# Fish Monitoring Survey for the Upper Tweed River Estuary Riparian and Aquatic Habitat Rehabilitation Project

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## 1. Introduction

### 1.1. Background

All organisms have co-evolved and developed complex relationships with their external environment to help them survive and to assist in making their 'living.' For fish, their external environment or habitat assists in a number of different ways, especially the recruitment, survival and thus supply of new fish into populations is dependent on the availability of resources and suitable water quality conditions.

Across the eastern Australian estuaries, populations of native fish such as Australian bass *(Macquaria novemaculeata)* and estuary perch *(Macquaria colonorum)* have repeatedly undergone historical declines corresponding with the extraction of commodities and the extensive development of catchments for agriculture. Subsequently, there have been a number of changes to rivers, and in particularly fish habitat through the loss of critical resources, which constrains fish populations from growing.

One of the primary ecological and water quality pressures on the Tweed River Estuary is modified riparian zones and impacts of river bank erosion. Bank erosion is caused by a combination of factors including catchment clearing, cattle access, flooding and wake wave energy. The impacts are exacerbated by a general absence of good quality native riparian vegetation. Bank erosion adds to high turbidity and elevated nutrient levels. The clearing of riparian vegetation has also resulted in a reduction of in-stream wood loads. These woody structures or 'snags' provide direct benefits, such as the provision of cover, feeding opportunities and refuge for local fish species including the *Macquaria* genus. Modification of riparian zones has induced a raft of degradative aquatic environmental changes, especially to fish habitat and has reduced availability of resources on which these fish depend.

To address these issues Tweed Shire Council will undertake detailed rehabilitation and design work in the Upper Tweed River Estuary:

- Improve riparian and aquatic habitat over a 500m total bank length.
- Stabilise erosion along 200m of river bank.
- Revegetation and weed control along 270m length of Camphor Laurel dominated bank (3,000 square meters).
- Revegetation along 200m of existing pasture dominated river bank (2,000m$^2$).
- Install 600m of wildlife friendly fencing to restrict direct cattle access to the Tweed River and restoration sites.
- Installation of fabricated fish habitat structures.

- Installation of minimum of 20 large (7m long x 400-600mm diameter) hardwood logs with root balls attached, to add to bank resilience and missing resources to assist species that aggregate in the lower salinity zone of the upper estuary.

Reversing the extensive, historical, catchment degradation and associated impacts on waterways through incremental undertaking of restoration activities is expected to benefit many aquatic organisms. Restoration means intervening in an artificial way to replicate nature to augment its quality. The purpose of monitoring restoration is to identify and gauge the response of aquatic organisms to experimental restoration activities. Thus, monitoring has an important value to provide needed information, to determine which, when or how species use newly improved patches, intelligence that provides critical feedback and guidance such as how to distribute limited restoration resources to incrementally achieve larger-scale restoration objectives.

Measurement through time and across space both need careful consideration to gain insight into organisms use of restored habitat patches. Time, especially, given that monitoring effort may need to be expended over sometime (e.g. months or even years) to characterize response from a range of different organisms of interest. A sampling tool that could be undertaken easily, cost-effective and flexible in sampling through a range of times, is likely to yield important information on the response.

Underwater video and angling have been identified as potential sampling tools that meet these requirements. These tools have been used in other local studies such as the Coldstream River Resnagging, Fish Monitoring Report (Aquatic Science & Management, 2018). This document outlines methods for the deployment of underwater video cameras both before and after the works are completed. The footage will be analysed to determine any difference in the distribution and abundance of fish and other aquatic organisms'. This will provide insight into the response of local species to rehabilitation actions.

### 1.2. Project goals

The aim of conducting this study is to document the post-restoration response of fish and other aquatic organisms using underwater video and angling to environmental restoration activities in the upper Tweed River. A specific focus will be characterising the response of fish to the addition of woody structures in the restored area in contrast to unmanipulated control areas (no woody structures added), both before and after the completion of restoration works.

A secondary objective of this project is to further trial low-cost video and fishing (recreational angling) as potential monitoring tools that could be employed by individuals and community groups to assist in the collection of scientific information around determining the response of aquatic organisms to restoration programs.

**Figure 1**. The underwater camera (BRUV) being deployed at the site.

# 2. Methods

## 2.1. Site Location

The rehabilitation site is located adjacent to where Dunbible Creek intersects with the Tweed River at Murwillumbah (see Figure 2).

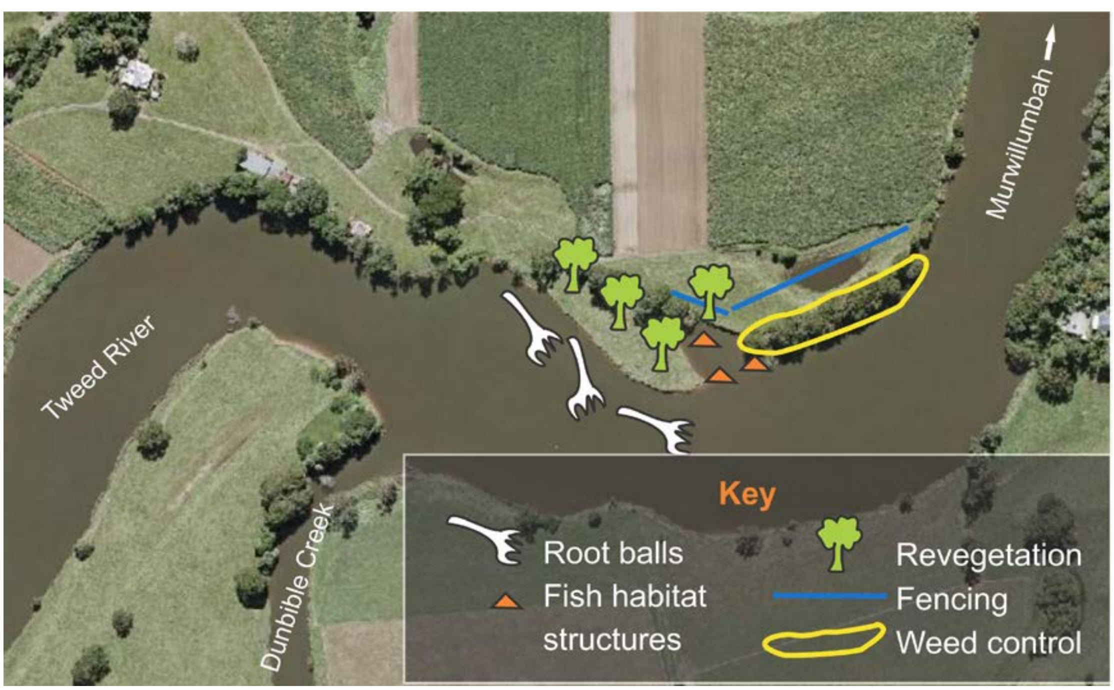


**Figure 2**. Site Location showing areas and types of rehabilitation planned.

## 2.2. Monitoring design

This study implements an inferentially-strong Before-After, Control-Intervention (or impact) design. BACI designs involve comparisons of control (unmanipulated) and intervened (restored) locations, both before and after the implementation of management treatment (Downes et al. 2002). Over time, it is expected that locations with restoration treatments will be characteristically different to unmanipulated control locations.

Aquatic organisms are expected to respond positively to restoration, a positive response might be expected to reflect higher numbers of species, numbers of individuals or presence at the restored reach after the completion of works. Considering restoration works involve the use of machinery, some disturbance may also be expected and thus any initial, negative effect of organisms avoiding restored areas is also of interest to detect.

In order to detect a response to restoration, several logical statements must be validated. The null hypothesis ($H_0$:) is an expectation of no difference in measurements between times and locations. Alternatively, to satisfy a restoration response, there must a temporal change at the restoration location, plus there must also be evidence of a difference between control and restored locations either in the after period or before period. Detection of an effect due to restoration activities would be through rejection of specific null hypotheses of interest:

(1) $H_0$: restored site metrics in before-period = restored site metrics in after-period
(2) $H_0$: control site metrics in before-period = control site metrics in after-period
(3) $H_0$: restored site metrics = control site metrics in after-period

In this study it is expected that a response to restoration treatments could manifest itself in terms of different measured metrics such as species (species richness), their abundance (number per sample unit) or occurrence (e.g. patterns of use – proportion of time detected present) and size patterns. As there are several metrics of interest to describe the ecological response to restoration, a number of univariate (e.g. species-level, size distribution) and multivariate (e.g. assemblage level – combinations of species and abundance) statistical tool could be used, but choice will depend on data quality, including meeting the necessary underlying assumptions of applying these analytical tools.

## 2.3. Sampling equipment: Baited Remote Underwater Video (BRUV)

A BRUV was constructed by OzFish Tweed River Chapter. The frame consists of 18mm PVC pipe and fittings with holes to allow for quick submersion. A PVC arm protrudes, presenting a plastic mesh bait holder which is positioned in front of the camera. A small mesh bag (20 x 15cm) with a zip is placed inside the mesh to prevent the bait from rapid dispersion when submerged. The camera is a GoPro Hero 3 mounted inside a waterproof casing (see Figure 3). A heavy chain is attached to the frame to give the structure weight. For deployment and retrieval, a short rope is tied to the frame with a plastic bottle (float) tied to the bitter end. Contact details are written on the bottle in case an angler tries to retrieve it.

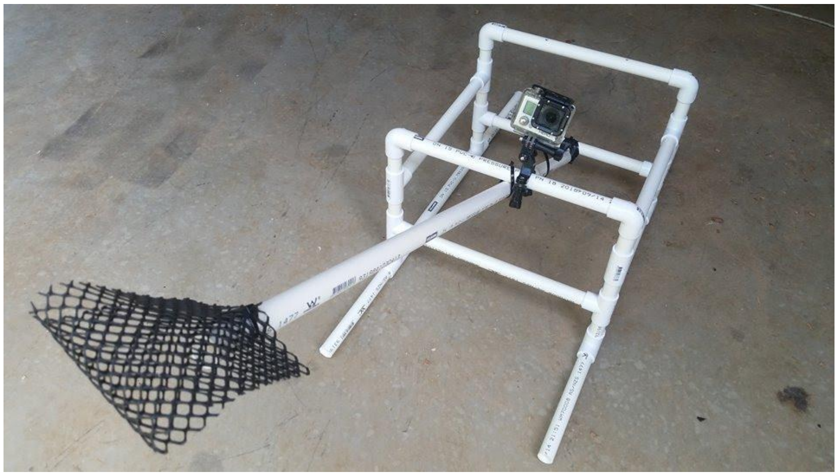

**Figure 3**. The BRUV

### 2.4 Angling as a sampling tool

Perhaps the most commonly used index of relative abundance in fisheries studies is catch (C) per unit effort (*f*) (King, M 2007). In this study the catch per unit effort (C/*f* or CPUE) will be determined by the number of fish caught by angling during times of BRUV deployment. Sampling by angling was done at a location adjacent to the area where filming took place so as not to scare the fish away.

Fishing gear consists of two 2-4kg Shimano Catana rod combos with 1,000 size Nexave reels spooled with 10lb PowerPro braided line. Leaders consist of 2m lengths of fluorocarbon line. One outfit is baited with a deep diving Jackall Chubby lure in black market colour and the other line is baited with a 100mm Shimano wriggler on a 1/12 jig head hook. Gear type was chosen due to its popularity with anglers to target local species such as bream, flathead, estuary perch and Australian bass. To help the quality of the catch effort data, the number and distance of casts and the rate of retrieve will remain consistent at each site.

### 2.5 BRUV Sampling

A total of 2 BRUV deployments (sampling) made at each of the 8 locations (2 x 8) for a total of 16 drops, both before and after rehabilitation for a grand total of 32 drops (16 + 16 = 32) i.e. ‘before’ and’ after’ rehabilitation sample at 8 different locations: 4 reference (existing snags) and 2 treatment (no snags – resnagging planned) and 2 control (no snags) for a total of 16 deployments ‘before’ and 16 deployments ‘after’. (see Figure 4.)

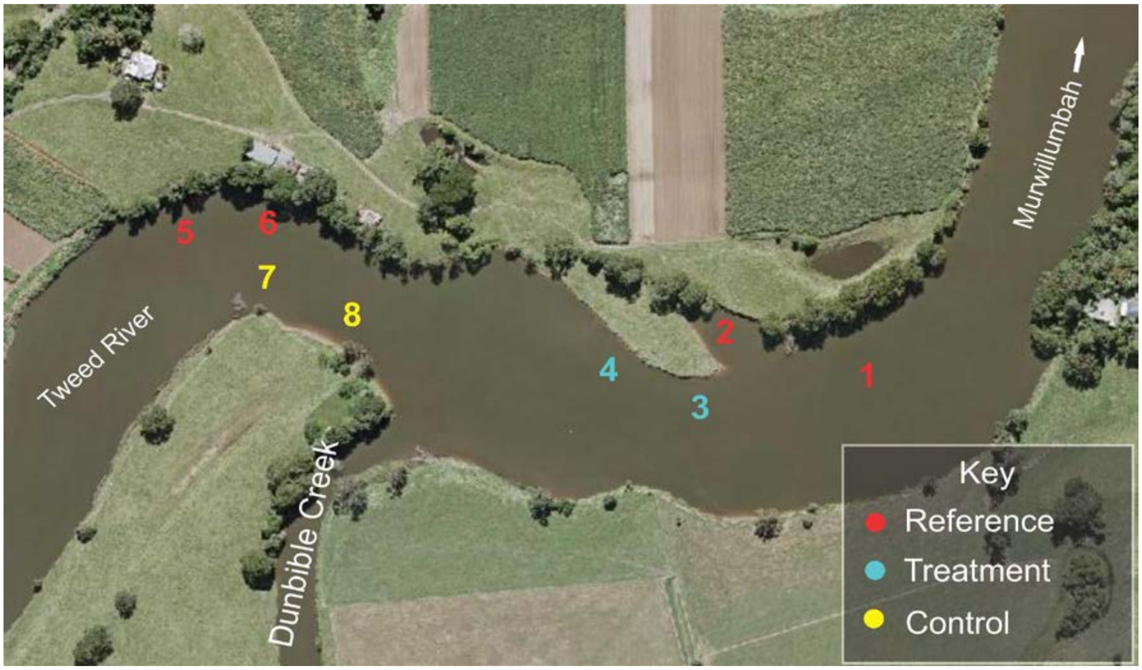


**Figure 4**. The Sample Site showing BRUV deployment locations; 4 reference, 2 treatment and 2 control locations.

To maximize battery life and memory camera to be set to 1080p and 30 frames per second. Bait mesh with a mixture of pilchards and white bread soaked in tuna oil and garlic at a distance of 30cm in front of the camera lens. Sampling took place around high tide, during spring tides. Each deployment (sampling) was 15 minutes in duration.

### 2.4. Video Analysis

Video analysis is based on methods outlined in a similar study in The Clarence River Catchment, (Aquatic Science & Management, 2018). Video played on a 15-inch laptop monitor and pause when any activity was noted. Used frame by frame advances to count and identify fish and other aquatic fauna and record in a database.

Counted the maximum number of fish of any species visible in any individual frame in each of 15 minute samples ($MaxN_{30}$) used as a surrogate for relative abundance (see Cappo *et al.* undated). Thus, for each combination of location and treatment there are 6 MaxN values, 2 values from before and after the rehabilitation.

## 3. Results

### Before Rehabilitation

The results of the sampling prior to the rehabilitation project show a higher number of fish in locations with woody snags, compared to locations with no snags at all i.e. > 1,000 fish were observed among the fallen timber and root systems, compared to 31 fish in locations with no snags. Greater varieties (7 species of fish) were also found around snags compared to 2 species without snags (see Table 1).

When comparing reference locations, the greatest number and variety of fish were found at sites with a combination of both woody snags and riparian vegetation i.e. >1,000 fish were observed at sites 5&6 (snags & vegetation) compared to sites 1&2 (snags only) where only 5 fish were observed.

| | Location | No. & type of fish caught | No. & type of fish observed |
|---|---|---|---|
| **Reference (Snags)** | 1 | 0 | 0 |
| | 1 | 0 | 3 bream |
| | 2 | 0 | 0 |
| | 2 | 1 bass | 1 mud crab |
| | 5 | 0 | 1 bream |
| | 5 | 0 | 1 stingray, 4 small fish |
| | 6 | 0 | 1 bass, 1 bream , 1 mullet, 6 glassfish |
| | 6 | 0 | 1 bass, 1 scat, 2 bream, 1,000+ glassfish |
| **Treatment (Snags planned)** | 3 | 1 flathead | 0 |
| | 3 | 0 | 30 small fish |
| | 4 | 0 | 0 |
| | 4 | 0 | 0 |
| **Control (No Snags)** | 7 | 0 | 0 |
| | 7 | 0 | 0 |
| | 8 | 0 | 0 |
| | 8 | 0 | 0 |

***Table 1.*** The number and type of fish caught whilst fishing and observed on video at the reference, treatment and control locations.

## 4. Discussion

The aim of the rehabilitation project is to enhance and protect fish habitat, improve fish passage and increase water quality in the Tweed River. These types of works are focussed on enhancing areas where fish seek to move, feed and find shelter. These riparian areas have been found to provide key resources for fish.

For example, studies have shown that overhanging vegetation provides a number of key benefits to fish including the provision of shade and regulation of water temperatures in areas where fish prefer to gather. Some local native fish species reply on up to 40% of their diet consisting of insects that fall from overhanging vegetation.

It is evident that the complex root structures of riparian vegetation help in the prevention of erosion by holding the soil together. Riverbank vegetation also acts as a biomechanical filter, assisting in the prevention of excess nutrients entering the waterway. Reduced nutrient and sediment levels are associated with a reduction in turbidity and overall increased water quality.

Root balls and other woody structures are thought to provide many benefits including shelter from the elements such as strong currents and shade from the sun. These structures also act as places to find food, ambush prey and give shelter from predators. Large woody structures have the added benefit of slowing water velocity, which also reduces erosion and therefore turbidity.

## 5. Conclusion

The ‘before’ sampling results reveal far greater numbers and variety of fish located around snaggy areas such as root balls and fallen timber as compared to areas void of structure. Further, at locations that contain both structure and riparian vegetation, even greater numbers and varieties of fish were found. This is conducive with expectations that submerged structures and river bank vegetation attracts fish and provides the kind of resources they need.

By further enhancing fish habitat with the kind of restoration work outlined above, the expectation would be for an increase in fish numbers observed in the project area. However more sampling after the project is finished is required to complete this comparison and gauge the effectiveness of the rehabilitation project.

## References

Aquatic Science & Management (2018) *Coldstream River Resnagging, Fish Monitoring Report.* Mathew Birch

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