2.1, 2.2 2.3 and 2.4**.

Access to some sites was restricted in the current monitoring period. Sites 13e, 26b and OPP4 could not be accessed for either survey in 2022 due to landholder restrictions. Sites OPP5, C5 and C13 could not be accessed during the May 2022 survey due to extreme wet conditions on the access track more than 2 km away from the site. Site OPP5 could not be accessed during the September 2022 survey due to unsafe wet conditions on the access track more than 2km away from the site.



LEGEND

- OPP
- WQ
- Drainage line
- Approved project boundary



Devils Pulpit Pacific Highway Upgrade - Post Construction  
Monitoring of Oxleyan Pygmy Perch and Surface Water  
2383-1005

**Study Area and Site Location**

Illustration 2.1

Illustration 2.1 Map of Devils Pulpit (DP) sampling sites (from GeoLINK 2015)

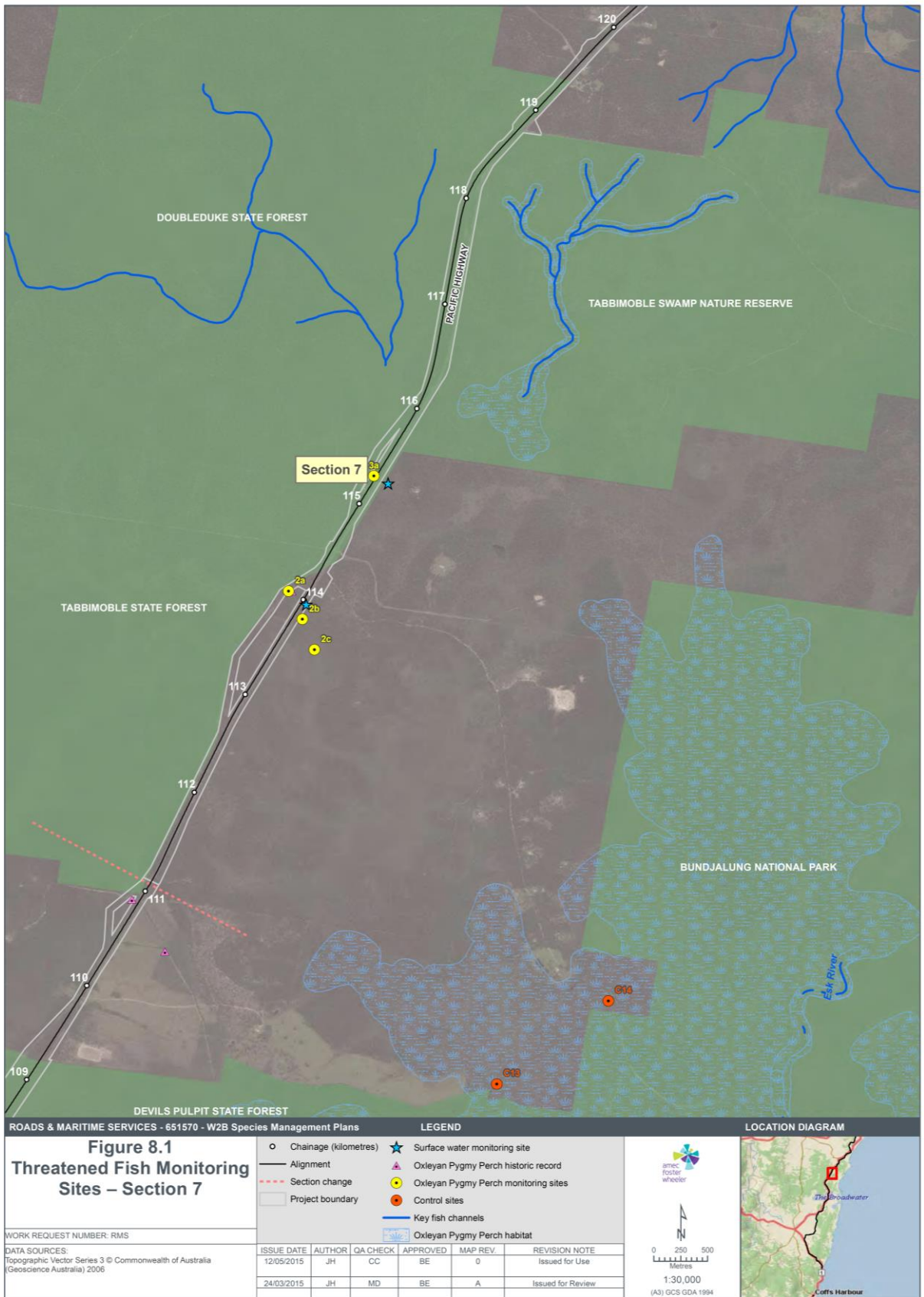


Illustration 2.2 Map of Section 7 sampling sites taken from the TFMP (RMS 2015)

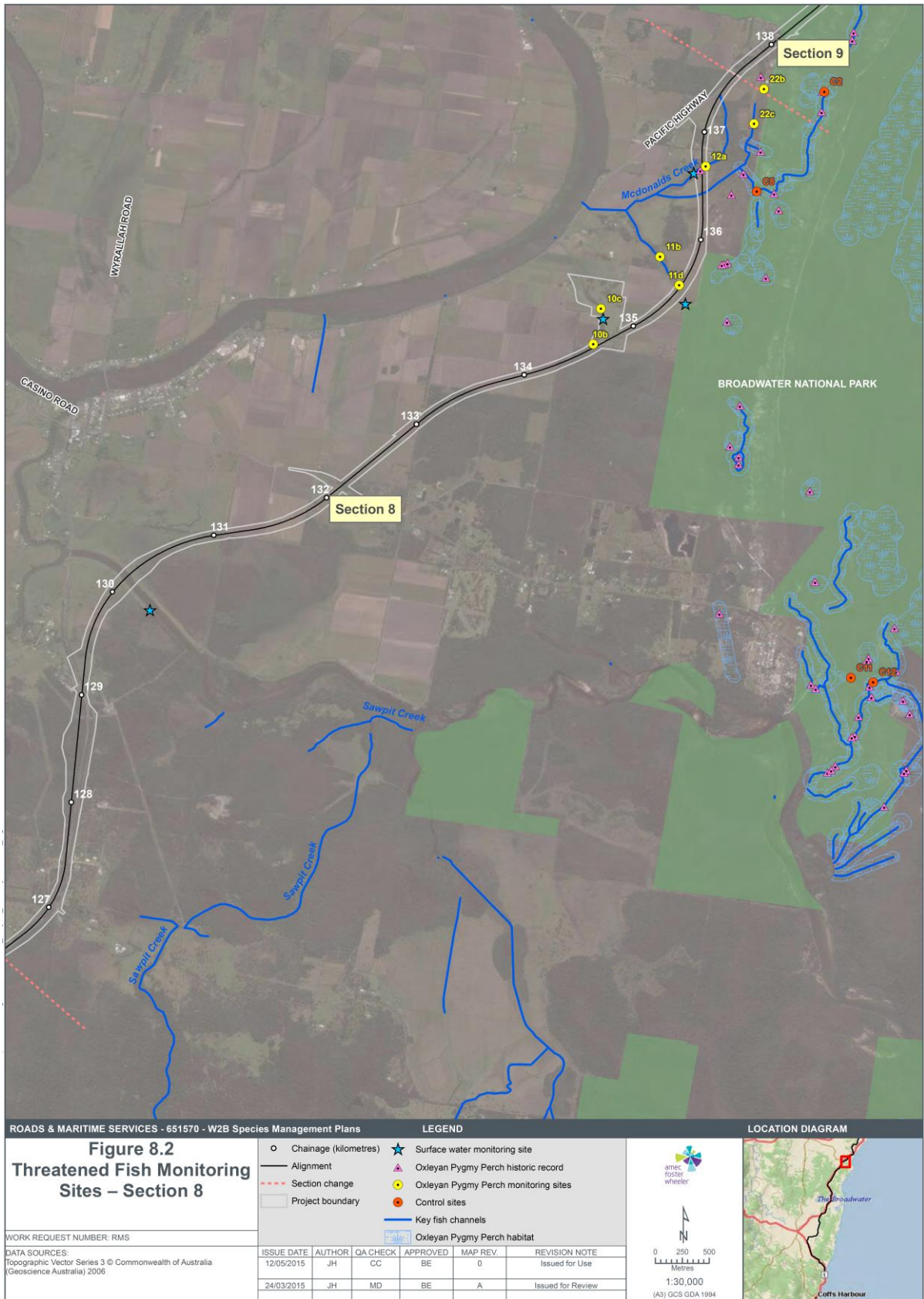


Illustration 2.3 Map of Section 8 sampling sites taken from the TFMP (RMS 2015)

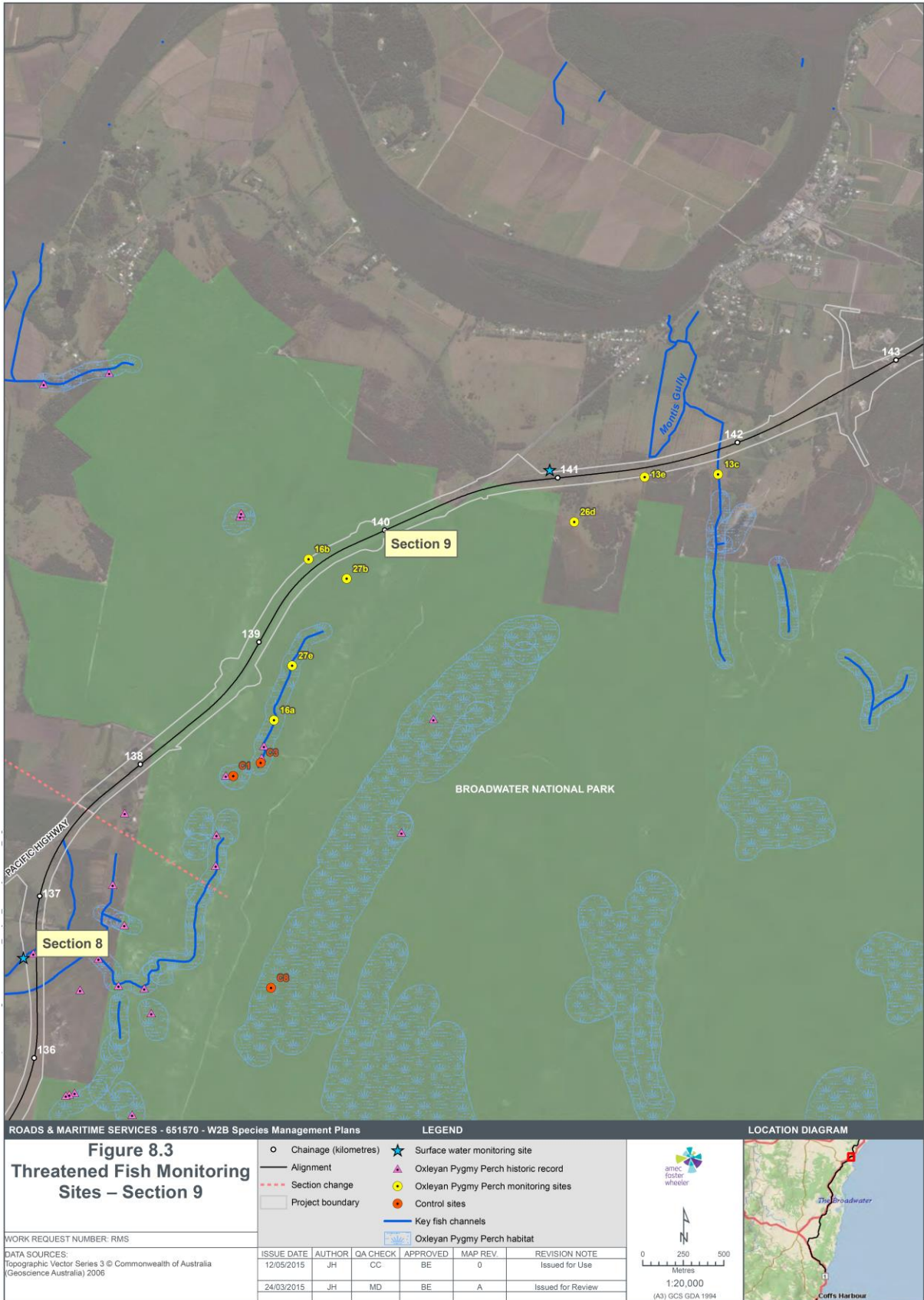
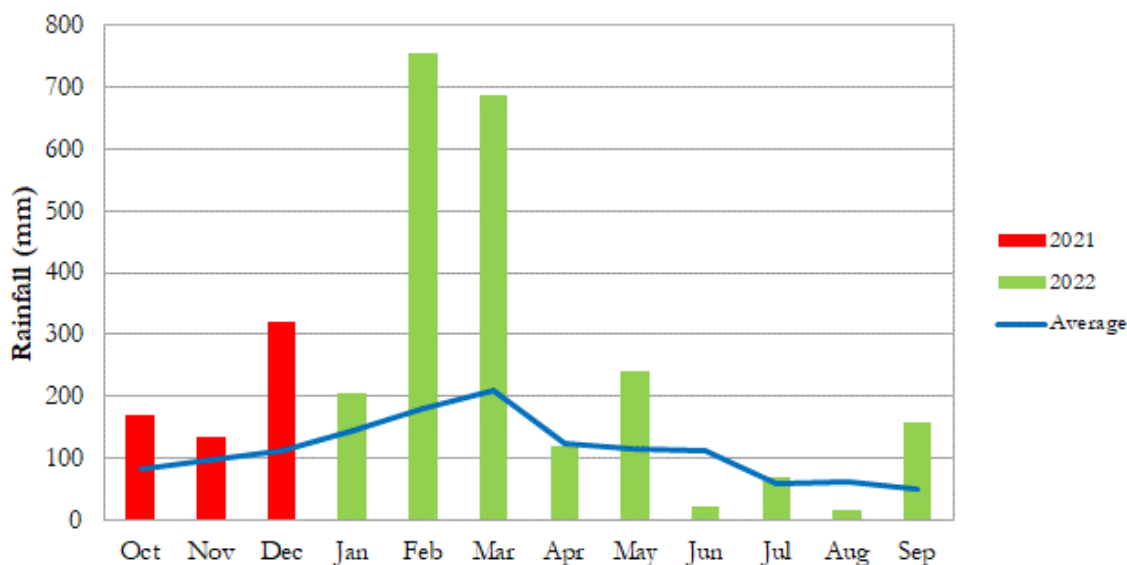


Illustration 2.4 Map of Section 9 sampling sites taken from the TFMP (RMS 2015)

## 2.2 Timing

Bi-annual targeted threatened fish monitoring is scheduled to occur in May/June and August/September and align with the methods used during the pre-construction survey. During this reporting period the surveys were undertaken in May 2022 and September 2022.

Monitoring was scheduled to avoid the OPP breeding season, which peaks between October and April, and timed to ensure optimum conditions with respect to water levels.



**Figure 2.1 Mean monthly rainfall and total monthly rainfall from the New Italy Bureau of Meteorology station for the current reporting period.**

The total rainfall for this annual reporting period was 215% of the yearly average. Approximately half of the annual rainfall was concentrated into two months, February and March 2022. (**Figure 2.1**). At the time of the May 2022 survey most sites were very wet, with water overtopping the banks at some sites and some sites inaccessible due to water over the access tracks. Average and low monthly rainfall in the lead-up to the September 2022 survey meant that accessibility was improved and less sites were prone to bank overtopping. Fluctuating water levels are an important consideration because they significantly change the ability to capture fish and also heavily impact the habitat measurements collected.

## 2.3 Fish Survey

Fish sampling was undertaken under a *Fisheries Management Act 1994* Section 37 permit using a combination of back-pack electro-fisher and unbaited box traps, in accordance with procedures for Oxleyan Pygmy Perch outlined in the *Survey guidelines for Australia's Threatened Fish* (DSEWPaC, 2011), and Knight *et al.* (2007). In summary, this involved:

- The deployment of 10 unbaited standard collapsible bait traps at each site for a standard 30-minute period. Traps were redeployed for an additional 30-minute period where no Oxleyan Pygmy Perch were recorded at the sampling station in the first 30-minute period
- Undertaking back-pack electrofishing at each site, where safe to do so. Backpack electrofishing was restricted to shallow areas (e.g., <1 m deep) due to safety issues with use in deeper water. The electrofisher settings were adjusted according to conductivity to



ensure that fish were stunned temporarily. Settings were recorded at each site and are presented in **Table 2.2** and **Table 2.3**. Sampling was undertaken at each site for 600 seconds of pulse time or two passes of all available habitats. Stunned fish were collected using a 5mm dip net (knotless mesh). If 30 individual OPP were captured at one site further efforts were abandoned to minimise processing times and ensure that captured fish were released back into the environment in good condition.

**Table 2.2 Details of electrofisher settings and effort at each site in May 2022**

<i>Section</i>	<i>Site</i>	<i>Voltage (V)</i>	<i>Pulse Freq (Hz)</i>	<i>Duty Cycle (%)</i>	<i>Passes</i>	<i>Seconds Pulsed</i>
6	OPP1	225	50	12	1	601
6	OPP2	175	50	12	2	614
6	OPP3	250	50	12	2	525
6	OPP4	No Access				
6	OPP5	No Access				
6	OPP6	100	50	12	2	390
6	OPP7	200	50	12	1	604
7	2a	75-100	50	12	2	340
7	2b	75	50	12	2	408
7	2c	75	50	12	2	239
7	3a	250	50	12	2	602
8	10b	250	50	12	1	604
8	10c	150	50	12	2	540
8	11b	150	50	12	1	609
8	11d	100	50	12	1	622
8	12a	75-100	50	12	1	602
9	13b	75	50	12	1	654
9	13c	150	50	12	1	607
9	13e	No Access				
9	16a	175	50	12	1	604
9	16b	200	50	12	1	611
8	22b	225	50	12	1	609
8	22c	200	50	12	1	601
9	26d	No Access				
9	27b	200	50	12	1	605
9	27e	200	50	12	2	341
Control	C1	250	50	12	1	609
Control	C2	200	50	12	1	602
Control	C3	175	50	12	2	618
Control	C5	No Access				
Control	C8	75-200	50	12	2	350
Control	C11	250	50	12	1	609
Control	C12	225	50	12	1	602
Control	C13	No Access				
Control	C14	100	50	12	1	622

**Table 2.3 Details of electrofisher settings and effort at each site in September 2022**

<i>Section</i>	<i>Site</i>	<i>Voltage (V)</i>	<i>Pulse Freq (Hz)</i>	<i>Duty Cycle (%)</i>	<i>Passes</i>	<i>Seconds Pulsed</i>
6	OPP1	250-300	50	12	1	608
6	OPP2	250	50	12	1	613
6	OPP3	300	50	12	2	483
6	OPP4	No Access				
6	OPP5	No Access				
6	OPP6	100	50	12	1	602
6	OPP7	175	50	12	2	613
7	2a	175	50	12	2	477
7	2b	75-125	50	12	2	370
7	2c	Dipnet only - insufficient water to electrofish				
7	3a	250	50	12	1	619
8	10b	250	50	12	1	604
8	10c	150	50	12	2	426
8	11b	225	50	12	1	737
8	11d	75	50	12	1	609
8	12a	125	50	12	1	602
9	13b	150	50	12	1	625
9	13c	250	50	12	1	610
9	13e	No Access				
9	16a	250	50	12	1	608
9	16b	275	50	12	1	608
8	22b	275	50	12	1	601
8	22c	200-300	50	12	1	608
9	26d	No Access				
9	27b	300	50	12	1	601
9	27e	250	50	12	1	597
Control	C1	275	50	12	1	611
Control	C2	175	50	12	1	602
Control	C3	250	50	12	1	618
Control	C5	150	50	12	1	598
Control	C8	250	50	12	1	637
Control	C11	250	50	12	1	602
Control	C12	150-225	50	12	1	603
Control	C13	250	50	12	1	597
Control	C14	125	50	12	1	622

All captured fish were retained in aerated storage buckets until all fishing at the station had been completed to avoid skewing results with recapture. Captured fish were identified, counted and measured for total length. Abnormalities including wounds or deformities were recorded at the time of capture. Exotic species captured were euthanased in accordance with approved animal ethics procedures (Barker *et al.*, 2009).

## 2.4 Water Quality

At each site physico-chemical water quality parameters were measured in surface water with a HORIBA U52 multimeter to determine the suitability of the site for Oxleyan Pygmy Perch in terms of water quality. The parameters measured were temperature, conductivity, dissolved oxygen, pH and turbidity.

## 2.5 Habitat Description

A general description of the habitat characteristics of each monitoring site was made, documenting riparian vegetation characteristics and condition, stream substrate composition and profile, areas of bank erosion and sedimentation, and overall aquatic habitat condition. The methods described in Pusey, Kennard & Arthington (2004) formed the basis of habitat descriptions.

At each monitoring site the following in-stream habitat features were recorded as key determinants of habitat suitability for the target fish species:

- average channel depth from 3 points in each site;
- average stream width from 3 points in each site;
- per cent cover of large woody debris (>150 mm stem diameter), small woody debris and leaf litter from 12 points in each site;
- per cent cover of submerged and emergent macrophytes from 12 points in each site. Species of aquatic vegetation were also recorded;
- substrate composition from 12 points in each site in per cent cover of mud, sand, fine gravel (2-16mm), coarse gravel (16-64 mm), cobble (64-128 mm), rock and bedrock;
- per cent of bank classified as undercut (20 cm overhang), or as root masses averaged from 4 transects at each site;
- per cent cover of riparian vegetation averaged from 4 transects at each site; and
- flow rates.

In order to collect this data three transects were positioned perpendicular to stream flow and the substrate composition, debris cover and vegetative cover were estimated in four individual 0.5 m x 0.5 m quadrats randomly positioned along each transect. Wetted width and depth were also measured at each of these transects. Additionally, 4 transects, representing a total of 20 per cent of wetted stream perimeter, were randomly positioned along each bank and longitudinal percentage cover estimates of root masses, bank and vegetation overhangs and riparian cover were made along each transect.

At some sites, the steepness of the banks and depth of the water combined to make it difficult to lay and interpret quadrats. On such occasions, and on others where the wetted width of the stream was less than 2.5 m, the full complement of 12 quadrats was not utilised.

In addition to the above structural habitat descriptions an inventory of aquatic plants at each site was compiled.

Photographs were taken facing upstream and downstream from a standard, central position at each site. The locations of the photographic monitoring point as well as upstream and downstream site boundaries were recorded with a GARMIN GPS map 62 handheld GPS to facilitate repeat sampling. All spatial data were collected and are reported in WGS84.

# Results

## 3.1 Fish Surveys

During the May 2022 survey approximately 247 hours of fish trapping and 15,944 seconds of electrofishing were used. During the September 2022 survey approximately 261 hours of fish trapping and 17,711 seconds of electrofishing were used.

There were some sites where fish capture was not attempted during the two surveys this year due to either changing access permission to private lands or unsafe access at the time of the survey. These sites were:

- Sites OPP4, 13e and 26d, which had access restrictions at the time of the May 2022 and September 2022 surveys.
- Site OPP5, which could not be accessed due to an unsafe access track at the time of the May 2022 and September 2022 surveys.
- Sites C5 and C13, which could not be accessed due to an unsafe access track at the time of the May 2022 survey.

In the May 2022 survey a total of 1,938 fish from eleven species were captured. Of the total number of fish captured, 1,218 individuals from ten species were captured using the electrofisher and 720 individuals from seven species were captured using fish traps.

In the September 2022 survey a total of 3,834 fish from ten species were captured. Of the fish captured during the September 2021 survey 2,182 individuals from ten species were captured using the backpack electrofisher and 1,652 individuals from seven species were captured using bait traps.

In the May 2022 survey 154 individual OPP were captured. Of these, 49 were captured using the backpack electrofisher and 105 in fish traps. In the May 2022 survey OPP were captured at 9 of the 24 impact sites and at 6 of the 11 control sites.

In the September 2022 survey 327 individual OPP were captured. Of these 145 were captured using the backpack electrofisher and 182 in fish traps. In the September 2022 survey OPP were captured at 9 of the 24 impact sites and at 7 of the 11 control sites.

The most commonly captured species of fish during the May 2022 survey was the Mosquitofish (*Gambusia holbrooki*). Individuals of this species accounted for approximately 40 per cent of the total number of fish captured in the May 2022 survey. The most commonly captured species of fish during the September 2022 survey was the Firetail Gudgeon (*Hypseleotris galli*), accounting for approximately 36 per cent of the fish captured. Overall, OPP accounted for approximately 8 per cent of the fish captured in the May 2022 survey and approximately 9 per cent of the fish captured during the September 2022 survey.

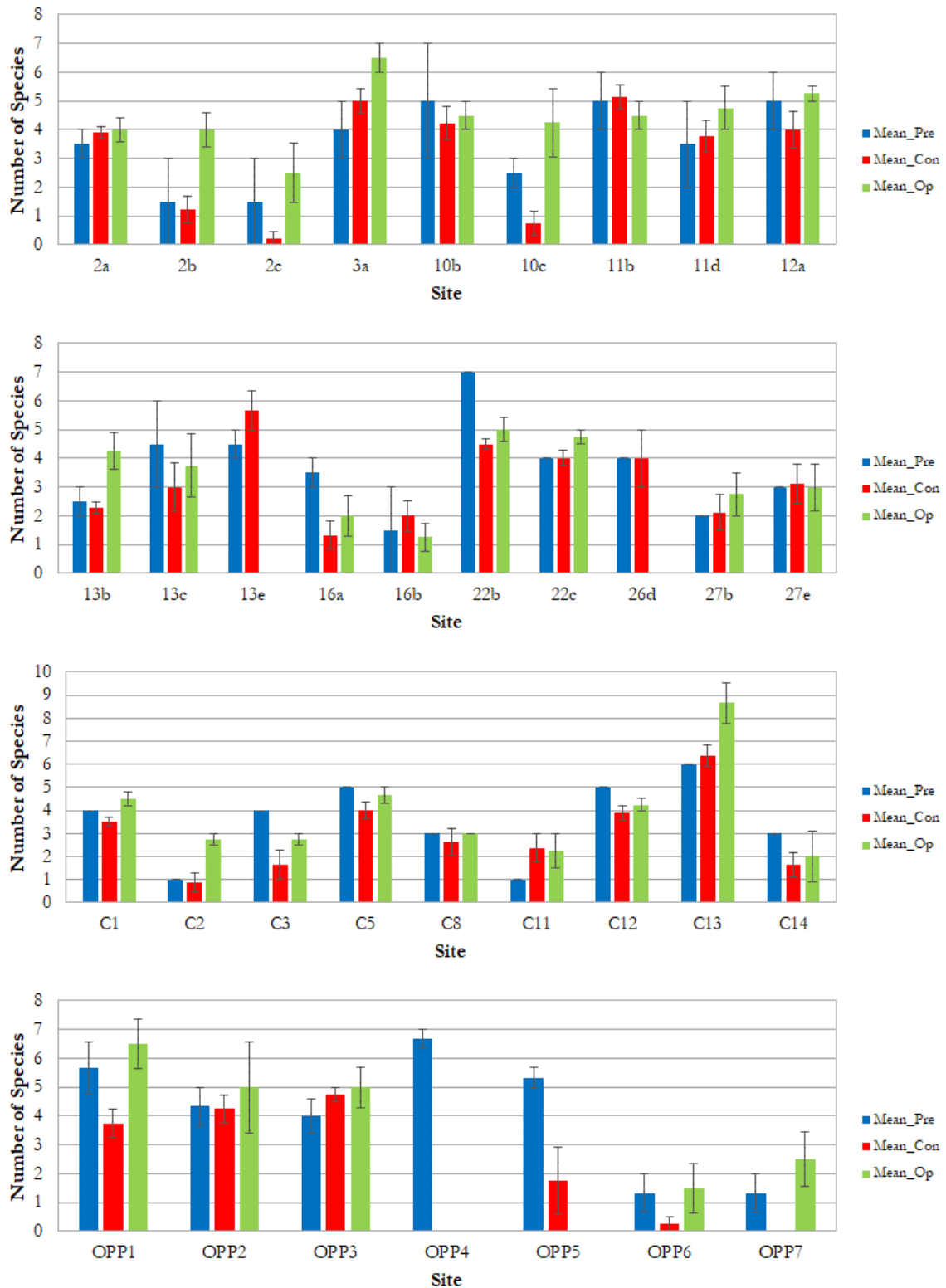


Figure 3.1 Mean  $\pm$  SE taxonomic richness of captured fish at all sites during the operational phase surveys to date (plotted against Mean  $\pm$  SE in preconstruction and construction phase surveys)

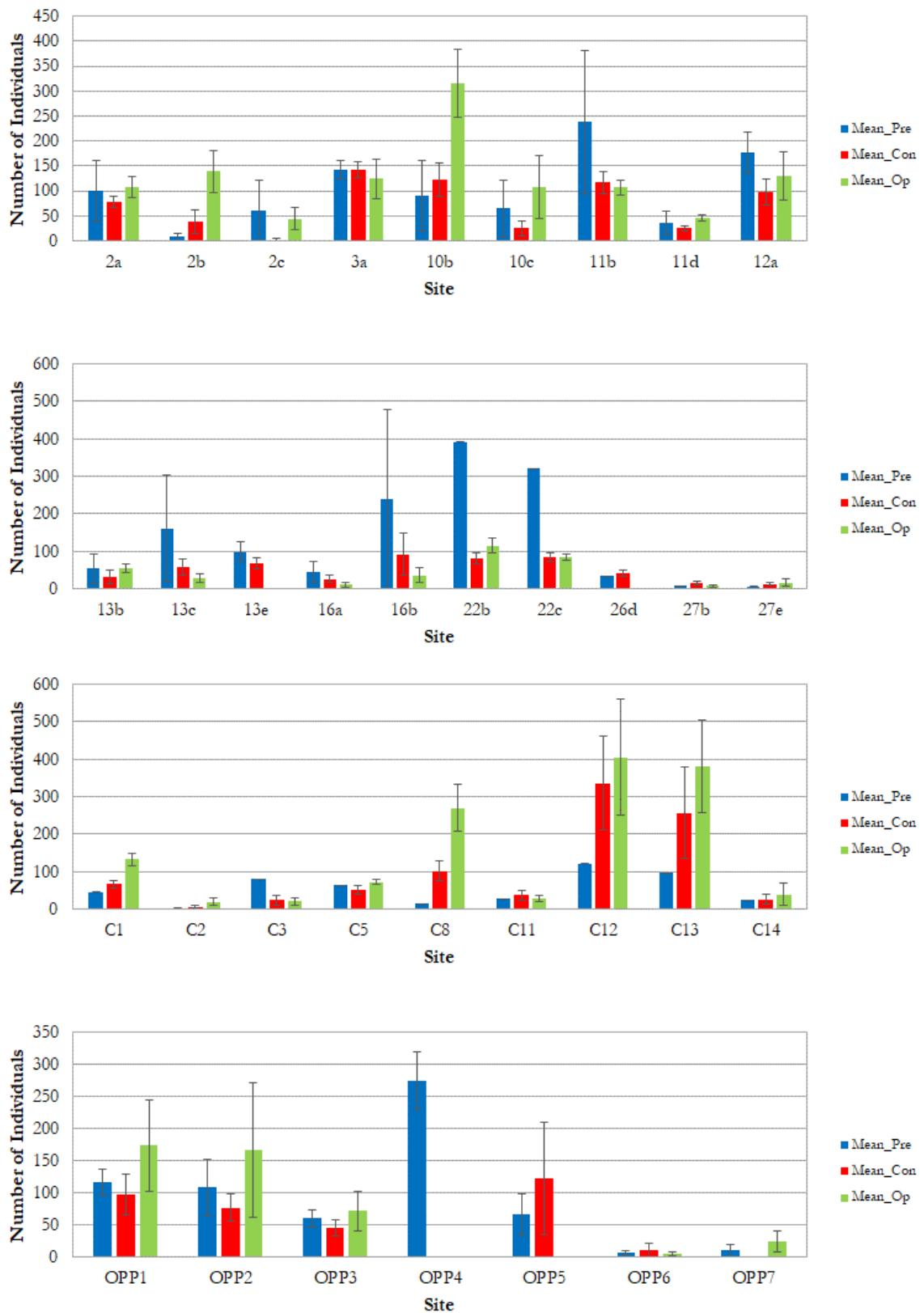


Figure 3.2 Mean  $\pm$  SE abundance of captured fish at all sites during the operational phase surveys to date (plotted against Mean  $\pm$  SE in preconstruction and construction phase surveys)

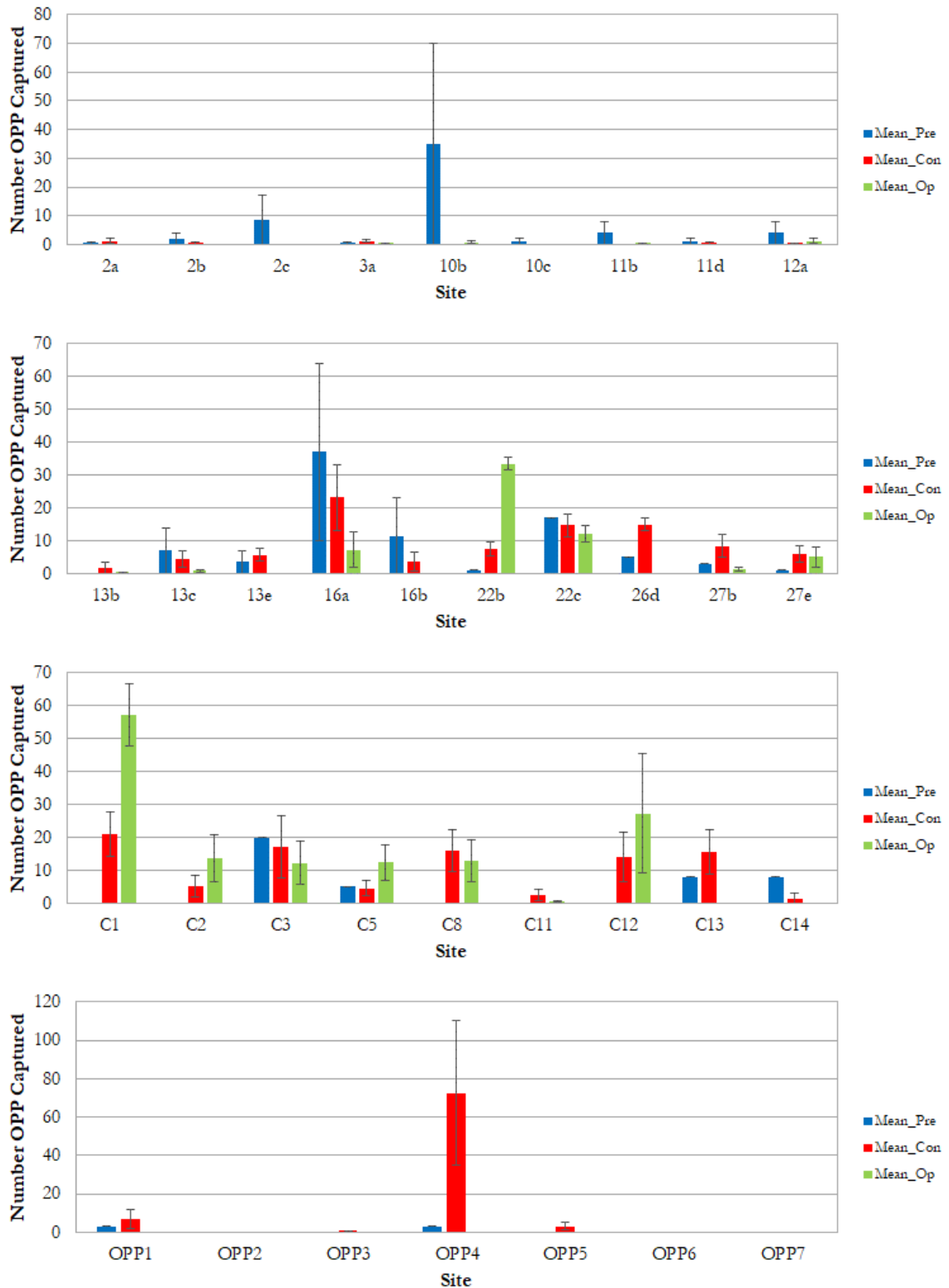


Figure 3.3 Mean  $\pm$  SE OPP captured at all sites during the operational phase surveys to date (plotted against Mean  $\pm$  SE in preconstruction and construction phase surveys)

The results during operational monitoring to date have been comparable with the results of pre-construction and construction phase monitoring at most impact and control sites in terms of fish diversity and abundance (Figures 3.1 and 3.2). With very few exceptions average diversity and abundance at each site falls within the variability identified during pre-

construction and or construction phase sampling. In the 2 surveys this year between one and seven species of fish were captured at each site where surveys were possible. In the May 2022 survey the sites with the highest diversity of captured fish were 3a, 10c, 11b, 13c and 22b. In the September 2022 survey the sites with the highest diversity of captured fish were C13, 10b, 10c, 11d, 12a and 13b.

Between 1 and 468 individual fish were captured at the impact sites during the two surveys this year. The impact sites where the most fish were captured during the May 2022 survey were 10b, 22b and 11b. In the September 2022 survey the impact sites where the most individual fish were captured were 10b, 10c and 12a.

The total number of individual fishes captured at the control sites varied between 4 and 503, with the largest numbers of fish captured at C1 and C12 in the May 2022 survey and C12 and C8 in the September 2022 survey.

The average numbers of OPP captured at each site during pre-construction, construction and operational (to date) phase monitoring are presented in **Figure 3.3**. The numbers of OPP captured during this reporting period were moderately high in May 2022 and high in September 2022. The number of OPP captured at each site fluctuated between the May 2022 and September 2022 surveys. OPP were captured at 18 sites in the two surveys this year (compared to 22 sites in 2017, 17 sites in 2018, 5 sites in 2019, 7 sites in 2020 and 11 sites in 2021). The increased number of sites where OPP were captured and the increased numbers of OPP captured, in comparison to the previous 3 years, is an indication of the improved breeding and dispersal conditions associated with rainfall in December 2020, March 2021 and February-March 2022. It is also an indication of the general recovery of the OPP population from the severe drought conditions (and associated bushfires) up to and including December 2019 and January 2020 and strong evidence that highway operation is not negatively impacting OPP populations overall.

The full results of the May 2022 and September 2022 fish surveys are presented in **Appendix B**.

The capture of OPP has varied significantly between sites and over time since monitoring along the W2B upgrade began in 2013. The average capture per survey at each site during pre-construction, construction and operational phase (to date) monitoring is presented in **Figure 3.3**. The figures indicate that average pre-construction phase captures were larger than average operational phase captures at several impact sites, including sites 2a, 2b, 10b, 10c, 11b, 11d, 12a, 13c, 16a, 16b, 22c and 27b, although pre-construction phase variability was very high at most of these sites. Average operational phase OPP captures were also higher at some impact sites, including 22b and 27e. Average captures at the control sites during the operational phase monitoring to date have mostly been larger than or equivalent to captures during the pre-construction phase monitoring, the exceptions being sites C3, C13 and C14.

When the control and impact sites are considered as a group, the pre-construction and construction phase average captures per site show a reduction in the average OPP capture at impact sites in the construction and operational phase monitoring and an increase in the average capture at control sites in the construction phase monitoring (**Figure 3.4**).



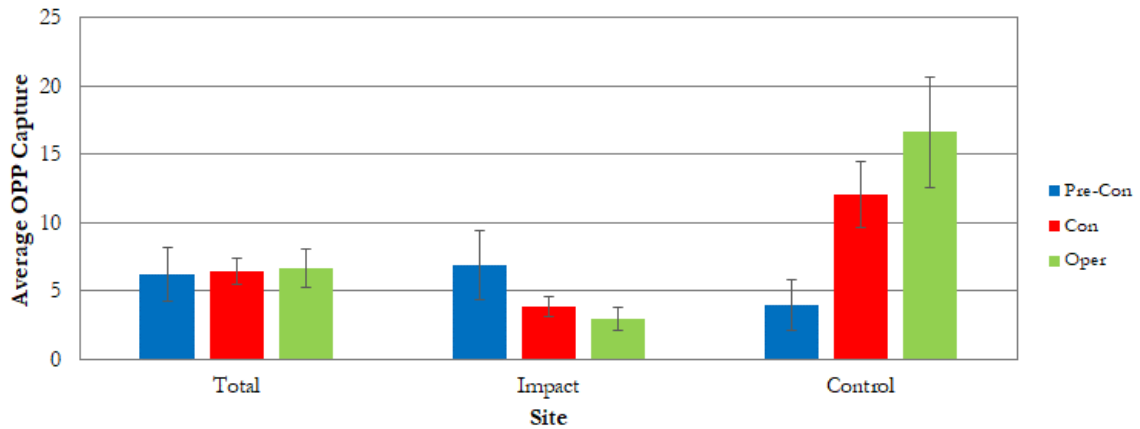


Figure 3.4 Mean ± SE OPP capture at combined control and impact sites in pre-construction, construction and operational phase monitoring to date (pre-construction data from GeoLINK 2014, 2015a & 2015b, Hyder 2012)

### 3.2 Water Quality

The results of water quality samples are presented in **Tables 3.1** and **3.2**. The results are indicative of the water quality at the time of sampling only and are likely to fluctuate considerably at each site according to weather and seasonal conditions.

Table 3.1 Results of water quality sampling from all sites for the May 2022 survey

Site	Date	Temperature °C	pH	Conductivity mS/cm	Turbidity NTU	DO mg/L	DO% %
OPP1	6/05/2022	19.33	4.69	0.025	45.6	7.41	82.7
OPP2	6/05/2022	19.03	5.09	0.026	40.9	6.67	74.1
OPP3	6/05/2022	19.75	4.95	0.032	38.1	7.1	80
OPP4		No Access					
OPP5	6/05/2022	No Safe Access					
OPP6	6/05/2022	19.82	4.98	0.028	60.9	6.34	71.5
OPP7	6/05/2022	19.47	4.91	0.026	42.9	7.57	84.8
2a	2/05/2022	19.61	4.88	0.086	22.5	2.93	32.9
2b	2/05/2022	21.27	5.18	0.157	16.6	1.9	22
2c	2/05/2022	21.38	5.64	0.095	19.8	6.57	76.2
3a	8/05/2022	18.65	5.23	0.054	26.9	7.4	81.6
10b	3/05/2022	19.24	5.27	0.167	39.7	0	0
10c	5/05/2022	24.38	4.95	0.095	56.3	10.9	133.1
11b	5/05/2022	20.12	4.99	0.114	53.4	4.33	49.1
11d	5/05/2022	22.34	4.33	0.111	7.6	5.13	60.5
12a	3/05/2022	18.05	4.18	0.124	5.9	1.74	19
13b	3/05/2022	18.27	4.95	0.09	8.1	1.84	20.2
13c	5/05/2022	18.18	3.69	0.112	4.6	0.74	8.1
13e		No Access					
16a	4/05/2022	20.86	3.82	0.085	8.7	5.81	66.8
16b	7/05/2022	19.83	5.86	0.151	7	2.42	27.3
22b	7/05/2022	20.42	3.99	0.153	118	4.03	45.9
22c	7/05/2022	19.84	3.67	0.102	5.3	2.04	23
26d		No Access					

Site	Date	Temperature	pH	Conductivity	Turbidity	DO	DO%
		°C		mS/cm	NTU	mg/L	%
27b	7/05/2022	19.98	4.64	0.061	10.6	0.61	6.9
27e	4/05/2022	20.7	3.34	0.125	9.3	6.51	74.6
C1	4/05/2022	20.54	3.63	0.095	8.4	3.89	44.4
C2	8/05/2022	20.01	3.88	0.09	9.2	3.54	40.1
C3	4/05/2022	17.94	3.65	0.087	25.3	2.33	25.4
C5	7/05/2022	No Safe Access					
C8	8/05/2022	18.51	3.69	0.115	28.4	1.56	17.2
C11	9/05/2022	18.3	3.63	0.138	2.5	1.45	15.9
C12	9/05/2022	17.36	4.05	0.088	2.3	5.49	59
C13	2/05/2022	No Safe Access					
C14	2/05/2022	18.79	5.05	0.099	12.7	3.68	40.7

**Red Text** Outside of the known range of OPP  
**Blue Text** Within a range thought to provide OPP with a competitive advantage  
**Green Text** OPP captured at site during this survey

**Table 3.2 Results of water quality sampling from all sites for the September 2022 survey**

Site	Date	Temperature	pH	Conductivity	Turbidity	DO	DO%
		°C		mS/cm	NTU	mg/L	%
OPP1	5/09/2022	13.58	4.58	0.064	31.3	4.88	48.5
OPP2	5/09/2022	15.72	4.67	0.115	31.7	5.99	62.3
OPP3	5/09/2022	16.82	4.46	0.112	27.8	6.01	63.9
OPP4		No Access					
OPP5	5/09/2022	No Safe Access					
OPP6	5/09/2022	13.59	5.45	0.123	25.9	7.78	77.3
OPP7	5/09/2022	16.24	5.12	0.113	31	7.11	74.8
2a	1/09/2022	16.4	5.59	0.079	16.5	5.56	58.6
2b	1/09/2022	21.05	6.78	0.431	34.3	8.19	94.5
2c	1/09/2022	20.7	6.34	0.167	461	4.25	48.6
3a	8/09/2022	15.37	5.56	0.075	42.5	7.15	73.8
10b	2/09/2022	17.07	5.7	0.309	24.5	3.03	32.4
10c	2/09/2022	17.32	5.17	0.184	202	2.27	24.4
11b	6/09/2022	15.13	5.11	0.099	125	6.1	62.7
11d	2/09/2022	18.36	5.48	0	399	3.98	43.7
12a	2/09/2022	15.53	4.29	0.182	93.2	2.49	25.8
13b	2/09/2022	14.63	4.44	0.162	76.1	2.02	20.9
13c	6/09/2022	17.38	4.2	0.114	207	3.3	35.5
13e		No Access					
16a	7/09/2022	15.38	3.24	0.094	10.8	1.53	15.8
16b	4/09/2022	15.22	6.32	0.185	40.5	3.64	37.4
22b	4/09/2022	16.48	4.39	0.08	15.1	6.21	65.6
22c	4/09/2022	17.35	4.41	0.073	16.8	6.52	70.1
26d		No Access					
27b	6/09/2022	14.07	4.37	0.07	14.2	3.29	33.1
27e	7/09/2022	16.37	3.63	0.13	12.3	2.83	29.8
C1	7/09/2022	14.87	3.95	0.068	39.3	4.91	50.2
C2	8/09/2022	13.21	3.8	0.102	20.6	4	39.4
C3	4/09/2022	18.65	4.08	0.109	28.7	8.01	88.4
C5	7/09/2022	13.22	3.37	0.065	79.9	3.44	33.9
C8	8/09/2022	14.5	3.8	0.154	19.2	2.02	20.5
C11	6/09/2022	18.79	3.49	0.137	14	3.12	34.5

<i>Site</i>	<i>Date</i>	<i>Temperature</i>	<i>pH</i>	<i>Conductivity</i>	<i>Turbidity</i>	<i>DO</i>	<i>DO%</i>
		°C		mS/cm	NTU	mg/L	%
C12	6/09/2022	19.39	3.83	0.092	13.4	5.41	60.5
C13	1/09/2022	16.33	5.79	0.122	13	3.28	34.6
C14	1/09/2022	14.88	6.24	0.11	27.9	2.32	23.7

**Red Text** Outside of the known range of OPP  
**Blue Text** Within a range thought to provide OPP with a competitive advantage  
**Green Text** OPP captured at site during this survey

The results of the water quality measurements show that, at the time of sampling, the water quality at most sites was within the known physico-chemical tolerances of OPP (refer to **Table 1.1**). At approximately two-thirds of the sites the pH values were in the range thought to provide OPP with a competitive advantage. There were some sites where the water quality was outside of the known tolerance ranges of OPP with respect to dissolved oxygen, conductivity and turbidity in the 2022 surveys. Notably, at the majority of the sites where OPP were captured during this reporting period the water quality measurements were within the known tolerance ranges of OPP and pH was recorded within the range thought to provide OPP with a competitive advantage.

Although the dissolved oxygen (DO) concentrations at multiple sites were below the levels thought to be ideal for fish survival and function (> 4-5 mg/L), OPP are commonly associated with dystrophic (low DO concentration) waterways and the swamps and streams in the wallum country favoured by OPP are typically low in DO. During the surveys in 2022 OPP were captured from 8 sites where DO concentrations of less than 2.15 mg/L were measured.

A comparison of threatened fish monitoring pre-construction and construction phase water quality ranges with the water quality results collected during the May 2022 and September 2022 surveys is presented in **Appendix C**. The great majority of results are within the ranges measured in pre-construction and construction phase monitoring.

### 3.3 Habitat Description

Habitat availability and condition varied across the study area. A brief description of the general habitat conditions at each location is presented in **Table 3.3**. Summary results from habitat surveys are displayed in graphical form in **Appendix A**. The two approaches, qualitative and quantitative, are intended to be used in conjunction. An inventory of aquatic plants found at each site during this reporting period is presented in **Table 3.4**, **Table 3.5**, **Table 3.6** and **Table 3.7**.

The flows were highly variable during this reporting period, mostly due to very heavy rainfall in the lead up to the May 2022 survey. In September 2022 flows were negligible (< 0.1m/s) at the majority of the sites visited. At some sites habitat descriptions and measurements were hampered by the depth and flow velocities at the time of the surveys. In particular, access to the bed and banks of sites 3a and OPP3 could not be accessed for measurements during one or both of the surveys during this reporting period.

**Table 3.3 Brief descriptions of habitat features at all impact sites**

<i>Section</i>	<i>Site</i>	<i>Habitat Description</i>
7	2a	Site 2a is located approximately 200m upstream of the upgrade corridor and consists of two pools located either side of a culvert on a dirt road. The benthic material was dominated by mud but varied across the site and included sand and gravel in some areas. Structural habitat at the site was comprised mostly of leaf litter, undercut banks and root balls, all of which were variable within the site. The riparian zone was well vegetated and continuous with adjacent forest. There was no aquatic vegetation and no flow at the time of either survey. There was some remaining evidence of bushfire around the site.
7	2b	Site 2b is located in a shallow drainage line immediately downstream of a bank of new box culverts under the Pacific Highway. There was very limited structural habitat. The benthic material was mostly mud with a small amount of gravel, sand and scour rock. The riparian zone was cleared for construction and the creek bed altered for asset protection.
7	2c	Site 2c is also located in a shallow drainage line approximately 300m downstream of the existing highway. Site 2 is ephemeral and carries no water in moderately dry conditions. There was water at the time of both surveys in 2022. Most signs of bushfire have disappeared.
7	3a	Site 3a consists of a wide, shallow channel located directly upstream of an existing highway bridge. The benthic material is variable throughout the site, including mud, sand, fine gravel, coarse gravel and rock. There is a variety of structural habitat available, including a number of fallen logs, a moderate cover of woody debris and leaf litter, dense beds of aquatic vegetation and occasional root balls and undercut banks. The aquatic vegetation is dominated by Water Ribbons ( <i>Cyanogeton procerum</i> ) and Maundia ( <i>Maundia triglochinoides</i> ). The margins are mostly steep. A bridge has been built over the site and shading has affected the vegetation cover. At the time of the May 2022 survey the bed and banks could not be accessed but at the time of the September 2022 survey there was very little flow.
8	10b	Site 10b is an excavation located within the upgrade corridor at the point where a wide ephemeral wetland of variable depth drains out into open agricultural land. The benthic material included mud and sand and scour rock when water levels are high. Structural habitat availability varied throughout the site, although there was mostly a high proportional cover of leaf litter and some emergent and submerged vegetation. The stream margins vary between rock, bare sand and grass. There was no flow at the time of sampling. This site has been substantially modified during construction, including the construction of an upstream refuge pool, a deepened channel under the bridge crossing and installation of rock scour protection on the northern margin of the existing excavation.
8	10c	Site 10c consists of a shallow, broad, degraded natural drainage line through agricultural land. It is located downstream of the upgrade corridor. The stream margins were flat and grassed. Cattle access to the water has reduced. Vegetative and structural habitat varies across the site from emergent grasses and Spikerushes to bare unconsolidated sediments. The benthic material was mud. There was no flow at the time of either survey.
8	11b	Site 11b consists of a narrow channel, possibly modified by excavation, draining agricultural land and cane fields. The benthic material was mud, with a high proportional cover of debris. Other structural habitat included scattered rushes, regular root balls and trailing vegetation. The stream banks were relatively well vegetated with a mixture of trees, rushes and grasses. There was low flow at the time of both surveys.

<b>Section</b>	<b>Site</b>	<b>Habitat Description</b>
8	11d	Site 11d consists of a narrow, shallow channel, probably modified by excavation, draining sugar cane fields. The benthic material was mud, with a moderate proportional cover of leaf litter and a sparse cover of mostly senescing emergent aquatic plants. The stream margins were steep and grassy, with no undercutting, little trailing vegetation and very little root mass. This site has been substantially modified during construction including revegetation and formalising of the channel. Shading effects from the bridge are evident. There was low flow at the time of both surveys.
8	12a	Site 12a consisted of a narrow channel, possibly modified by excavation, draining agricultural land. The benthic material was mud, with a high proportional cover of leaf litter and dense emergent plants, mostly Grey Rush ( <i>Lepironia articulata</i> ) and Jointed Twig-rush ( <i>Baumea articulata</i> ), in some areas. The degree of riparian cover, undercutting and root mass varies across the site. There was low flow at the time of both 2022 surveys. The site has now been significantly modified by a diversion and revegetation. Shading effects from the constructed bridge are evident.
9	13b	Site 13b is located in a very shallow drain on agricultural land. The benthic material was dominated by mud, with a small proportion of sand and some scour rock. There was a high proportion of leaf litter and a moderate cover of emergent plants. The banks at this site vary across the site from grassy to bare scour rock. There was no flow at the time of either survey. The site has been significantly modified by a bridge construction, diversion, reshaping and revegetation.
9	13c	Site 13c is located in a narrow, deep drain on agricultural land approximately 20m upstream of the new highway crossing. The benthic material was dominated by mud, with a small proportion of sand. There was a high proportion of leaf litter and scattered small woody debris. Other structural habitat included dense emergent vegetation in some areas. The banks at this site were grassy and there are scattered rushes. There was limited flow at the time of both 2022 surveys.
9	13e	Site 13e consists of a small billabong located along the path of an agricultural drain. It was approximately 15 m wide at its widest point and 1.2m deep. The margins were gently sloping and grassy. At the time of the last survey in September 2017 most of the structural habitat was formed by submerged and emergent vegetation. The benthic material was dominated by mud with low percentage of sand. There was no flow. Site 13e is located on private property with no access arrangement in place for this monitoring period.
9	16a	Site 16a consists of a wetland pool in an old sand mining channel located within Broadwater National Park approximately 150 m to the east of the existing highway. The benthic material was mud and sand and the site contained little structural habitat aside from a regular but low proportional cover of leaf litter, a high proportional cover of submerged vegetation and scattered emergent vegetation. There was no flow at the time of either survey.
9	16b	Site 16b consists of a wide, shallow wetland pool located approximately 50m to the west of the existing highway. The benthic material was a mixture of sand and mud. Structural habitat availability varied across the site with a dense cover of emergent aquatic plants in some areas, a moderate cover of leaf litter and small woody debris in some areas and bare sediment in others. This site has been significantly modified during construction of the Woodburn-Broadwater access road by construction of a drought refuge pool, removal of some riparian vegetation and partial infilling of the eastern margin.

<b>Section</b>	<b>Site</b>	<b>Habitat Description</b>
8	22b	Site 22b is an excavation located approximately 100m E of the upgrade corridor on a private property. The margins of the dam varied between gently sloping and steep and were moderately vegetated. Structural habitat was dominated by submerged vegetation and trailing vegetation with occasional debris. The benthic material was mostly sand. There was no flow during either survey.
8	22c	Site 22c is a deep excavation located in an agricultural drainage line approximately 250m E of the upgrade corridor on a private property. The margins were well vegetated and there was a high proportion of trailing vegetation, mostly Sphagnum moss and Bladderwort ( <i>Utricularia sp.</i> ). Structural habitat is limited in the middle but around the margins consisted of submerged vegetation and occasional debris. The benthic material was mostly sand. There was no flow during either survey.
9	26d	Site 26b is a deep pool in a shallow natural drainage line. At the time of the last survey in September 2017 the margins were very well vegetated and trailing vegetation was a major habitat feature. Other structural habitat included dense submerged vegetation and stands of emergent rushes. The benthic material was mostly sand and there was no flow at the time of sampling. Site 26d is located on private property with no access arrangement in place for this monitoring period.
9	27b	Site 27b is a shallow, natural depression in a paperbark swamp. At the time of sampling, it was continuous with the surrounding forest with no clear margin. Structural habitat was formed by a high proportional cover of submerged vegetation and leaf litter, irregular woody debris and scattered but dense stands of emergent rushes, mostly Jointed Twig-rush. The benthic material was mud with no flow evident at the time of sampling.
9	27e	Site 27e is a shallow, natural depression in a paperbark swamp. At the time of sampling, it was continuous with the surrounding forest with no clear margin. Structural habitat was formed by a high proportional cover of leaf litter, regular woody debris and scattered submerged vegetation and stands of emergent rushes, mostly Jointed Twig-rush. The benthic material was mud with no flow evident at the time of sampling.
DP	OPP1	Site OPP1 is an excavation located approximately 50m to the north, and offstream of Tabbimoble Channel 2. The benthic material is mud. Structural habitat was abundant, including fallen trees and a high proportional cover of leaf litter, small woody debris and emergent aquatic plants (mostly <i>Maundia triglochinooides</i> , <i>Cyanogeton procerum</i> , and <i>Philydrum lanuginosum</i> ). The riparian zone is densely covered with paperbarks and acacia. The site is very rarely subject to flow events. The site was heavily impacted by 2019 bushfires but most signs of bushfire have now disappeared.
DP	OPP2	Site OPP2 is located in Tabbimoble Channel 2 immediately downstream of the upgraded Pacific Highway crossing. The site is relatively uniform in width and depth with the exception of a gravel bar running through the middle of the site. At the time of the May 2022 sampling, the waterway had burst its banks and no habitat measurements were collected. Additionally, the channel could not be accessed and sampling was undertaken from the banks. Benthic material is primarily mud with low proportional cover of gravel, sand and rock. Structural habitat included rootballs, overhanging banks and small but dense beds of emergent vegetation including <i>Maundia triglochinooides</i> and <i>Eleocharis sphacelata</i> .

<i>Section</i>	<i>Site</i>	<i>Habitat Description</i>
DP	OPP3	Site OPP 3 is located in Tabbimoble Floodway 3 immediately downstream of the upgraded Pacific Highway crossing. The site was relatively uniform in width and depth. Previously, benthic material at this site was dominated by mud, with very little leaf litter and a low proportional cover of small and large woody debris. Structural habitat was limited with no aquatic vegetation recorded and limited overhanging banks and root balls. The riparian margin was continuously but narrowly vegetated. At the time of the May and September surveys the flow was very fast and the water was too deep to safely access the channel. Sampling had to be undertaken from the banks and no habitat measurements could be collected.
DP	OPP6	Site OPP 6 is immediately upstream (west) of the upgraded Pacific Highway crossing where Tabbimoble Floodway 3 opens out into an area of semi-permanent swampland. The site was heavily impacted by 2019 bushfires, but signs of the bushfires have mostly disappeared.
DP	OPP7	Site OPP 7 is immediately upstream (west) of the upgraded Pacific Highway crossing where Tabbimoble Floodway 2 opens out into an area of flood prone land/ephemeral swampland with ill-defined channels. Flow was very fast at the time of the May 2022 surveys and the waterway had burst the banks of the small, dispersed channels. The site was heavily impacted by 2019 bushfires, but signs of the bushfires have mostly disappeared.

A number of sites were heavily impacted by the bushfires of summer 2019 – 2020. In particular, a number of the sites around Tabbimoble were subject to high intensity bushfires that burnt the surrounding vegetation and, in some cases, the wetland vegetation itself. The proportional cover of charcoal in the benthic material at these sites (OPP1, OPP5, OPP6, OPP7, 2a, 2c, C13 and C14) has now reduced and vegetation is largely returning to the pre-bushfire conditions. It is likely that any impacts of the bushfires upon water quality have also reduced over time.

**Table 3.4 Aquatic plants identified at impact sites during the May 2022 survey**

<i>Species Name</i>	Common Name	2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e	16a	16b	22b	22c	26d	27b	27e
<i>Azolla spp</i>	Azolla														x				x	
<i>Bacopa monnieri</i>	Water Hyssop	x																		
<i>Baloskion (Restio) pallens</i>	Zigzag Rush													x	x	x				
<i>Baloskion (Restio) tetraphyllum</i>	Feathery Rush															x	x			
<i>Baumea articulata</i>	Jointed Rush								x	x									x	x
<i>Baumea rubiginosa</i>	Baumea														x					
<i>Baumea sp.</i>	A rush			x																
<i>Blechnum sp.</i>	Fern													x						x
<i>Carex appressa</i>	Tall Sedge										x									
<i>Carex fascicularis</i>	Tassel Sedge	x		x	x			x												
<i>Chorizandra cymbaria</i>	Heron Bristle-sedge	x							x					x	x					x
<i>Cyperus sp.</i>	Sedge		x																	
<i>Eleocharis acuta</i>	Common Spikerush						x				x									
<i>Eleocharis sphaelata</i>	Tall Spike-rush											x								
<i>Gabnia sieberana</i>	Sawsedge					x		x		x	x			x	x	x	x		x	x
<i>Isolepis inundata</i>	Swamp Club Rush	x		x																
<i>Juncus prismatocarpus</i>	Branching Rush		x	x																
<i>Juncus usitatus</i>	Common Rush		x			x				x	x	x				x				
<i>Leersia hexandra</i>	Swamp Ricegrass		x		x	x	x	x		x	x									
<i>Lemna spp.</i>	Duckweed														x				x	
<i>Lepironia articulata</i>	Grey Rush					x								x	x				x	x
<i>Lomandra hysterix</i>	Creek Mat rush	x		x	x	x			x	x	x					x				
<i>Ludwigia peploides</i>	Water Primrose						x													
<i>Maundia triglochinoides</i>	Maundia				x															
<i>Nymphaea sp.*</i>	Waterlily*					x		x				x				x			x	x
<i>Paspalum distichum</i>	Water Couch		x			x	x	x		x	x									
<i>Persicaria deciepens</i>	Slender Knotweed					x	x		x						x					



Species Name	Common Name	2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e	16a	16b	22b	22c	26d	27b	27e
<i>Persicaria hydropiper</i>	Water Pepper						x				x									
<i>Persicaria orientalis</i>	Princes Feather						x													
<i>Persicaria strigosa</i>	Prickly Knotweed					x		x		x	x									
<i>Philydrum lanuginosum</i>	Frogsmouth	x	x				x		x											x
<i>Schoenoplectus mucronatus</i>	Marsh Clubrush		x			x														
<i>Sphagnum sp.</i>	Peat Moss													x		x	x			x
<i>Typha orientalis</i>	Cumbungi										x									
<i>Utricularia sp.</i>	Bladderwort						x							x	x	x	x		x	x

\* Introduced Species

Grey cells indicate site not surveyed.

**Table 3.5 Aquatic plants identified at control and Devils Pulpit sites during the May 2022 survey**

Species Name	Common Name	C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4	OPP5	OPP6	OPP7
<i>Balaskion (Restio) pallens</i>	Zigzag Rush	x		x		x	x	x									
<i>Balaskion (Restio) tetraphyllum</i>	Feathery Rush					x		x									
<i>Baumea articulata</i>	Jointed Rush		x													x	
<i>Baumea rubiginosa</i>	Baumea		x				x			x		x					
<i>Carex fascicularis</i>	Tassel Sedge											x					x
<i>Chorizandra cymbaria</i>	Heron Bristle-sedge		x	x		x				x	x						x
<i>Cyanogeton procerum</i>	Water Ribbons									x							
<i>Cyperus difformis</i>	Dirty Dora											x					
<i>Cyperus papyrus*</i>	Papyrus*															x	
<i>Elatine gratioloides</i>	Waterwort									x							
<i>Eleocharis acuta</i>	Common Spikerush											x					
<i>Eleocharis sphacelata</i>	Tall Spike-rush										x					x	
<i>Gahnia sieberana</i>	Sawsedge		x	x		x	x	x				x					
<i>Isolepis inundata</i>	Swamp Club Rush									x							x
<i>Juncus prismatocarpus</i>	Branching Rush											x					
<i>Juncus usitatus</i>	Common Rush							x			x	x					

Species Name	Common Name	C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4	OPP5	OPP6	OPP7
<i>Leersia hexandra</i>	Swamp Ricegrass										x	x	x			x	x
<i>Lepironia articulata</i>	Grey Rush	x															
<i>Lomandra hysterix</i>	Creek Mat rush									x		x					x
<i>Maundia triglochinooides</i>	Maundia										x					x	
<i>Nymphaea sp.*</i>	Waterlily*	x															
<i>Paspalum distichum</i>	Water Couch										x	x	x			x	x
<i>Persicaria hydropiper</i>	Water Pepper										x						
<i>Philydrum lanuginosum</i>	Frogsmouth									x	x	x				x	x
<i>Schoenoplectus mucronatus</i>	Marsh Clubrush										x	x					
<i>Sphagnum sp.</i>	Peat Moss	x	x	x		x		x									
<i>Utricularia sp.</i>	Bladderwort	x	x	x		x				x							

\* Introduced Species

Grey cells indicate site not surveyed.

**Table 3.6 Aquatic plants identified at impact sites during the September 2022 survey**

Species Name	Common Name	2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e	16a	16b	22b	22c	26d	27b	27c
<i>Azolla spp.</i>	Azolla														x					
<i>Baloskion (Restio) pallens</i>	Zigzag Rush			x										x	x	x				
<i>Baloskion (Restio) tetraphyllum</i>	Feathery Rush														x	x	x			
<i>Baumea articulata</i>	Jointed Rush									x	x			x					x	x
<i>Baumea rubiginosa</i>	Baumea		x	x											x	x	x		x	
<i>Blechnum sp.</i>	Fern									x				x					x	x
<i>Carex appressa</i>	Tall Sedge									x	x									
<i>Carex fascicularis</i>	Tassel Sedge				x			x												
<i>Ceratophyllum demersum</i>	Hornwort				x															
<i>Chorizandra cymbaria</i>	Heron Bristle-sedge		x	x																
<i>Cyngneton procerum</i>	Water Ribbons				x															
<i>Eleocharis acuta</i>	Common Spikerush						x				x									
<i>Eleocharis sphacelata</i>	Tall Spike-rush						x					x								
<i>Enteromorpha spp.</i>	Green Alga					x				x	x	x								

Species Name	Common Name	2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e	16a	16b	22b	22c	26d	27b	27e
<i>Gabnia sieberana</i>	Sawsedge					x		x		x	x			x	x	x	x		x	x
<i>Gleichenia dicarpa</i>	Pouched Coral Fern																x			
<i>Isolepis inundata</i>	Swamp Club Rush		x	x					x											
<i>Juncus prismatocarpus</i>	Branching Rush		x						x											
<i>Juncus usitatus</i>	Common Rush		x			x	x	x	x	x	x	x								
<i>Leersia hexandra</i>	Swamp Ricegrass					x	x	x		x		x								
<i>Lemna spp.</i>	Duckweed														x					
<i>Lepironia articulata</i>	Grey Rush					x				x				x	x					x
<i>Lomandra hysterix</i>	Creek Mat rush	x		x	x			x	x	x	x					x				
<i>Maundia triglochinooides</i>	Maundia				x															
<i>Nymphaea sp.*</i>	Waterlily*					x						x				x				x
<i>Ottelia ovalifolia</i>	Swamp Lily	x			x	x														
<i>Paspalum distichum</i>	Water Couch						x	x			x	x								
<i>Persicaria deciepens</i>	Slender Knotweed							x	x		x									
<i>Persicaria hydropiper</i>	Water Pepper					x	x	x	x	x	x									
<i>Persicaria orientalis</i>	Princes Feather						x													
<i>Persicaria strigosa</i>	Prickly Knotweed					x		x												
<i>Philydrum lanuginosum</i>	Frogsmouth		x	x	x				x		x									x
<i>Schoenoplectus mucronatus</i>	Marsh Clubrush					x														
<i>Sphagnum sp.</i>	Peat Moss								x	x	x			x		x	x		x	x
<i>Typha orientalis</i>	Cumbungi										x									
<i>Utricularia sp.</i>	Bladderwort		x											x	x	x	x		x	x

\* Introduced Species

Grey cells indicate site not surveyed.

**Table 3.7 Aquatic plants identified at control and Devils Pulpit sites during the September 2022 survey**

Species Name	Common Name	C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4	OPP5	OPP6	OPP7
<i>Alisma plantago</i>	Common Water-plantain									x							
<i>Azolla spp.</i>	Azolla								x								
<i>Balaskion (Restio) pallens</i>	Zigzag Rush	x	x	x	x	x	x	x									
<i>Balaskion (Restio) tetraphyllum</i>	Feathery Rush		x	x	x	x											

Species Name	Common Name	C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4	OPP5	OPP6	OPP7
<i>Baumea articulata</i>	Jointed Rush		x						x								x
<i>Baumea rubiginosa</i>	Baumea	x	x	x	x	x	x	x		x							
<i>Carex fascicularis</i>	Tassel Sedge										x		x				
<i>Chorizandra cymbaria</i>	Heron Bristle-sedge									x	x						x
<i>Cyngneton procerum</i>	Water Ribbons								x								x
<i>Eleocharis sphacelata</i>	Tall Spike-rush								x		x						x
<i>Enteromorpha spp.</i>	Green Alga				x				x								
<i>Enhydra fluctuans</i>	Buffalo Spinach								x								
<i>Gabnia sieberana</i>	Sawsedge		x	x	x	x											
<i>Isolepis inundata</i>	Swamp Club Rush										x						x
<i>Juncus prismatocarpus</i>	Branching Rush																x
<i>Juncus usitatus</i>	Common Rush											x					
<i>Leersia hexandra</i>	Swamp Ricegrass								x		x	x	x				x
<i>Lepironia articulata</i>	Grey Rush	x															
<i>Lomandra hysterix</i>	Creek Mat rush										x	x	x				x
<i>Maundia triglochbinoides</i>	Maundia										x						
<i>Nymphaea sp.*</i>	Waterlily*	x							x								
<i>Ottelia ovalifolia</i>	Swamp Lily								x		x						x
<i>Paspalum distichum</i>	Water Couch											x	x				x
<i>Persicaria strigosa</i>	Prickly Knotweed								x		x						
<i>Philydrum lanuginosum</i>	Frogsmouth									x	x						x
<i>Potamogeton octandrus</i>	Pondweed								x								
<i>Schoenoplectus mucronatus</i>	Marsh Clubrush											x					
<i>Sphagnum sp.</i>	Peat Moss	x	x	x	x	x		x									
<i>Typha orientalis</i>	Cumbungi								x								
<i>Utricularia sp.</i>	Bladderwort	x	x	x		x											

\* Introduced Species

Grey cells indicate site not surveyed.

## Discussion and Conclusion

The two fish surveys completed during the second year of the operational phase for the W2B Threatened Fish monitoring were completed in May and September 2022. There were OPP captured at 11 of the 24 impact sites and 7 of the 11 reference locations during this reporting period. Habitat quality and availability varied across the sites sampled, as did water quality. Due to very consistent rainfall during this reporting period, all sites had sufficient water at the time of the surveys, although there were some sites that were inaccessible due to the wet ground conditions. At most impact and control sites the combination of habitat and water quality was more favourable for occupation by OPP than was recorded in the 2019, 2020 and 2021 surveys, particularly in relation to structural habitat availability, pH and dissolved oxygen. In addition, there were very good dispersal opportunities for OPP in the February and March 2022 floods. These factors are reflected in the greater numbers of sites where OPP were captured and the greater number of individual OPP captured.

In comparison with previous results (Hyder 2012, GeoLINK 2014 & 2015, Jacobs 2018, 2019, 2020, 2021), a moderately large number of OPP were captured during the two surveys this year. Overall, the operational phase results to date indicate a slight reduction in the average number of OPP captured per site when compared with the average catches from the pre-construction and construction phase monitoring at impact sites and a slight increase in the same measure at control sites. However, as noted in the final construction phase Threatened Fish Monitoring Report, reduced average capture at impact sites over the course of the construction phase monitoring has also been observed at control sites and environmental conditions unrelated to W2B upgrade construction explain much of the variation observed in the dataset.

Fish habitat data collected during this reporting period indicates continued variability among both impact and control sites. Most of the variability is explained by environmental conditions unrelated to the W2B upgrade operation with the exception of sites where construction of crossings has necessitated changes to stream morphology and benthic materials. At some of those sites there are positive signs that habitat rehabilitation efforts have been successful, including improved vegetative cover and structural habitat features such as leaf litter. Water quality measurements collected during this reporting period were also variable within and between sites. Again, much of the observed variability is explained by environmental conditions unrelated to highway operation.

Operational phase monitoring is proceeding at all of the 24 impact and 11 control sites that were being monitored at the end of the construction phase threatened fish monitoring. During this monitoring period operational phase threatened fish monitoring along the W2B Upgrade was undertaken according to the TFMP, with the exception of monitoring at sites where access was denied by landholders (OPP4, 13e, 26d) and sites where unsafe conditions restricted access (OPP5 - both surveys, C5 and C13 - May 2022 only).

The fishing effort for the two surveys this year consisted of 507 individual fish trapping hours and 33,655 seconds of electrofishing. A total of 1,938 fish were captured in May 2022 and 3,834 fish were captured in September 2022. These totals included 154 (8%) OPP and 327 (9%) OPP respectively. The OPP capture rates (as a percentage of total fish captured) in previous surveys have varied between 1% and 25%. The sites where OPP were captured in 2022 included:

- Seven of the eleven control sites. OPP were captured at site C1, C2, C3, C8, C11 and C12 during both surveys and C5 in the September 2022 survey.
- Eleven of the twenty-four impact sites. OPP were captured at 10b, 13c, 16a, 22b, 22c, 27b and 27e during both surveys, 3a and 11b during the May 2022 survey only and 12a and 13b during the September 2022 survey only. The capture at site 3a was the first since May 2018, the captures at 10b and 11b were the first since pre-construction and the capture at 13b was the first there since September 2017.

Notably this reporting period saw the first capture of OPP in the Tabbimoble subcatchment since extensive bushfire activity occurred there in late 2019/early 2020, and the first captures in the unnamed drain south of Laing Hill since 2013.

Plentiful rainfall in 2021 and 2022 would have resulted in good breeding and dispersal conditions for OPP. This is reflected in the increased numbers of OPP captured during the current reporting period and the increased number of sites at which OPP were captured in comparison to the results from the 2019, 2020 and 2021 surveys (**Table 4.1**). The proportion of juvenile OPP, and the overall size distributions of OPP, captured during the surveys this year indicate more stable OPP populations with healthy recruitment of juvenile OPP at some sites but not others and at sites numbers larger than 16 (**Figures 4.1 and 4.2**). Recruitment of juvenile OPP at some sites may be hampered by low population densities and it may be some years before OPP populations recover from the impacts of drought and bushfire.

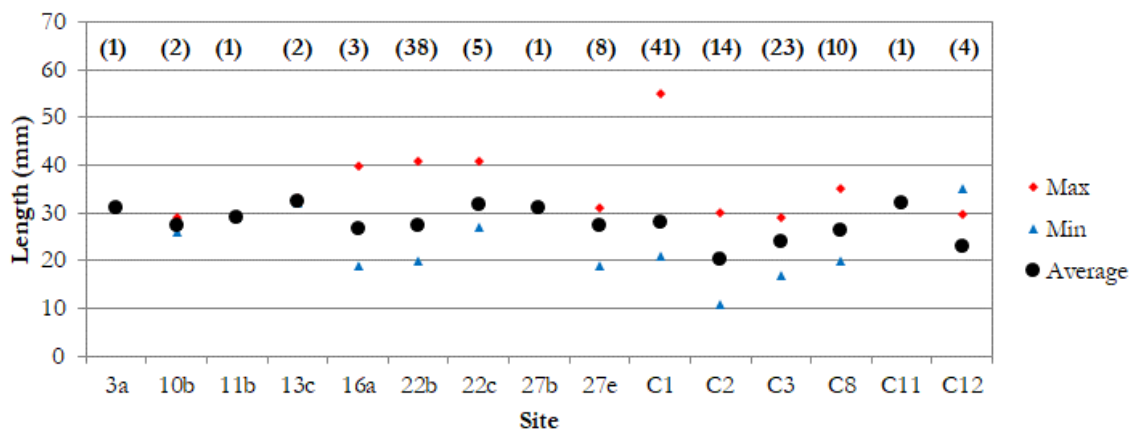


Figure 4.1 Length distribution data of OPP captured in the May 2022 survey (counts in brackets)

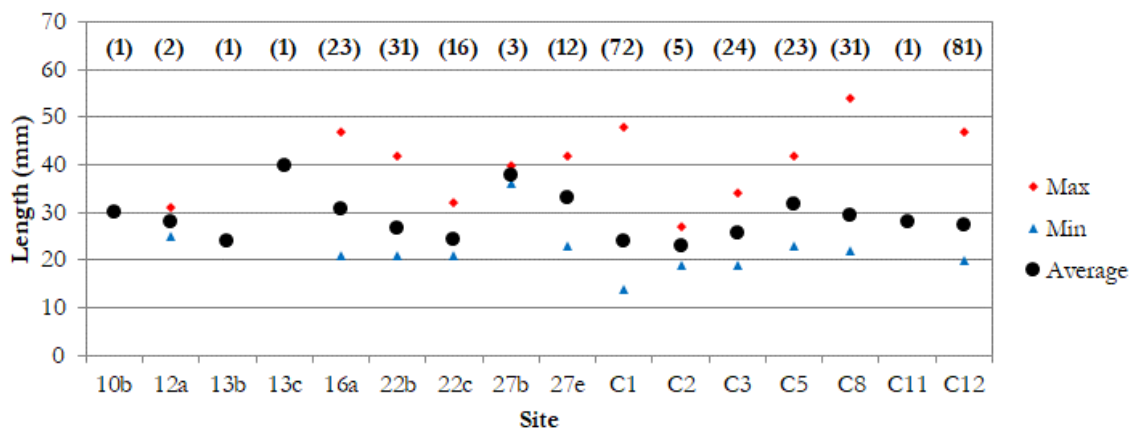


Figure 4.2 Length distribution data of OPP captured in the September 2022 survey (counts in brackets)

**Table 4.1 Proportion of juvenile OPP (<25mm total length) as a percentage of total OPP captured**

<i>Survey</i>	<i># Sites Accessed</i>			<i># OPP Captured</i>			<i>% Juvenile OPP captured</i>		
	<i>Total</i>	<i>Impact</i>	<i>Control</i>	<i>Total</i>	<i>Impact</i>	<i>Control</i>	<i>Total</i>	<i>Impact</i>	<i>Control</i>
September 2013	14	14	-	221	221	-	41.3	41.3	-
September 2014*	34	23	11	182	44	138	7.7	0	10.1
September 2016	13	13	-	137	137	-	12.4	12.4	-
May 2017	27	18	9	229	89	140	69.9	52.8	80.7
September 2017	28	19	9	425	170	255	73.4	56.5	84.7
May 2018	26	17	9	263	109	154	22.1	23.9	20.8
September 2018	25	16	9	265	96	169	27.9	18.8	33.1
July 2019*	32	22	10	8	7	1	0	0	0
September 2019*	31	21	10	33	21	12	0	0	0
May-June 2020*	32	22	10	27	4	23	85.2	100	83.6
September 2020*	32	22	10	56	35	21	44.6	60	19.0
May 2021*	31	22	9	102	43	59	46.1	46.5	45.8
September 2021*	32	22	10	200	57	143	44	42.1	44.8
May 2022	29	22	7	154	61	93	36	20	47
September 2022	31	22	9	327	90	237	39	29	41

\* Survey included Devils Pulpit Sites

There has been a high degree of variability in the numbers of OPP captured at each site since monitoring began in 2013, at both the impact and control sites. Due to the opportunistic life cycle strategies and quick responses to stochastic environmental factors displayed by OPP (Knight *et al.* 2012) it is expected that surveys conducted at different times would yield different results depending upon favourable or unfavourable breeding and dispersal conditions. A comparison of average OPP capture at impact and control sites in the pre-construction, construction and operational (to date) phases of monitoring shows an increase in the average capture at control sites and a decrease in the average capture at impact sites (Figure 3.5). However, as discussed in the previous annual Threatened Fish Monitoring Report (TfNSW 2021, Figure 4.3), trend analysis shows that throughout construction phase monitoring there was a similar trend towards reduced capture at both impact and control sites. A trend of increasing average capture is evident during the operational phase to date at both control and impact sites (Figure 4.4). Additionally, the observed increase in average capture at control sites between the pre-construction and construction phase monitoring is likely to be driven by the fact that no control sites were monitored during pre-construction monitoring in September 2013 after breeding and dispersal conditions had been very good. Pre-construction phase monitoring at control sites was only undertaken in September 2014, after a drought that resulted in very poor breeding and dispersal conditions and many dry sites, leading to very low numbers of OPP captures at both control and impact sites.

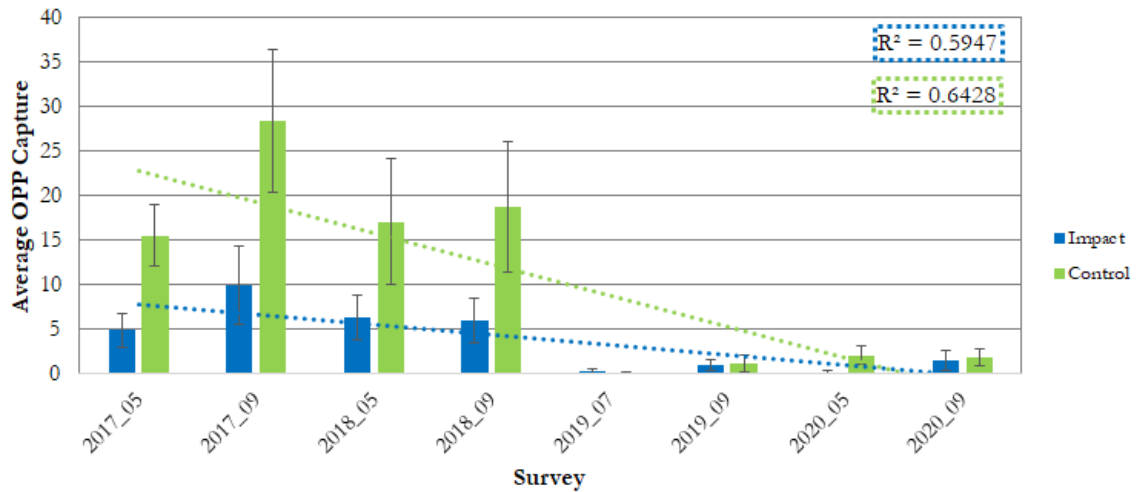


Figure 4.3 Mean ± SE OPP capture per site at impact and control sites during construction phase monitoring.

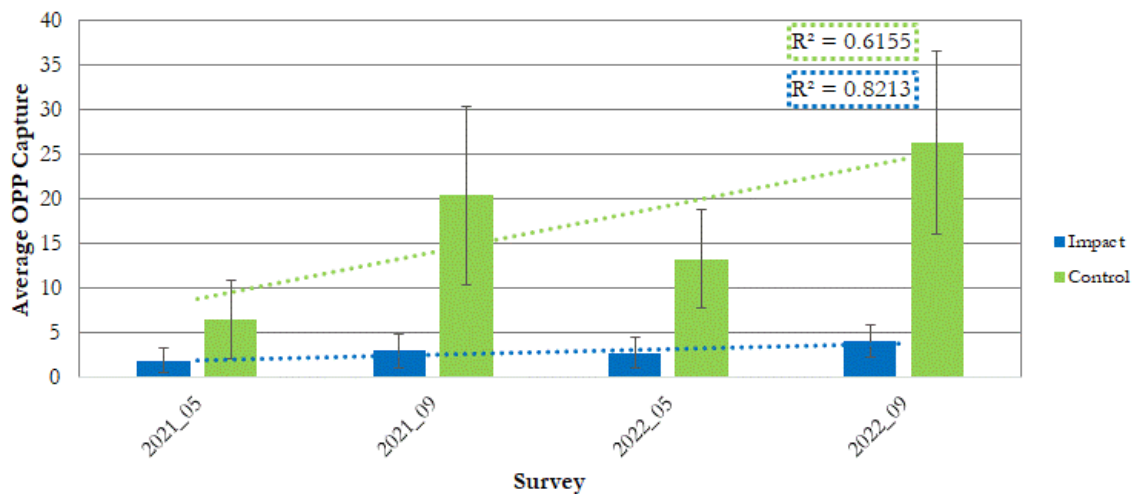


Figure 4.4 Mean ± SE OPP capture per site at impact and control sites during operational phase monitoring to date.

The numbers of Mosquitofish (*Gambusia holbrooki*) encountered at each site are of specific interest as predation by this species is identified as a Key Threatening Process under the *Biodiversity Conservation Act 2016* and they are antagonistic towards OPP. There has been variation in the numbers of Mosquitofish encountered during threatened fish surveys to date. During the surveys this year, Mosquitofish were captured in very large numbers at both control and impact sites. In comparison with the pre-construction and construction phases, the average catch of Mosquitofish to date in operational phase monitoring has increased slightly although there are high levels of variation in the dataset (Figure 4.5). During the operational phase monitoring to date there has been an increase in the average capture of Mosquitofish at the impact sites, but not at the control sites, when compared with the pre-construction and construction phase monitoring. The increased average capture at impact sites has resulted from very strong increased captures at sites 2b, 10b, 16b, OPP1 and OPP2 (Figure 4.6).



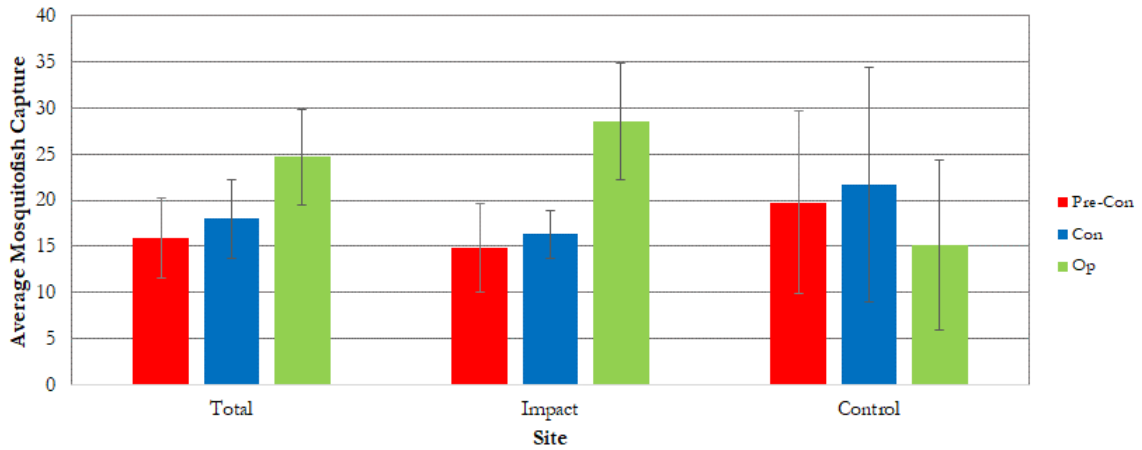


Figure 4.5 Mean  $\pm$  SE Mosquitofish Capture at all impact and control sites in the pre-construction, construction and operational phase surveys.

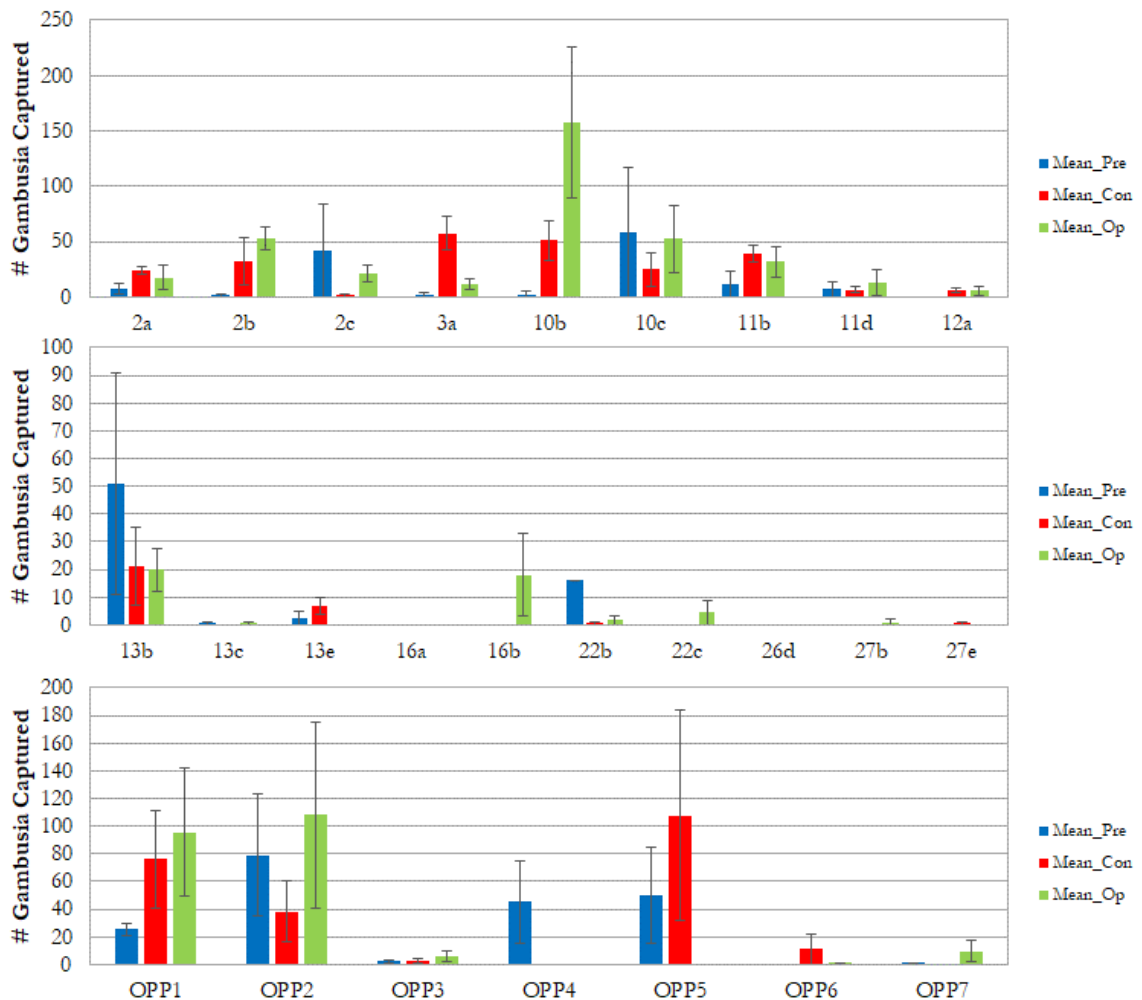


Figure 4.6 Mean  $\pm$  SE Mosquitofish capture at impact sites during each monitoring phase

This study measured vegetative and physical habitat features including, flow, width, depth, benthic material, aquatic vegetation, debris, riparian cover and stream bank forms. Over the course of the two surveys this year we have collected a large volume of information describing habitat conditions at all sites qualitatively and quantitatively. All of the sites surveyed had at least some habitat features commonly associated with OPP (Knight & Arthington 2008). Variation among habitat features collected during the operational phase surveys to date was

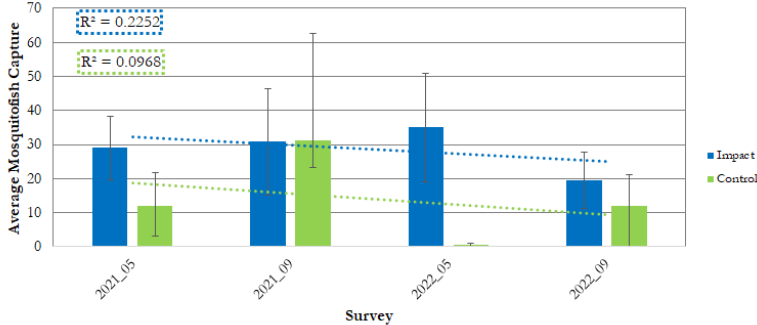
similar to previous surveys undertaken as part of pre-construction and construction phase monitoring. A graphical assessment of the habitat data collected in the pre-construction, construction and operational (to date) phases of monitoring is presented in **Appendix A**. The analysis indicates significant differences between data collected in the pre-construction, construction and operational (to date) phases at a relatively low number of sites and for some variables only. In general, the observed differences are evenly spread between the impact and control sites. Many of the differences observed are simply a function of hydrological condition, such as width and depth measurements or, in some cases, aquatic vegetation cover, benthic material, trailing vegetation and stream bank form, which can vary at some sites in relation to the water depth and width. Observer bias is also a significant factor, particularly in relation to variables such as riparian cover. Fixed point photographs at each site (presented in the final annual report) are a useful reference for determining actual differences in such cases.

Several disturbances potentially relating to construction impacts were described in the final construction phase monitoring report (TfNSW 2021). Most of these resulted from necessary changes to the shape of waterways associated with crossing designs, clearing of riparian vegetation around bridge abutments and/or material use such as rock utilised as scour protection around bridge abutments. There were also some changes in vegetative cover at crossing sites, for example, where rehabilitation efforts had successfully resulted in increased emergent vegetation cover or where shading from bridge crossings resulted in reduced vegetation cover. The results of habitat monitoring during this first year of the operational phase are similar to those of the later years of construction phase monitoring, indicating no changes associated with operation of the highway. Due to the small size of the operational phase dataset the standard errors of the operational phase means presented in **Appendix A** are large. It is expected that further monitoring will lead to a reduction in the variability and that any emerging trends associated with operation of the highway will become clear.

This study also measured physicochemical water quality variables. During this reporting period most water quality measurements were within the known ranges of waters inhabited by OPP, with the exception of very low conductivity measurements at some sites in May 2022, a small number of elevated turbidity measurements in September 2022 and a moderate number of very low DO concentrations in May 2022. The majority of turbidity measurements outside of the range of OPP were collected at impact sites but the other notable measurements were evenly spread between impact and control sites. All pH measurements collected during the 2022 surveys were within the reported ranges of waters known to be inhabited by OPP.

The Threatened Fish Management Plan (Roads and Maritime 2015) outlines performance indicators for assessing the impacts of construction on threatened fish populations and habitats. The performance indicators, relevant notes and conclusions are listed in **Table 4.2**. To date, no recommendations with 'on-ground' implications have arisen from threatened fish monitoring. While there are some performance indicators that were not met during this second year of operational phase monitoring, they are generally minor and acceptable in nature and there are no recommended changes to highway operation arising from the data collected for this report.

**Table 4.2 Performance indicators for threatened fish management on the W2B upgrade.**

<i>Performance Indicator</i>	<i>Notes</i>	<i>Conclusion</i>															
Relative abundance of OPP in impact sites has reduced significantly when compared to control sites over three consecutive monitoring periods	Using number of OPP captured as a measure of relative abundance, the relative abundance of OPP at all sites increased in comparison to the three previous years (see <b>Figures 4.3</b> and <b>4.4</b> ).	Performance indicator met - No significant impact from highway operation															
Occurrence of Eastern Gambusia in waterways where they have not previously been recorded	<p>Eastern Gambusia were captured at three impact sites during this reporting period where they had not previously been captured; 16b and 22c and 27b. However, they were also captured at one control site, C1 where they had not been observed since May 2017. They had previously been captured in all of the subcatchment areas where these sites are located.</p> <p>Eastern Gambusia have now been captured at some sites during both construction phase and operational phase monitoring where they were not captured during pre-construction phase monitoring. However, these sites have included both control and impact sites. Trend analyses (TfNSW 2021) undertaken with construction phase data indicated that detected increases in the Eastern Gambusia populations were greater at control sites than at impact sites, suggesting that Eastern Gambusia population dynamics were not strongly associated with the construction of the highway. Similar analyses for operational phase data to date indicate that, although capture at impact sites has been greater on average, there are weak trends towards reduced average Mosquitofish capture at both control and impact sites.</p>  <table border="1" data-bbox="427 1218 1187 1541"> <caption>Average Mosquitofish Capture Data</caption> <thead> <tr> <th>Survey</th> <th>Impact (Average)</th> <th>Control (Average)</th> </tr> </thead> <tbody> <tr> <td>2021_05</td> <td>~28</td> <td>~12</td> </tr> <tr> <td>2021_09</td> <td>~30</td> <td>~30</td> </tr> <tr> <td>2022_05</td> <td>~35</td> <td>~1</td> </tr> <tr> <td>2022_09</td> <td>~20</td> <td>~12</td> </tr> </tbody> </table>	Survey	Impact (Average)	Control (Average)	2021_05	~28	~12	2021_09	~30	~30	2022_05	~35	~1	2022_09	~20	~12	Performance indicator not met – Highway operation does not appear to be the cause.
Survey	Impact (Average)	Control (Average)															
2021_05	~28	~12															
2021_09	~30	~30															
2022_05	~35	~1															
2022_09	~20	~12															
Survey of Class 1 and 2 waterways with known or potential OPP habitat identifies additional populations of OPP.	A population of OPP were found in the Montis Gully area during the construction period. As a result, an impact site (13b) was added to the list of sites monitored prior to the September 2017 survey. Monitoring is continuing at that site.	Performance indicator met during construction phase. No additional populations of OPP observed during operational phase monitoring to date.															

<i>Performance Indicator</i>	<i>Notes</i>	<i>Conclusion</i>
Any change in habitat structure downstream of construction area, i.e., macrophyte and woody snag cover.	Some minor changes to habitat structure around highway crossings were noted during the construction phase monitoring (discussed in TfNSW 2021). At this stage of the operational phase monitoring no new changes to habitat structure related to highway operation have been detected.	Performance indicator met
Any change in natural stream flow and velocity resulting in threatened fish being trapped in isolated pools.	No significant changes to stream flow and velocity have been noted to date. Flow rates greater than 0.1 m/second have only been detected on a few occasions throughout monitoring. Several sites included in the monitoring program dry out on occasion. All sites subject to drying out were observed drying out in the pre-construction phase (GeoLINK 2014)	Performance indicator met
Any weed incursion into OPP waterways	There were no new introduced species of aquatic plants observed at any of the control or impact sites during the surveys this year.	Performance indicator met
No threatened fish species observed in ponds where fish have been translocated to.	OPP were translocated from construction sites at Montis Gully (Ch 141100 - 141900) and the Woodburn to Broadwater Service Rd (Ch 139000) on several occasions in 2017 into sites 27b and C1 during the course of dewatering and stream diversion activities. OPP, in relatively large numbers, were captured at C1 in all annual reporting periods to date. OPP were also captured at Site 27b during surveys this year, although capture throughout construction phase monitoring at 27b was highly variable, due in large part to drought conditions.	Performance indicator met in operational phase.
Any change in water quality from baseline conditions in the vicinity of, or downstream of the construction works	<p>The water quality results collected as part of the threatened fish monitoring gives some indication that there has been a reduction in the DO concentrations in the vicinity of construction works in comparison with baseline results. However, there was also a reduction in the DO concentrations at some of the control sites in comparison with baseline results.</p> <p>During the construction phase monitoring some of the pH measurements collected during threatened fish monitoring and during construction phase water quality monitoring indicated a potential increase in the pH around construction areas (TfNSW 2021). During operational phase threatened fish monitoring to date pH measurements have been lower at the majority of those sites (<b>Appendix C</b>).</p>	Performance indicator met during operational phase.
Any evidence of sediment or erosion being caused by the project	No erosion or sedimentation being caused by the project were noted during the threatened fish surveys during the construction and operational phase monitoring to date.	Performance indicator met.
Disparity in water quality between downstream and upstream monitoring sites observed during operation of the project	Information collected under the operational phase Water Quality Monitoring Program for the W2B upgrade will be used to assess whether the W2B upgrade is meeting requirements for this performance indicator.	To be confirmed.

In conclusion, the number of OPP that were captured during this reporting period increased in comparison to the previous three years of monitoring. The increased capture was noted at impact and control sites alike and is likely to be related to improved conditions for breeding

and dispersal between December 2020 and April 2021, and again between November 2021 and April 2022. The results of the 2022 survey included a number of very positive indications for OPP conservation generally:

- OPP were captured at Site 10b for the first time since May 2013, a good indication that the habitat rehabilitation measures at that site have been successful and further confirmation of the excellent dispersal conditions associated with heavy flooding. It is hoped that the drought refuge construction works undertaken at 10b will help maintain the population of OPP at this site.
- OPP were captured at site 3a for the first time since May 2018. This is also the first capture of OPP from the Tabbimoble Swamp catchment during W2B threatened species monitoring since bushfire activity in late 2019 and early 2020.
- OPP were captured at site 11b for the first time since May 2013, indicating that the connectivity measures implemented upstream of this site have successfully provided the opportunity for OPP to disperse along the unnamed tributary to MacDonaldis Creek
- OPP were captured at site 13b for the first time since September 2017, indicating that the habitat restoration measures at that site, which include dense growth of many of the

The data captured during this reporting period does not indicate that highway operation is negatively impacting OPP populations or habitat in the study area. Although average capture at impact sites during operational phase monitoring to date is lower than pre-construction average captures, average OPP capture during operational phase monitoring and the number of sites where they are being captured are both trending upwards.

# Project Team

- Chris Thomson – Project Director
- Mathew Birch – Aquatic Ecologist: Technical leader and author
- Brenton Hays – Field Team
- Matt Consterdine – Field Team
- Allie Cooke – Field Team
- Dave Consterdine – Field Team
- Jorja Vernon – Field Team

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# Appendix A

## Aquatic Habitat Summaries

Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

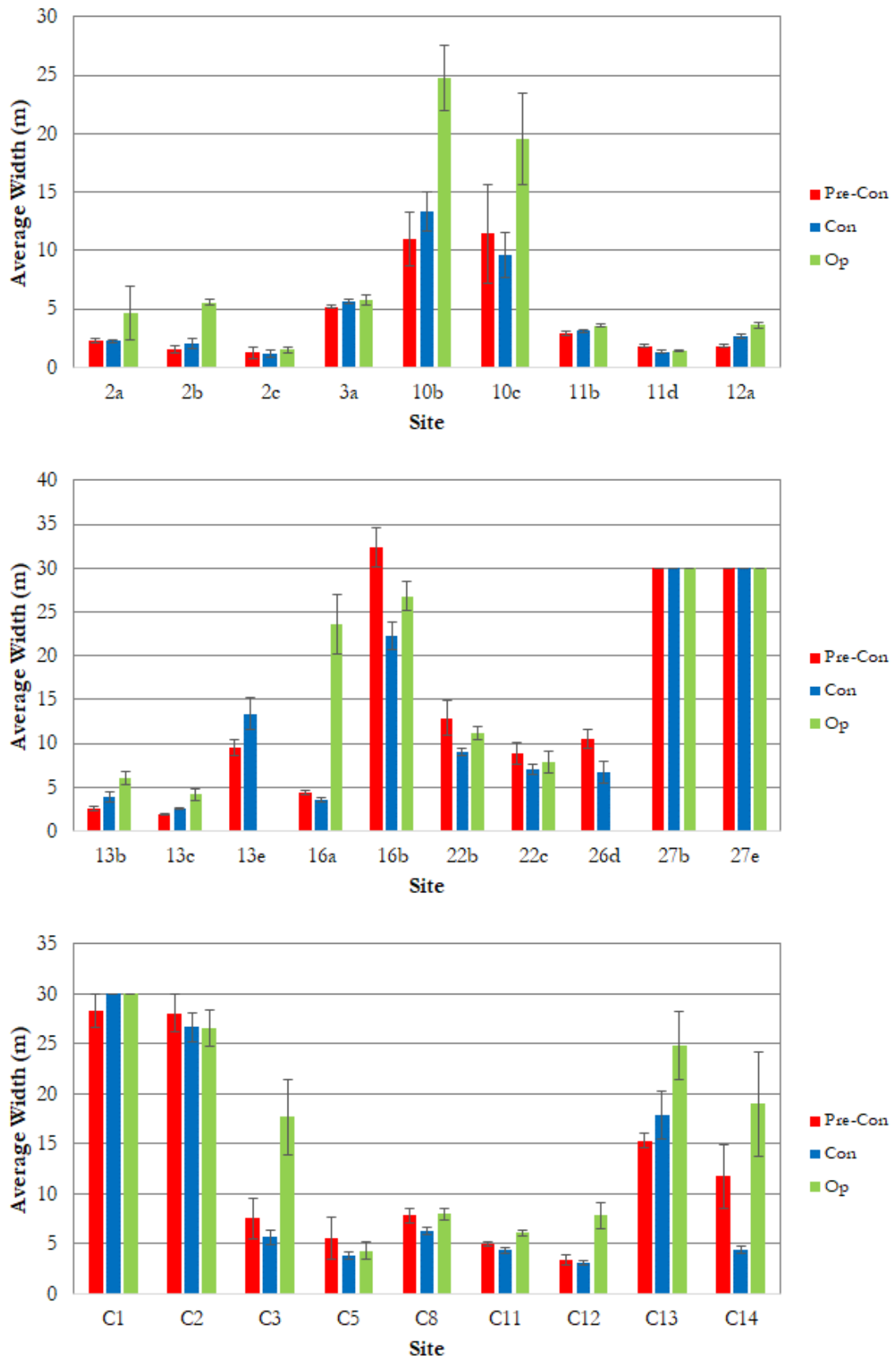


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

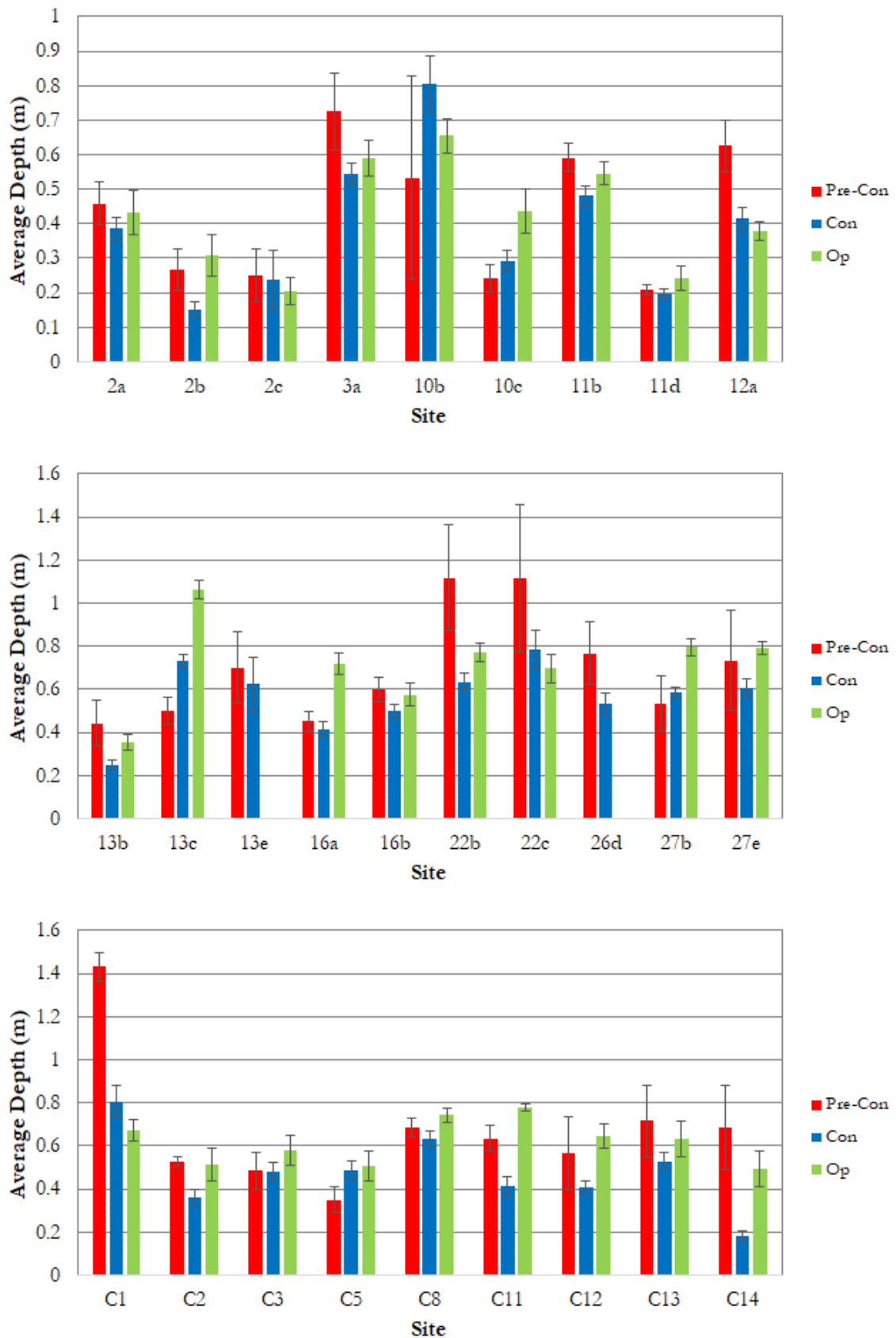


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

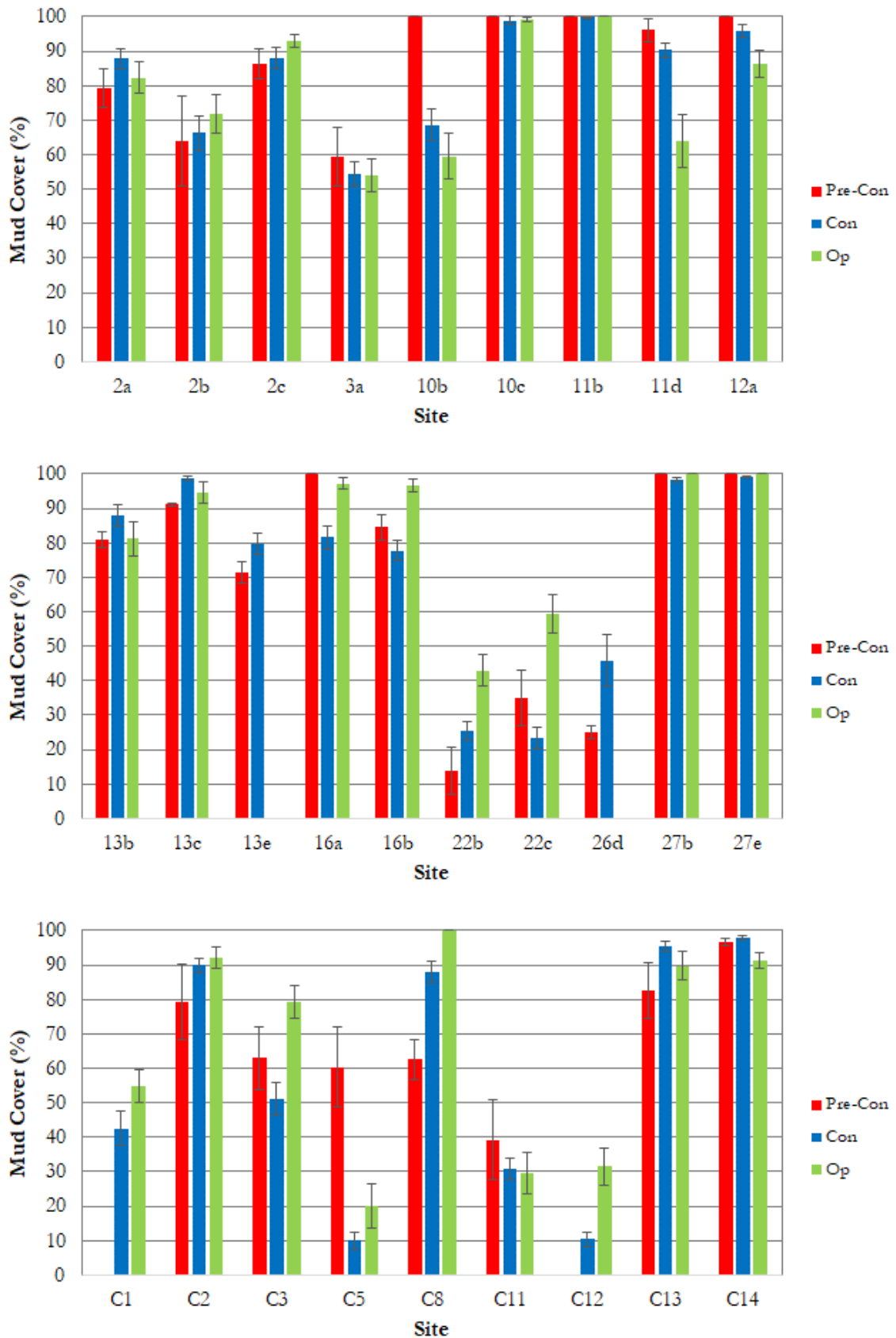


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

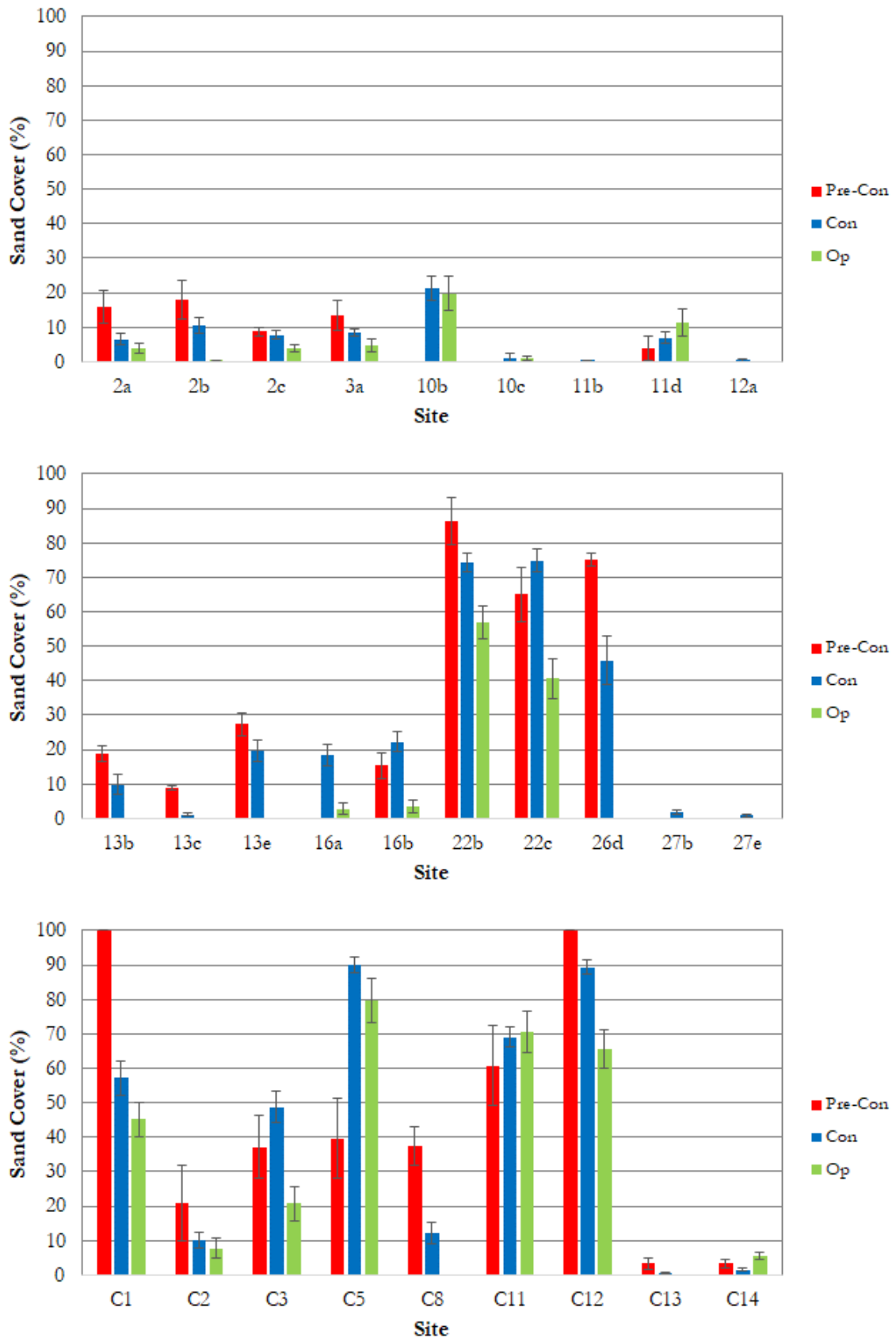


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

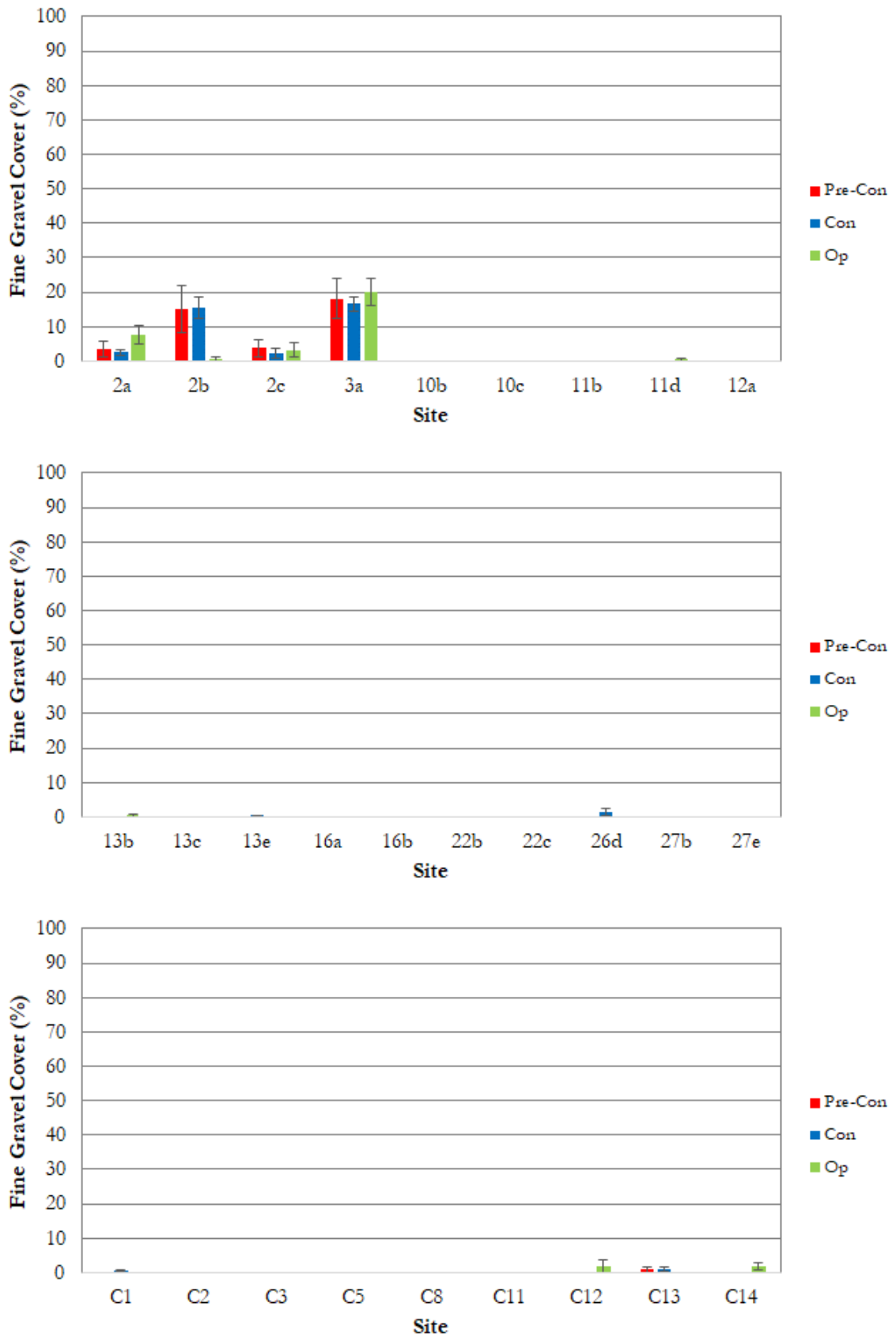


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

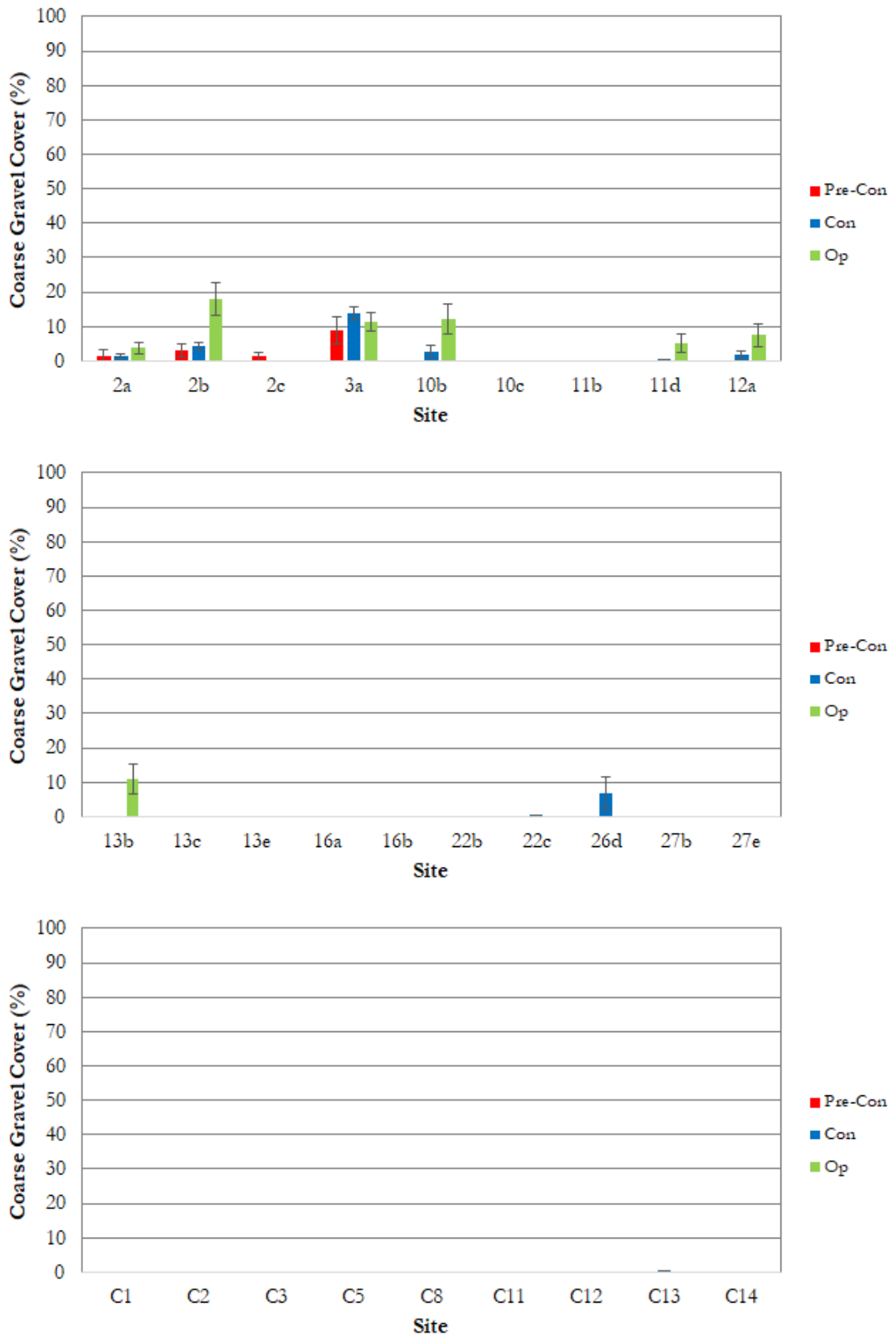




Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

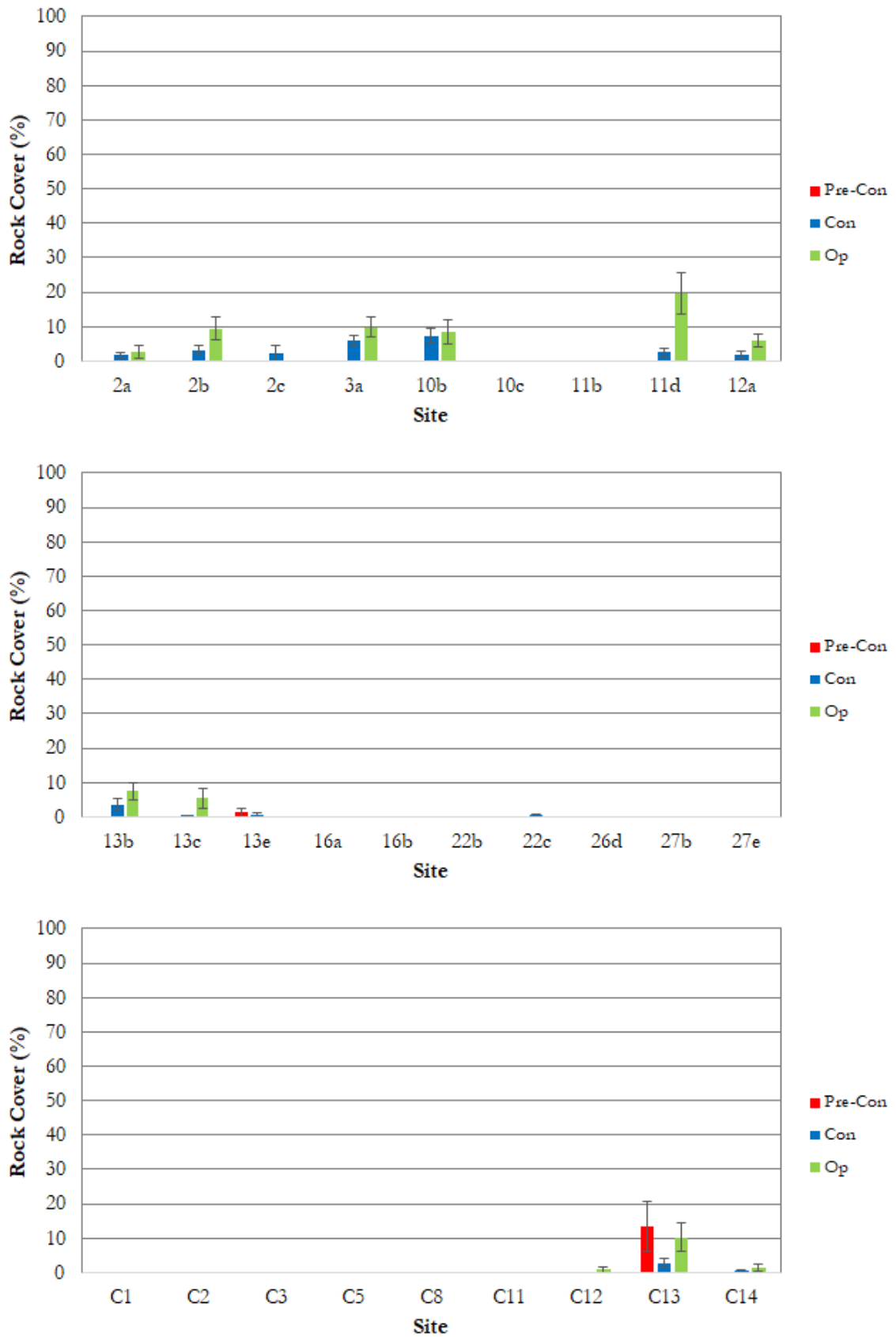


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

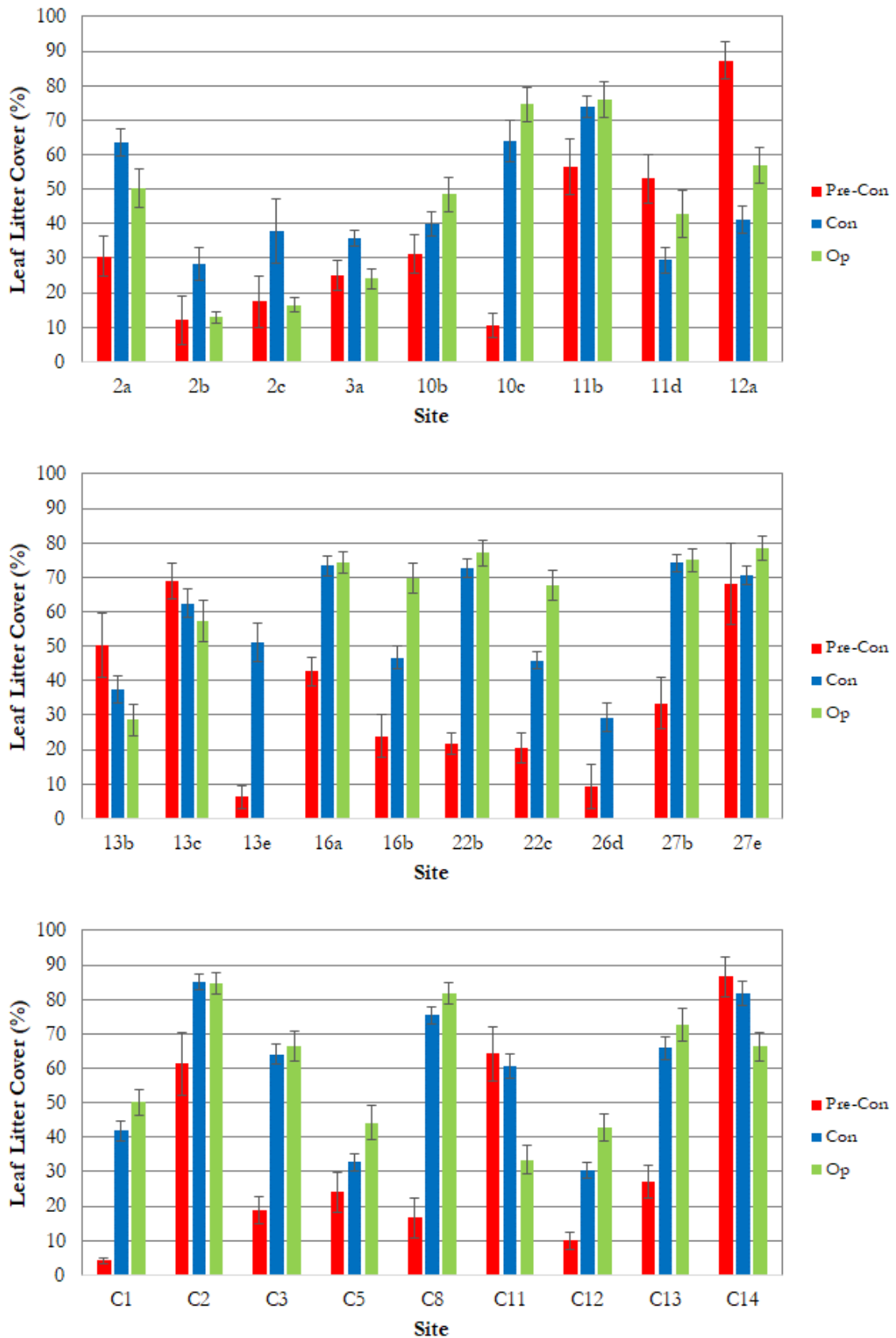


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

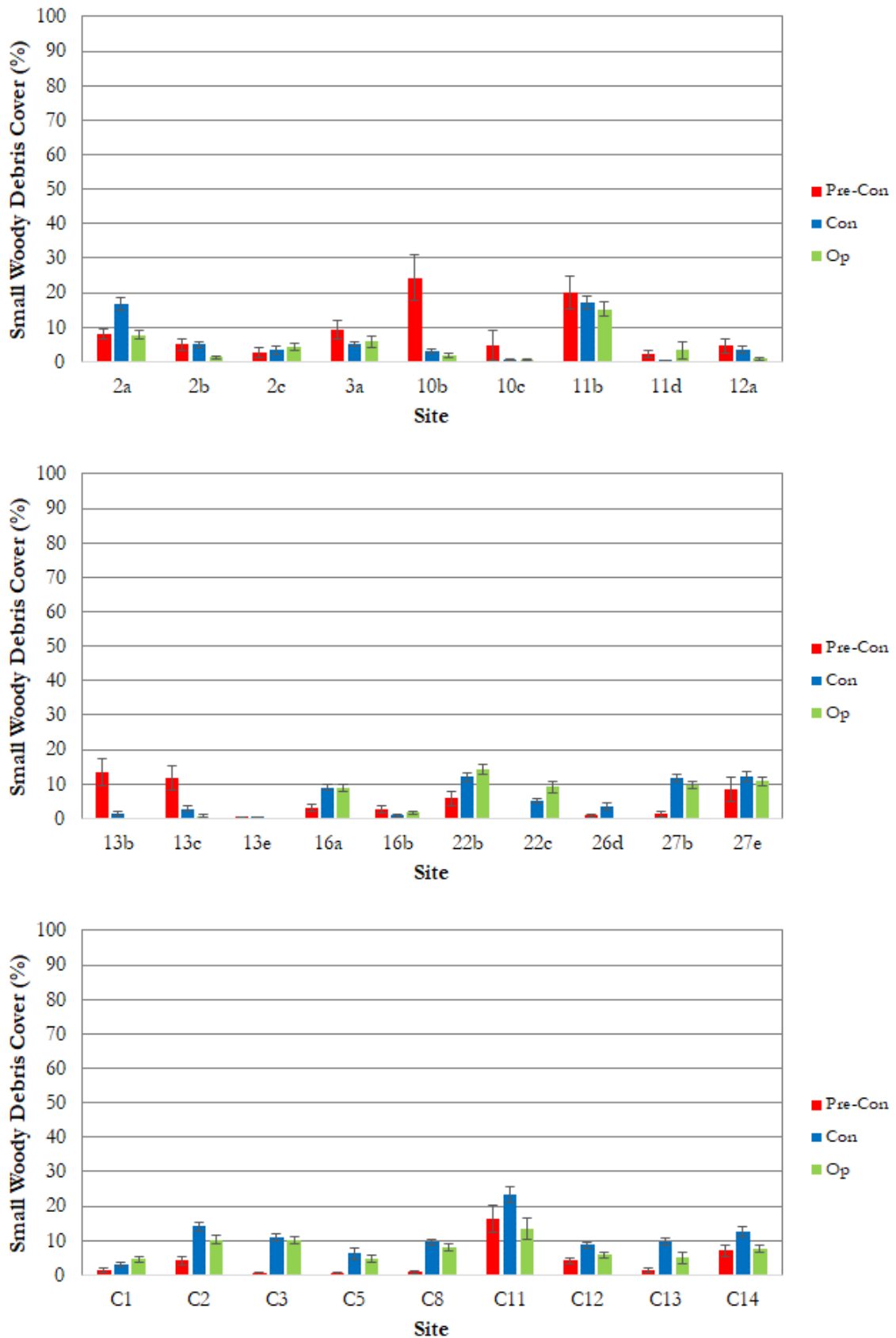


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

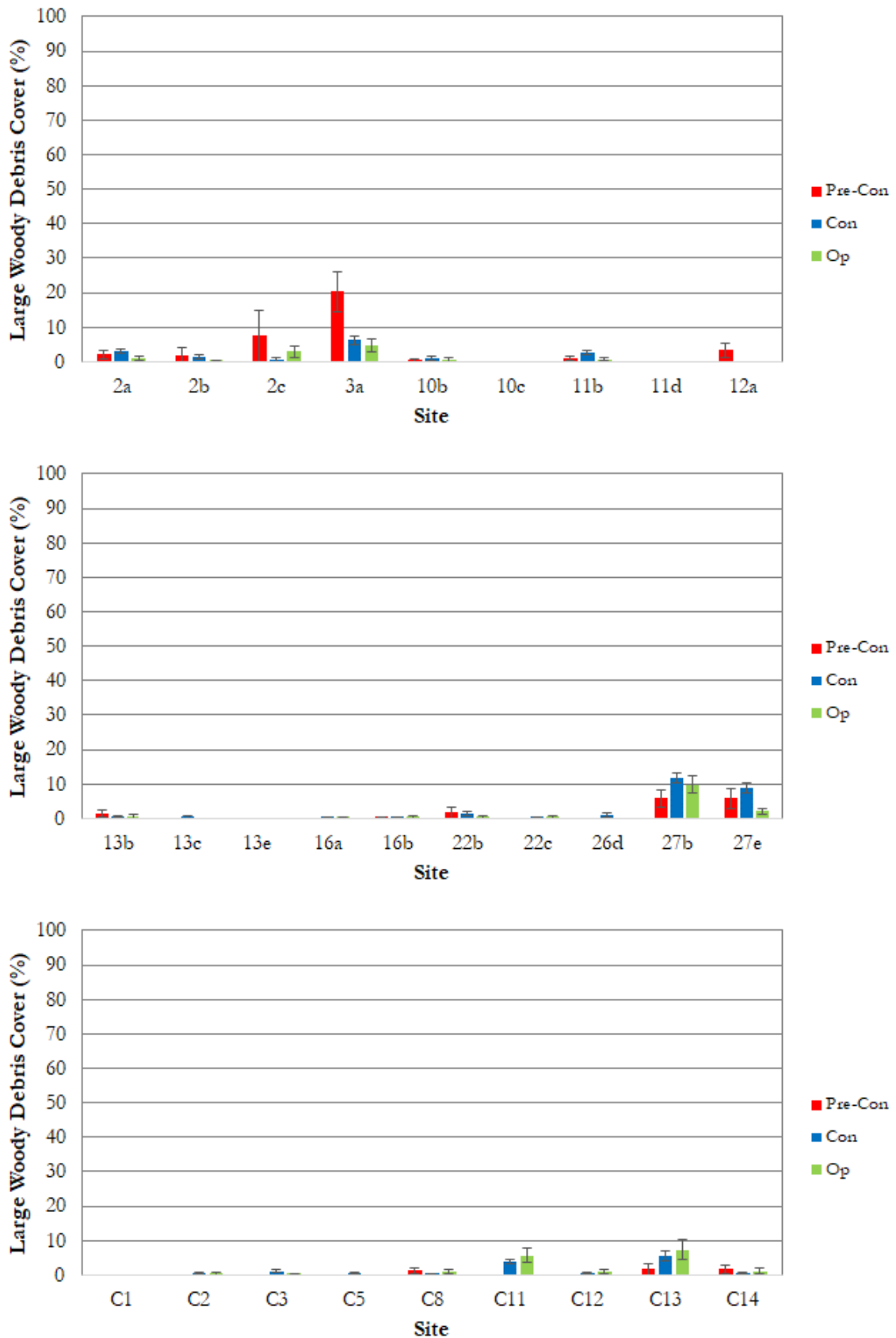


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

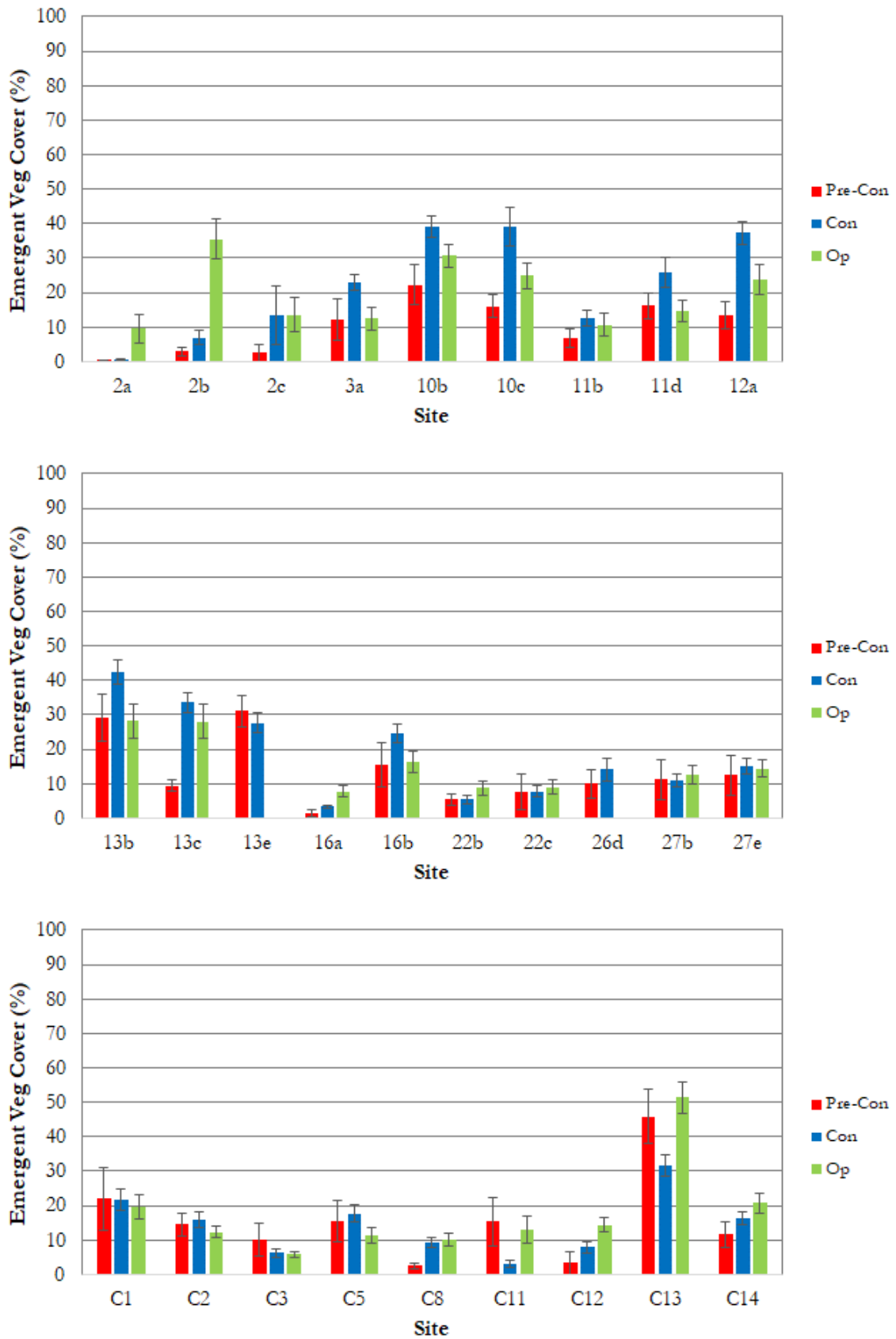


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

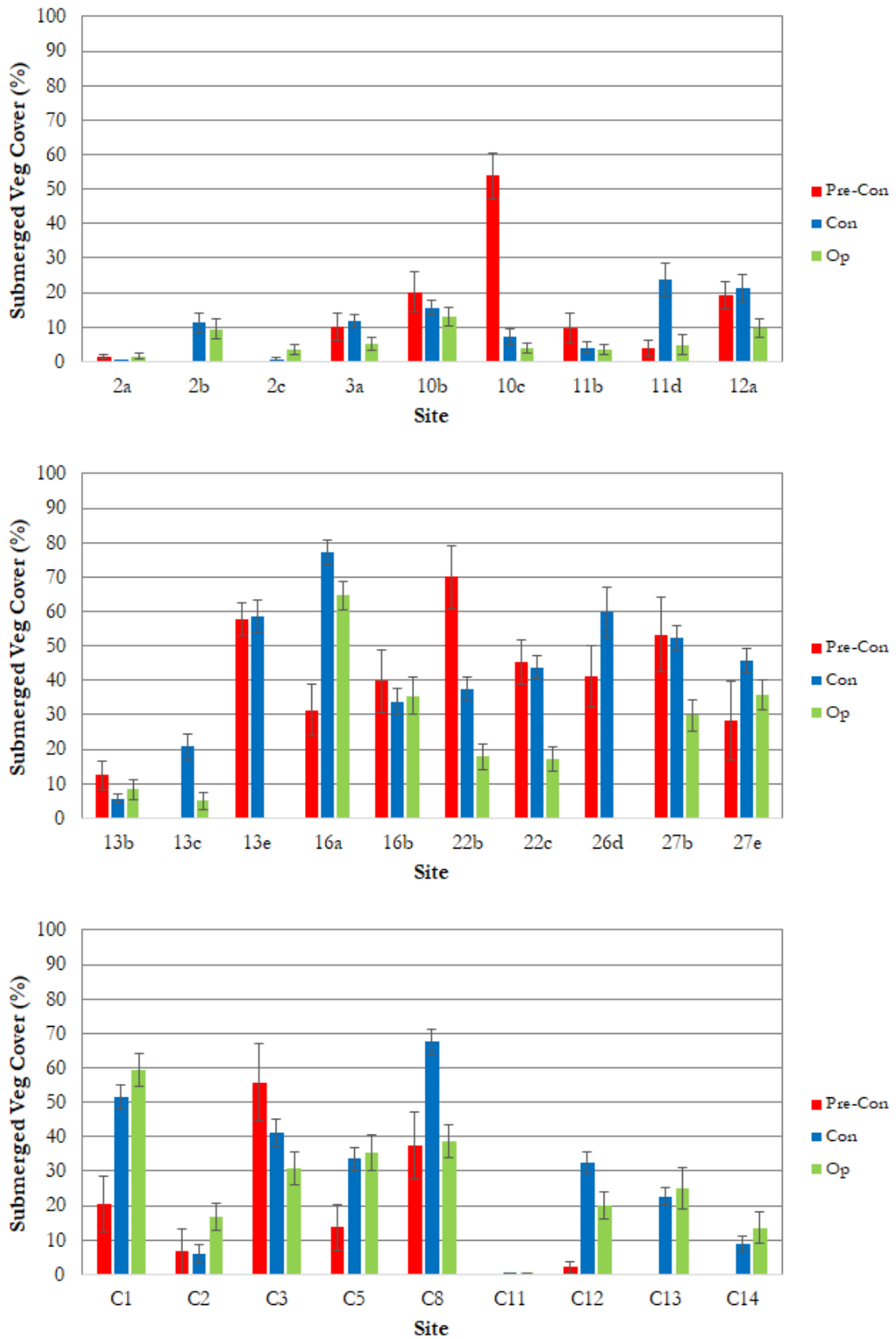


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

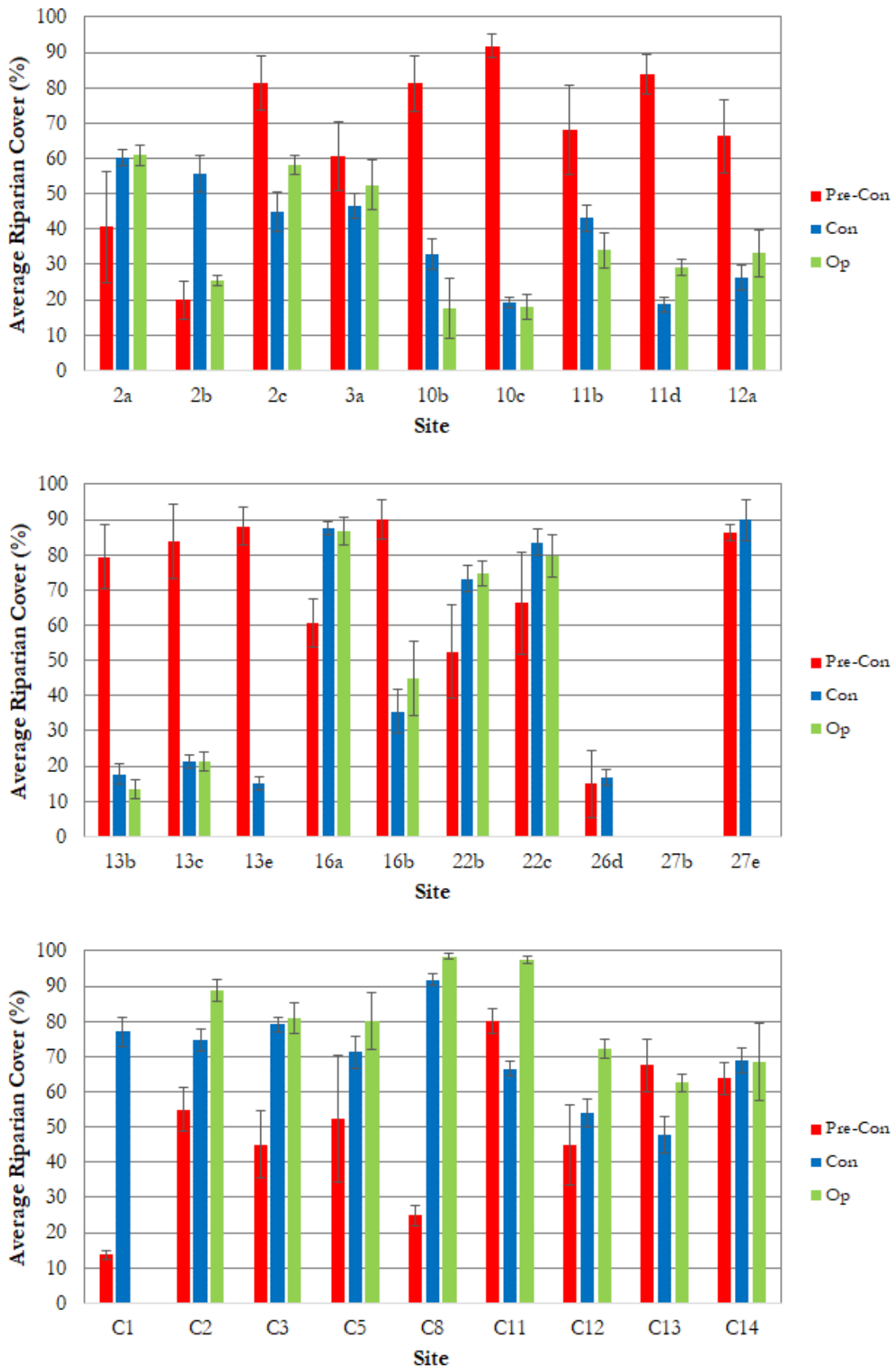


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

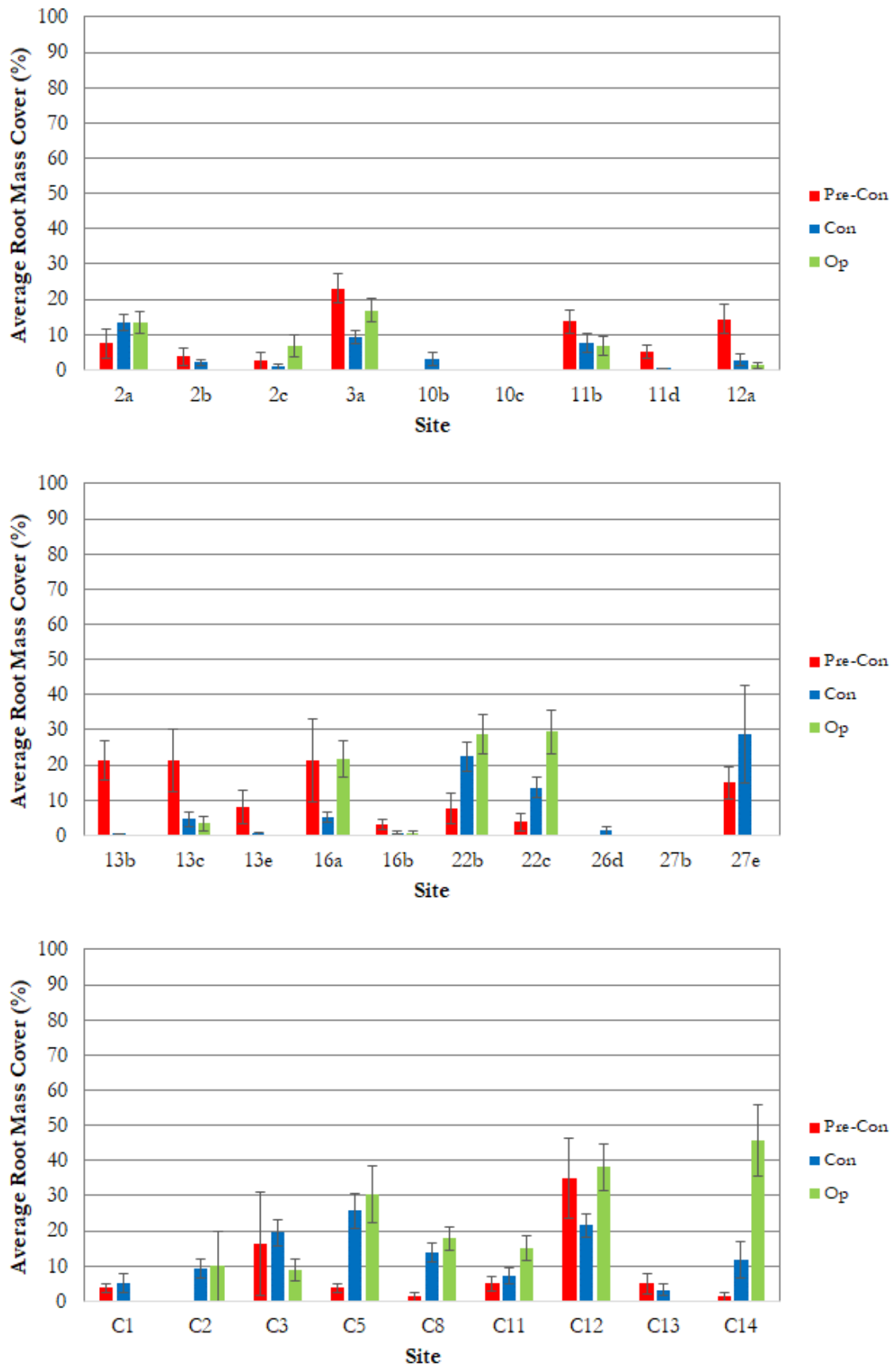




Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring

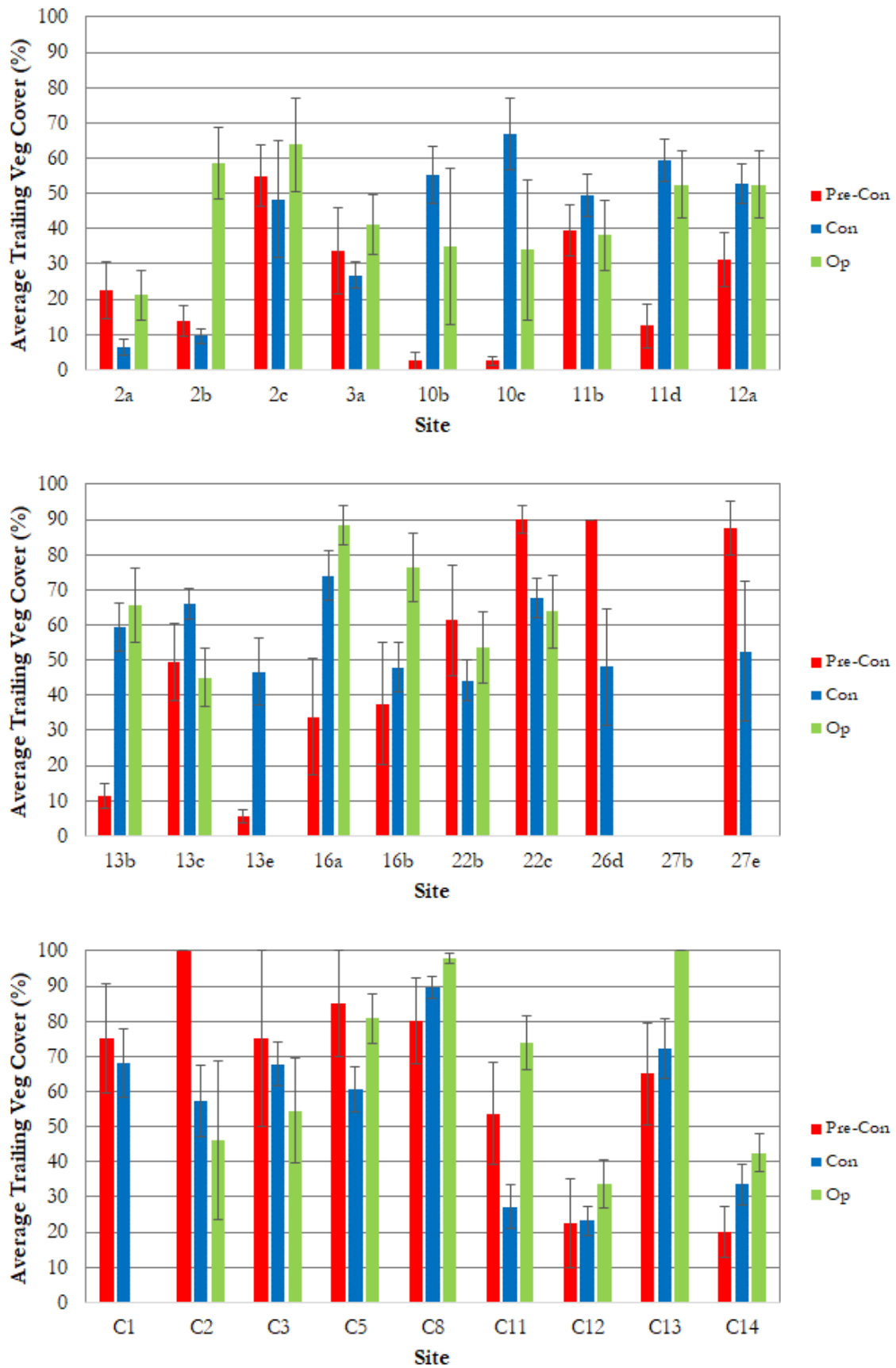
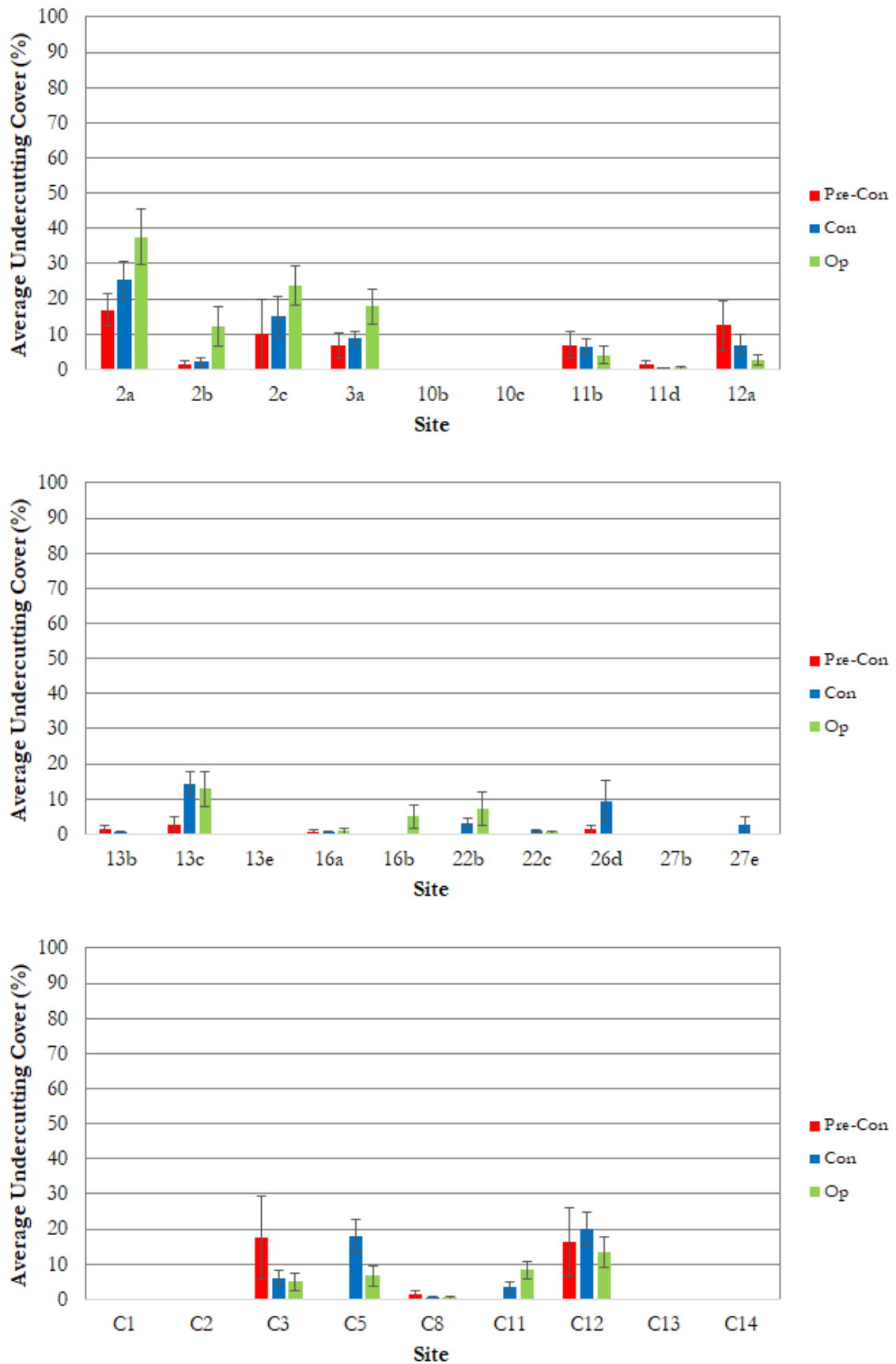


Figure A1 Average ( $\pm$ SE) habitat measurements at each site in the pre-construction, construction and operational phases of monitoring



# Appendix B

## Construction Phase Fish Monitoring Results

**Table B1. Summary of captures for all fishing methods at all impact sites during the May 2017 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e	16a	16b	22b	22c	26d	27b	27e
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	1	0	0	0	1	1	0	1	0	1	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	7	0	0	15	92	0	61	4	60	0	20	5	0	0	13	5	14	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	42	0	28	0	67	0	17	1	0	0	0	0	0	1	1
<i>Hypseleotris galii</i>	Firetail Gudgeon	49	1	4	103	45	1	43	3	37	0	3	13	0	4	26	64	0	4	5
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	1	0	0	0	18	0	46	3	0	0	3	0	6	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	3	0	4	0	0	0	0	0	0	5	7	6	3	6	34	13	7	1
<i>Gambusia</i>	Mosquito Fish	18	25	14	52	42	28	76	19	0	0	0	8	0	0	0	0	0	0	1

**Table B2. Summary of captures for all fishing methods at all control sites during the May 2017 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>								
		C1	C2	C3	C5	C8	C11	C12	C13	C14
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	1	0	0	1	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	1	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	0	0	0	11	0	0	7	11	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	1	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	9	2	8	31	97	39	90	4	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	18	17	33	2	30	6	14	9	11
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	28	0	7	10	18	7	96	5	2
<i>Gambusia</i>	Mosquito Fish	1	0	0	0	0	6	0	1	1

**Table B3. Summary of captures for all fishing methods at all impact sites during the September 2017 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e	16a	16b	22b	22c	26d	27b	27e
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	25	0	0	30	0	0	60	3	0	35	27	11	2	0	23	5	16	0	5
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	1	1	0	0	12	15	0	0	0	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	95	0	0	47	0	0	28	4	0	0	2	47	0	33	49	44	9	5	4
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	0	0	0	0	0	0	10	0	4	3	3	0	8	1	2
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	2	0	0	2	0	0	0	0	0	12	4	8	77	2	15	14	17	9	8
<i>Gambusia</i>	Mosquito Fish	15	0	0	15	0	0	28	1	0	10	0	1	0	0	2	0	0	0	0

**Table B4. Summary of captures for all fishing methods at all control sites during the September 2017 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>								
		C1	C2	C3	C5	C8	C11	C12	C13	C14
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	1	0	0	2	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	3	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	0	0	0	32	0	0	23	27	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	3	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	25	1	16	44	84	35	180	25	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	22	1	2	25	19	30	16	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	48	23	75	20	40	13	2	34	0
<i>Gambusia</i>	Mosquito Fish	0	0	0	0	0	12	0	4	0

**Table B5. Summary of captures for all fishing methods at all impact sites during the May 2018 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13c*	16a	16b	22b	22c	26d*	27b	27e
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	0	0	0	0	2	2	0	0	0	2	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	25	0	0	20	1	0	41	20	25	26	25	0	0	0	14	4	0	2	1
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	4	4	0	34	1	52	0	39	0	0	0	0	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	32	0	0	79	1	0	6	0	9	0	0	0	1	67	75	27	0	13	13
<i>Rhadinocestrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	0	0	0	0	0	0	6	0	14	13	14	7	0	2	1
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	2	0	0	0	4	1	0	4	0	32	2	7	10	0	28	19
<i>Gambusia</i>	Mosquito Fish	33	3	0	114	20	0	44	9	17	103	0	0	0	0	0	0	0	0	4

\* No survey - access restrictions.

**Table B6. Summary of captures for all fishing methods at all control sites during the May 2018 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>								
		C1	C2	C3	C5	C8	C11	C12	C13	C14
<i>Anguilla australis</i>	Shortfin Eel	0	0	1	1	1	1	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	2	0	0	7	0	0	5	8	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	9	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	26	0	0	11	96	8	96	18	0
<i>Rhadinocestrus ornatus</i>	Ornate Rainbowfish	28	0	9	4	37	0	32	60	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	51	0	5	0	39	0	16	43	0
<i>Gambusia</i>	Mosquito Fish	0	0	0	0	0	18	0	17	23

\* No survey - access restrictions.

**Table B7. Summary of captures for all fishing methods at all impact sites during the September 2018 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>																		
		2a	2b	2c	3a	10b	10c	11b*	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	32	0	0	16	10	0	0	22	23	1	78	0	0	0	15	31	0	3	1
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	8	17	0	0	1	64	0	44	0	0	0	1	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	49	0	0	77	9	0	0	0	3	0	0	0	0	527	82	84	0	5	4
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	0	0	0	0	0	0	11	0	2	2	12	0	0	10	3
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	1	0	0	3	0	29	0	7	22	0	21	13
<i>Gambusia</i>	Mosquito Fish	9	0	0	70	72	0	0	4	3	4	0	0	0	0	0	0	0	0	0

\* No survey - access restrictions.

**Table B8. Summary of captures for all fishing methods at all control sites during the September 2018 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>								
		C1	C2	C3	C5	C8	C11	C12	C13	C14
<i>Anguilla australis</i>	Shortfin Eel	0	0	1	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	0	0	0	23	0	0	0	12	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	10	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	41	0	2	8	136	56	889	35	1
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	21	0	4	0	10	0	79	83	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	25	0	23	2	15	0	65	38	1
<i>Gambusia</i>	Mosquito Fish	0	0	0	0	0	4	0	0	2

\* No survey - access restrictions.

**Table B9. Summary of captures for all fishing methods at all impact sites during the July 2019 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	31	0	0	9	2	0	14	9	4	3	0	0	0	0	4	10	0	0	1
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	29	0	14	0	6	0	0	0	0	0	0	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	26	0	0	45	5	0	0	0	0	0	0	0	0	5	11	12	0	0	3
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	4	0	0	0	0	0	0	0	0	0	0	18	31	0	0	1
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	1	
<i>Gambusia</i>	Mosquito Fish	40	0	0	109	57	0	30	0	7	2	0	0	0	0	0	0	0	0	0

\* No survey - access restrictions.

**Table B10. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the July 2019 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5	OPP6	OPP7
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	0	0	0	13	0	0	4	30	0	2	7	30	0	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	2	0	0	0	4	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	12	0	0	3	0	0	8	13	0	3	6	9	0	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	21	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia</i>	Mosquito Fish	0	0	0	0	0	0	0	17	0	45	8	8	0	0	0	0

\* No survey - access restrictions.



**Table B11. Summary of captures for all fishing methods at all impact sites during the September 2019 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>																		
		2a	2b	2c	3a	10b	10c	11b*	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	3	0	0	14	10	0	0	0	5	0	0	0	0	0	9	7	0	0	2
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	75	0	0	0	6	0	0	0	0	0	0	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	8	0	0	86	3	0	0	0	0	0	0	0	0	95	50	65	0	0	6
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	3	0	0	1
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12	0	0	5	
<i>Gambusia</i>	Mosquito Fish	40	0	0	14	54	0	0	0	19	1	0	0	0	0	0	0	0	0	0

\* No survey - access restrictions.

**Table B12. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the September 2019 survey**

<i>Scientific Name</i>	<i>Common Name</i>	<i>Site</i>															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5	OPP6	OPP7
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	1	0	0	12	0	0	6	34	0	4	70	31	0	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	25	0	1	0	4	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	30	0	0	13	0	0	238	32	0	46	20	36	0	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	28	0	0	43	0	0	22	1	0	0	1	1	0	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	9	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia</i>	Mosquito Fish	0	0	0	0	0	0	0	5	0	0	5	0	0	0	0	0

\* No survey - access restrictions.

**Table B13. Summary of captures for all fishing methods at all impact sites during the May – June 2020 survey**

Scientific Name	Common Name	Site																		
		2a	2b	2c*	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Ambassis agassizii</i>	Olive Perchlet	0	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	5	0	0	8	12	2	19	36	47	0	0	0	0	0	7	7	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	1	40	1	1	2	154	0	0	0	0	0	1	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	18	17	0	25	6	0	2	1	8	0	0	0	0	0	20	38	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	1	0	0	0	13	0	0	0	0	0	3	4	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	28	192	0	111	34	54	22	4	5	4	0	0	0	0	3	0	0	0	0

\* No survey - access restrictions.

**Table B14. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the May – June 2020 survey**

Scientific Name	Common Name	Site															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5	OPP6	OPP7
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	66	0	0	0	0	0	4	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	1	0	0	4	0	0	4	13	0	4	9	17	0	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	18	0	1	7	1	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	12	1	0	32	23	12	37	170	31	1	3	1	0	42	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	11	0	0	8	28	0	22	9	4	0	0	0	0	2	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	10	0	0	6	1	0	6	0	0	0	0	0	0	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	0	0	0	0	0	1	0	63	40	95	99	2	0	322	44	0

**Table B15. Summary of captures for all fishing methods at all impact sites during the September 2020 survey**

Scientific Name	Common Name	Site																		
		2a	2b	2c*	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	3	1	0	15	30	0	18	34	66	0	2	0	0	0	37	25	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	2	111	0	33	0	23	0	0	0	0	0	0	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	4	17	0	26	9	0	9	1	5	0	1	0	0	0	74	78	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	0	0	0	2	6	7	0	0	0	0	0	4	7	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	17	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	25	71	0	22	179	118	18	3	3	23	0	0	0	0	0	0	0	0	0

\* No survey - access restrictions.

**Table B16. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the September 2020 survey**

Scientific Name	Common Name	Site															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5	OPP6	OPP7
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	1	1	0	1	0	0	6	2	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	0	0	0	3	0	0	3	75	0	7	12	10	0	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	8	0	1	0	1	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	26	0	0	8	101	18	554	40	3	6	10	15	0	12	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	21	2	0	20	35	14	164	0	0	0	0	0	0	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	6	0	0	3	2	1	9	0	0	0	0	0	0	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	0	0	0	0	0	2	0	910	86	165	41	2	0	109	0	0

\* No survey - access restrictions.

**Table B17. Summary of captures for all fishing methods at all impact sites during the May 2021 survey**

Scientific Name	Common Name	Site																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Ambassis agassizii</i>	Olive Perchlet	0	9	71	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	18	0	1	52	5	6	19	24	24	5	2	0	0	0	26	7	0	2	3
<i>Hypseleotris compressa</i>	Empire Gudgeon	2	0	0	3	34	18	24	0	18	3	9	0	0	0	0	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	24	8	8	84	8	1	10	1	4	2	3	0	0	2	41	25	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	5	19	0	0	0	4	4	0	0	0	2	0	13	30	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	14	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	49	47	17	21	116	6	40	2	1	39	0	0	0	0	0	0	0	0	0

\* No survey - access restrictions.

**Table B18. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the May 2021 survey**

Scientific Name	Common Name	Site															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5*	OPP6	OPP7
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	14	35	7	2	2	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	1	0	0	4	0	0	8	12	1	3	3	4	0	0	6	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	18	0	21	5	1	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	19	0	2	21	227	16	86	19	68	109	23	35	0	0	3	6
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	20	0	4	0	1	0	0	0	1
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	37	3	2	27	56	14	123	11	2	14	4	75	0	0	3	5
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	41	2	1	6	1	0	8	0	0	0	0	0	0	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	0	0	0	0	0	6	0	97	18	146	126	18	0	0	2	8

\* No survey - access restrictions.

**Table B19. Summary of captures for all fishing methods at all impact sites during the September 2021 survey**

Scientific Name	Common Name	Site																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	20	8	0	31	53	0	43	25	100	18	0	0	0	0	14	27	0	0	3
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	24	0	0	157	0	16	0	52	12	0	0	0	0	1	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	99	97	0	83	2	0	10	27	0	0	1	0	0	0	23	26	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocestrus ornatus</i>	Ornate Rainbowfish	0	0	0	17	0	0	0	8	2	0	0	0	0	0	0	0	0	2	1
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	0	0	0	0	3	0	0	0	3	0	36	14	0	1	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	14	80	0	19	32	5	22	0	2	12	0	0	0	0	0	0	0	0	0

\* No survey - access restrictions.

**Table B20. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the September 2021 survey**

Scientific Name	Common Name	Site															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5	OPP6	OPP7
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	3	0	3	8	1	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	3	0	1	2	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	5	0	0	22	0	0	10	36	0	1	32	13	0	0	0	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	149	0	4	1	4	0	0	0	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	28	3	4	37	283	0	623	32	0	60	122	91	0	0	0	0
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	17	0	3	1	0	0	0	0	0
<i>Rhadinocestrus ornatus</i>	Ornate Rainbowfish	68	9	0	8	5	0	144	60	0	10	6	1	0	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	75	34	1	8	9	0	16	0	0	0	0	0	0	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	3	0	0	2	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	0	0	0	0	0	0	0	313	0	200	291	0	0	0	0	0

\* No survey - access restrictions.

**Table B21. Summary of captures for all fishing methods at all impact sites during the May 2022 survey**

Scientific Name	Common Name	Site																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	9	2	0	27	0	1	28	2	16	9	14	0	5	0	13	3	0	0	1
<i>Hypseleotris compressa</i>	Empire Gudgeon	1	0	0	0	17	28	38	0	16	7	14	0	0	0	27	0	0	1	0
<i>Hypseleotris galii</i>	Firetail Gudgeon	40	18	6	19	16	14	17	2	5	2	5	0	1	2	84	66	0	5	6
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	0	0	17	0	0	0	0	3	0	12	0	1	0	5	11	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	1	2	0	1	0	0	0	2	0	3	0	38	5	0	1	8
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	5	51	37	5	352	64	66	47	18	25	2	0	0	62	7	18	0	4	0

\* No survey - access restrictions.

**Table B22. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the May 2022 survey**

Scientific Name	Common Name	Site															
		C1	C2	C3	C5*	C8	C11	C12	C13*	C14	OPP1	OPP2	OPP3	OPP4*	OPP5*	OPP6	OPP7
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	5	0	0	0	0	0	3	0	0	0	0	0	2	0	0	1
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
<i>Hypseleotris galii</i>	Firetail Gudgeon	63	3	5	0	69	6	46	0	1	8	7	12	0	0	0	3
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	10	3	7	0	20	34	47	0	0	1	0	5	0	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	41	14	23	0	10	1	4	0	0	0	0	0	0	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	1	0	0	0	0	0	0	0	3	1	2	6	0	0	0	0

\* No survey - access restrictions.

**Table B23. Summary of captures for all fishing methods at all impact sites during the September 2022 survey**

Scientific Name	Common Name	Site																		
		2a	2b	2c	3a	10b	10c	11b	11d	12a	13b	13c	13e*	16a	16b	22b	22c	26d*	27b	27e
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	4	1	1	2	0	2	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	33	3	0	22	7	3	65	27	187	22	3	0	0	0	11	1	0	5	4
<i>Hypseleotris compressa</i>	Empire Gudgeon	0	54	0	1	315	136	24	1	45	49	37	0	0	0	15	16	0	4	12
<i>Hypseleotris galii</i>	Firetail Gudgeon	110	118	1	19	12	9	4	1	1	6	7	0	0	65	44	55	0	1	14
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	0	1	1	1	0	0	0	2	18	0	2	0	4	0	3	5	0	0	1
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	0	0	0	0	1	0	0	0	2	1	1	0	23	0	31	16	0	3	12
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	3	33	31	1	129	134	0	3	1	4	0	0	0	10	0	0	0	0	0

\* No survey - access restrictions.

**Table B24. Summary of captures for all fishing methods at all control and Devils Pulpit sites during the September 2022 survey**

Scientific Name	Common Name	Site															
		C1	C2	C3	C5	C8	C11	C12	C13	C14	OPP1	OPP2	OPP3	OPP4*	OPP5*	OPP6	OPP7
<i>Ambassis agassizii</i>	Olive Perchlet	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0
<i>Anguilla australis</i>	Shortfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Anguilla reinhardtii</i>	Longfin Eel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gobiomorphus australis</i>	Striped Gudgeon	0	1	0	16	0	0	5	13	0	5	12	5	0	0	6	0
<i>Hypseleotris compressa</i>	Empire Gudgeon	2	0	0	9	0	0	0	68	0	12	0	4	0	0	0	5
<i>Hypseleotris galii</i>	Firetail Gudgeon	56	1	5	9	333	17	268	138	0	37	5	5	0	0	0	33
<i>Melanotaenia duboulayi</i>	Crimson-spotted Rainbowfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
<i>Rhadinocentrus ornatus</i>	Ornate Rainbowfish	8	0	6	26	34	16	149	8	0	4	0	1	0	0	0	0
<b><i>Nannoperca oxleyana</i></b>	<b>Oxleyan Pygmy Perch</b>	72	5	24	23	31	1	81	0	0	0	0	0	0	0	0	0
<i>Tandanus tandanus</i>	Eel-Tailed Catfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carassius auratus</i>	Goldfish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Gambusia holbrooki</i>	Mosquito Fish	0	0	0	0	0	0	0	79	30	36	13	0	0	0	0	31

\* No survey - access restrictions.

# Appendix C

## Water Quality Comparisons



**Table C1. Comparison of Water Quality Ranges from pre-construction monitoring and construction phase TFMP monitoring**

Location	Sites	Parameter	Units	OPP Range	Pre-Con Range	Con Range	2021 Range	2022 Range	2023 Range
Unnamed waterway south of Serendipity Rd Ch. 11400	2a, 2b, 2c	Temp	(°C)	10.9 – 28.3	13.3 – 23.6	<b>10.76</b> – 22.01	17.88 – 22.27	16.4 – 21.28	
		DO	(mg/L)	2.15 – 10.02	4.11 - 10	<b>0</b> – 5.64	3.12 – 10.57	<b>1.9</b> – 8.19	
		pH		3.32 – 6.9	5 – 6.9	4.98 – <b>7.1</b>	5.44 – <b>7.51</b>	4.88 – 6.78	
		Conductivity	(mS/cm)	0.068 – 2.148	0.009 – 0.368	0.093 - 0.578	0.089 – 0.597	0.079 – 0.431	
		Turbidity	(NTU)	0 - 80	0.9 - 118	<b>0 - 446</b>	7.9 – 32.5	<b>16.5 - 461</b>	
Tabbimoble floodway no. 1 Ch. 115300	3a	Temp	(°C)	10.9 – 28.3	12.8 - 24	<b>10.11</b> – 19.4	16.93 – 18.38	15.37 – 18.65	
		DO	(mg/L)	2.15 – 10.02	1.3 - 8.07	4.4 - 7.71	5.55 – 5.8	7.15 – 7.4	
		pH		3.32 – 6.9	4.4 – 7.2	5.43 - <b>7.62</b>	5.51 – 5.86	5.23 – 5.56	
		Conductivity	(mS/cm)	0.068 – 2.148	0.009 – 0.140	0.089 - 0.331	0.112 – 0.163	<b>0.054</b> – 0.075	
		Turbidity	(NTU)	0 - 80	18.9 – 132	0 - 17	11	26.9 – 42.5	
Unnamed waterway south of MacDonalds Ck Ch. 134600	10b, 10c	Temp	(°C)	10.9 – 28.3	16.6 - 29	11.11 – 21.7	17.04 – 23.96	17.07 – 24.38	
		DO	(mg/L)	2.15 – 10.02	3.17 - 10	<b>0.58</b> - 6.32	<b>0.09</b> – 14.33	2.27 – 10.9	
		pH		3.32 – 6.9	4 – 9.3	4.7 - <b>7.06</b>	4.9 – 6.02	4.95 – 5.7	
		Conductivity	(mS/cm)	0.068 – 2.148	0.102 – 0.537	0.249 - 0.581	0.13 – 0.474	0.095 – 0.309	
		Turbidity	(NTU)	0 - 80	1.3 - 800	3.8 - 28.8	0 – 3.8	24.5 – 202	
MacDonalds Ck Tributary Ch. 135200, 135530 and 136450	11b, 11d, 22b, 22c	Temp	(°C)	10.9 – 28.3	15.4 – 26.7	<b>10.29</b> – 24.69	15.36 – 22.03	15.13 – 22.14	
		DO	(mg/L)	2.15 – 10.02	2.27 – 8.9	<b>0.74</b> - 9.46	<b>1.31</b> – 5.45	<b>2.04</b> – 6.52	
		pH		3.32 – 6.9	3.8 – 8.9	3.44 - 6.44	3.82 – 5.63	3.67 – 5.48	
		Conductivity	(mS/cm)	0.068 – 2.148	0.092 – 0.606	0.131 - 0.237	0.115 – 0.227	0 – 0.153	
		Turbidity	(NTU)	0 - 80	2.4 - 138	<b>0 - 212</b>	0 – 6.7	<b>5.3 - 399</b>	
MacDonalds Ck Ch. 136600	12a	Temp	(°C)	10.9 – 28.3	14.9 - 26	12.89 - 19.72	16.26 – 17.76	15.53 – 18.05	
		DO	(mg/L)	2.15 – 10.02	1.7 – 8.1	<b>0.43</b> - 2.74	<b>2.03</b> – 2.48	<b>1.74 - 2.49</b>	
		pH		3.32 – 6.9	3.6 – 6.3	<b>2.72</b> – 6.41	4.48 – 5.58	4.18 – 4.29	
		Conductivity	(mS/cm)	0.068 – 2.148	0.164 – 0.406	0.25 – 0.41	0.148 – 0.331	0.124 – 0.182	
		Turbidity	(NTU)	0 - 80	0 - 14	0 - 41.6	0	5.9 – 93.2	
Broadwater NP Swampland	16a, 16b, 27b, 27c	Temp	(°C)	10.9 – 28.3	18.6 – 21.45	<b>9.92</b> - 21.38	14.2 – 21.75	14.07 – 20.86	
		DO	(mg/L)	2.15 – 10.02	1.83 – 5.39	<b>0.62 - 10.28</b>	<b>0.2</b> – 10.95	0.61 – 6.51	

Location	Sites	Parameter	Units	OPP Range	Pre-Con Range	Con Range	2021 Range	2022 Range	2023 Range
Ch. 139000		pH		3.32 – 6.9	4.15 – 4.63	3.7 - 5.91	3.71 – 6.24	3.24 – 6.32	
		Conductivity	(mS/cm)	0.068 – 2.148	0.128 – 0.171	0.116 - 0.571	0.098 – 0.412	<b>0.061</b> – 0.185	
		Turbidity	(NTU)	0 - 80	0 - 703	0 - 64.2	0 – 18.8	7 – 40.5	
Montis Gully Tributary 1 Ch. 141180 and 141850	13b, 13c, 13e, 26d	Temp	(°C)	10.9 – 28.3	17.23 – 30.9	13.33 - 24.6	13.7 – 24.5	14.63 – 18.27	
		DO	(mg/L)	2.15 – 10.02	2.1 – 9.4	<b>0.29</b> - 4.23	<b>0.04 – 1.1</b>	<b>0.74</b> – 3.3	
		pH		3.32 – 6.9	3.7 - 7	3.44 – 6.8	3.67 – 6.36	3.69 – 4.95	
		Conductivity	(mS/cm)	0.068 – 2.148	0.026 – 0.209	0.137 - 0.818	0.138 – 0.293	0.09 – 0.162	
		Turbidity	(NTU)	0 - 80	0 - 225	<b>0 - 90</b>	7.6 – 9.1	4.6 - 207	
W of Bundjalung NP Approximately 4 km east of Ch. 110000	C13, C14	Temp	(°C)	10.9 – 28.3	18.09 – 19.11	11.79 - 17.4	17.65 – 19.5	14.88 – 18.79	
		DO	(mg/L)	2.15 – 10.02	2.24 – 4.38	<b>1.34</b> - 10.97	<b>0.89</b> – 5.38	2.32 – 3.68	
		pH		3.32 – 6.9	4.56 – 5.47	4.84 - 6.92	5.62 – 6.22	5.05 – 6.24	
		Conductivity	(mS/cm)	0.068 – 2.148	0.086 – 0.112	0.063 - 0.155	<b>0.065</b> – 0.134	0.099 – 0.122	
		Turbidity	(NTU)	0 - 80	0 – 8.7	0 - 18.9	0 – 0	12.7 – 27.9	
Broadwater NP 6.5 km east of Ch.13000	C11, C12	Temp	(°C)	10.9 – 28.3	15.91 – 18.49	<b>9.73</b> - 29.36	17.08 – 17.83	17.36 – 19.39	
		DO	(mg/L)	2.15 – 10.02	2.9 – 5.59	<b>1.76</b> - 8.35	2.28 – 4.04	<b>1.45</b> – 5.49	
		pH		3.32 – 6.9	3.85 - 4	3.79 - 4.54	4.11 – 4.33	3.49 – 4.05	
		Conductivity	(mS/cm)	0.068 – 2.148	0.124 – 0.149	0.106 - 0.278	0.081 – 0.145	0.088 – 0.138	
		Turbidity	(NTU)	0 - 80	0 – 2.3	0 - 6.8	0 – 0.8	2.3 – 14	
MacDonalds Ck Tributary 0.5 km east of 136600 and 1 km east of 137800	C2, C5	Temp	(°C)	10.9 – 28.3	16.87 – 17.78	<b>8.15</b> - 20.2	13.36 – 23.71	13.21 – 20.01	
		DO	(mg/L)	2.15 – 10.02	4.58 – 4.69	<b>2.08</b> - 5.42	<b>0.96</b> – 5.5	3.44 – 4.0	
		pH		3.32 – 6.9	3.7 – 4.22	<b>3.31</b> - 4.47	3.83 – 4.39	3.37 – 3.88	
		Conductivity	(mS/cm)	0.068 – 2.148	0.115 – 0.158	0.013 - 0.256	0.089 – 0.254	0.09 – 0.154	
		Turbidity	(NTU)	0 - 80	0 - 0	0 - 37.6	0 – 0	9.2 – 79.9	
Broadwater NP 1 km east of Ch 138000	C1, C3	Temp	(°C)	10.9 – 28.3	17.2 - 18.91	12.33 - 23.66	17.74 – 20.76	14.87 – 20.54	
		DO	(mg/L)	2.15 – 10.02	4.55 - 9.18	<b>1.35</b> - 9.65	2.82 – 7.88	2.33 – 8.01	
		pH		3.32 – 6.9	3.97 – 4.49	3.42 - 4.27	3.46 – 4.15	3.63 – 4.08	
		Conductivity	(mS/cm)	0.068 – 2.148	0.089 - 0.176	0.100 - 0.306	0.091 – 0.231	0.068 – 0.109	
		Turbidity	(NTU)	0 - 80	0 – 1.4	0 - 28.5	0 - 3	8.4 – 39.3	

Location	Sites	Parameter	Units	OPP Range	Pre-Con Range	Con Range	2021 Range	2022 Range	2023 Range
Broadwater NP 2 km east of 136400	C8	Temp	(°C)	10.9 – 28.3	17.98	12.18 - 19.02	17.51 – 22.33	14.5 – 18.51	
		DO	(mg/L)	2.15 – 10.02	5.77	2.46 - 9.96	<b>1.36</b> – 4.56	<b>1.56 – 2.02</b>	
		pH		3.32 – 6.9	3.95	<b>3.21</b> - 4.07	3.57 – 3.93	3.69 – 3.8	
		Conductivity	(mS/cm)	0.068 – 2.148	0.236	0.269 - 0.458	0.176 – 0.263	0.115 – 0.154	
		Turbidity	(NTU)	0 - 80	12.1	0 - 12.2	0	19.2 – 28.4	
Tabbimoble Channel 2	OPP1, OPP2, OPP4, OPP7	Temp	(°C)	10.9 – 28.3	7.86 – 18.66	8.91 – 16.15	16.04 – 17.54	13.58 – 19.47	
		DO	(mg/L)	2.15 – 10.02	3.17 – 8.74	<b>1.89</b> – 5.83	3.72 – 8.2	4.88 – 7.57	
		pH		3.32 – 6.9	4.79 – 6.92	5.06 – 6.8	5.35 – <b>6.93</b>	4.58 – 5.12	
		Conductivity	(mS/cm)	0.068 – 2.148	0.081 – 0.194	0.104 – 0.23	<b>0.039</b> – 0.215	<b>0.025</b> – 0.115	
		Turbidity	(NTU)	0 - 80	1.3 – 44.3	1.8 – 12.1	10.3 – 58.5	31.0 – 45.6	
Tabbimoble Channel 3	OPP3, OPP6	Temp	(°C)	10.9 – 28.3	11.66 – 19.14	11.99 – 18.14	16.59 – 18.46	13.59 – 19.82	
		DO	(mg/L)	2.15 – 10.02	4.64 – 6.53	<b>0.79</b> - 5.3	3.89 – 8.61	6.01 – 7.78	
		pH		3.32 – 6.9	4.99 – 6.11	5.87 – 6.56	5.4 – 6.28	4.46 – 5.45	
		Conductivity	(mS/cm)	0.068 – 2.148	0.128 – 0.215	0.171 – 0.185	<b>0.041</b> – 0.2	<b>0.028</b> – 0.123	
		Turbidity	(NTU)	0 - 80	0 – 6.5	0 - 0	5.3 – 44.7	25.9 – 60.9	

