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MACKAY WHITSUNDAY WQIP Barriers to Fish Migration Health Metrics

June 2015
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Cover Figure: Jolimont Creek Weir, Mt Ossa, Mackay Whitsunday Region

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Introduction

The majority of freshwater fish species of the Mackay Whitsunday region migrate at some stage during their life cycle. Some of these migrations are short and confined wholly to freshwater habitats, while some migrations occur across vast distances and between varying habitats, including between freshwater and near shore marine environments. Of the 48 freshwater fish species found to occur in the Mackay Whitsunday region (Moore, 2007), almost half (48%) require unimpeded access between freshwater and estuarine habitats to complete their life cycle and maintain sustainable fish populations.

Migration is therefore an essential life cycle adaptation utilised by many Mackay Whitsunday fish species. Migration strategies between key habitats have evolved for a variety of reasons, including; feeding and reproduction purposes, avoidance of predators, utilisation of nursery areas and to maintain genetic diversity. Barriers that prevent or delay connectivity between key habitats have the potential to impact migratory fish populations, decrease the diversity of freshwater fish communities and reduce the condition of aquatic ecosystems.

Queensland's two most important and iconic in-shore commercial net species, barramundi and sea mullet, require unimpeded access between freshwater and estuarine habitats to maintain sustainable populations, and occur in the Mackay Whitsunday region (Williams, 2002). Connectivity between habitats is therefore a critical component in managing aquatic environments, and crucial to ensuring the long-term sustainability of important commercial, recreational and indigenous fisheries that underpin the social fabric of many coastal Queensland communities.

Barriers to fish passage include any structure that impedes the movement of fish, such as culverts, pipes, road crossings, weirs and dams. These structures have been built for a variety of purposes such as irrigation supply, flow gauging and re-regulation, on-farm stock and irrigation supply, urban and industrial supply, flow management and flood control, road crossings or simply for urban beautification and recreation facilities (Marsden *et al.* 2003).

The number of barriers along a freshwater system and the distance to the first barrier in each high ordered stream can often be the limiting factor in determining the health of a particular waterway fish assemblage. High ordered and connected lowland aquatic ecosystems in the Mackay Whitsunday region generally contain diverse and abundant fish communities, with a high proportion of diadromous (fish that migrate between marine and freshwater habitats) species (Moore, 2007). The cumulative impact of barriers along high ordered streams has the ability to significantly reduce the amount of fish species upstream, particularly diadromous species, and in some instances may cause localised extinctions upstream of the barrier (Bunn and Arthington, 2002). Therefore, the amount of connected in-stream habitat longitudinally from the freshwater/estuarine interface upstream to the first barrier is extremely important. Simply, the greater the amount of connected in-stream habitat, the greater the diversity and abundance of diadromous species resulting in better condition fish communities.

The number of barriers located both laterally and longitudinally upstream along the waterway also significantly reduces the ability of diadromous species to reach upstream nursery areas. Diadromous species may be able to utilise intermittent high flow conditions that may 'drown out' the barrier, enabling them to ascend upstream, but only if they are present at the barrier when the barrier experiences 'drown out' conditions and exhibit swimming abilities sufficient to ascend

past the barrier. The chances of the 'right' conditions prevailing at the next barrier upstream, and then the barrier after that, and so on, is reduced each time. Therefore the cumulative impact, i.e. the number of barriers, and the distance or amount of available in-stream habitat between barriers is an extremely important attribute influencing the composition of Mackay Whitsunday fish communities.

Water Quality Improvement Plan Health Metrics: Barriers to Fish Migration

Area (ha) of Stream Habitat per Barrier to Fish Migration

Fisheries QLD spatial waterway data layer 'Queensland waterways for waterway barrier works' was utilised to calculate the area (ha) of stream habitat within each sub-catchment and to locate and identify barriers to fish passage on important 'High' and 'Major' risk streams. 'Queensland waterways for waterway barrier works' data layer categorised all of Queensland's streams based on the level of risk any waterway barrier works would pose to fisheries resources on each particular stream. Streams classified as 'High' (red coloured streams) and 'Major' (purple and grey coloured streams) were used for the purposes of this barrier metric. Queensland waterways that fall within these two categories were determined by Fisheries QLD (2013) based on; stream order, stream slope, flow regime, number of fish present, and fish swimming ability (Table 1). Fisheries QLD (2013) stream classification colours and associated stream characteristics are used to determine whether the site of proposed waterway barrier works requires assessment and approval under the *Fisheries Act 1994* (Qld).

Streams that fall within 'Major' and 'High' impact categories are generally: lower in the catchment; higher ordered streams; with low gradients. These streams are categorised by having a high diversity of species, often with weak swimming abilities. Barriers located on high gradient, top of catchment 'Moderate' (Amber) and 'Low' (Green) impact streams (stream order 1-2) are still important, but are not as influential in determining fish community assemblage within aquatic ecosystems as barriers on 'Major' and 'High' impact streams (Figure 1). For this reason, only barriers located on 'Major' and 'High' impact streams have been used for this metric. Not all identified barriers to fish passage in the Mackay Whitsunday region have been groundtruthed to confirm the presence of a barrier, and therefore are termed 'likely' barriers.

Table 1. Stream characteristics used to determine Fisheries QLD stream classification.

Option	Risk of Impact & Stream classification (colour code)	Stream characteristics
a.	Major (Purple)	Strahler stream orders 4-7
b.	High (Red)	Strahler stream orders 2-3 with low gradient Strahler stream order 3 with medium gradient

Stream habitat area (ha) for this metric was determined by first measuring the stream width (bankfull height) ten times along the course of each sub-catchment, including upper, middle and lower stream reaches and averaging these measurements. The following formula:

$$\frac{\text{average stream width (m)} * \text{total stream length (m)}}{10\,000}$$

Was used to acquire stream habitat area in hectares for each sub-catchment. This was then divided by the number of likely barriers in each sub-catchment to determine stream habitat area (ha) per barrier to fish passage metric (Figure 2). Scores were then assigned based on the amount of stream habitat area (ha) per barrier to fish passage (Table 2). Stream habitat (ha) per barrier, number of likely barriers and score are shown below in Table 3.

Table 2. Scoring range and subsequent score for the sub-catchment condition metric: Stream habitat (ha) per barrier to fish migration.

Stream Habitat (ha) per barrier metric	
Scoring Range	Score
No Barriers	5
25.1 - No Barriers	4
10.1 - 25	3
5.1 - 10	2
0 - 5	1



Figure 1. Gauging weir fish barrier on the Andromache River (Barrier ID 3999, Rank 25). This particular barrier is located on 'Major' impact stream determined by the 'Queensland waterways for waterway barrier works' data layer.

Table 3. Showing sub catchment total stream habitat (ha), number of likely barriers, stream habitat (ha) per barrier and subsequent sub-catchment metric score.

Receiving Waters	Sub Catchment	Total Stream Habitat (ha)	Likely Barriers	Stream Habitat (ha) per barrier	Score
Whitsunday Coast	Repulse Creek	39.4	0	No Barriers	5
Sandringham Bay	Mackay City	20.1	0	No Barriers	5
Ince Bay	Cape Creek	3.6	0	No Barriers	5
Carmila Coast	Gillinbin Creek	49.1	0	No Barriers	5
Repulse Bay	Andromache River	259.5	2	129.7	4
Sandringham Bay	Blacks Creek	331.3	6	55.2	4
Repulse Bay	Upper Proserpine River	52.6	2	26.3	4
Edgecumbe Bay	Eden Lassie Creek	148.5	6	24.8	3
Seaforth Coast	St Helens Creek	62.0	3	20.7	3
Edgecumbe Bay	Gregory River	82.4	4	20.6	3
Repulse Bay	O'Connell River	279.5	16	17.5	3
Repulse Bay	Waterhole Creek	32.0	2	16.0	3
Carmila Coast	Marion Creek	49.2	4	12.3	3
Carmila Coast	West Hill Creek	57.1	5	11.4	3
Repulse Bay	Lethe Brook	136.2	13	10.5	3
Repulse Bay	Thompson Creek	42.6	5	8.5	2
Seaforth Coast	Murray Creek	226.6	27	8.4	2
Repulse Bay	Proserpine R Main Channel	58.6	8	7.3	2
Sandringham Bay	Pioneer R Main Channel	411.5	61	6.7	2
Ince Bay	Rocky Dam Creek	131.5	26	5.1	2
Carmila Coast	Flaggy Rock Creek	30.3	6	5.1	2
Seaforth Coast	Blackrock Creek	82.6	18	4.6	1
Seaforth Coast	Constant Creek	54.4	12	4.5	1
Sandringham Bay	Upper Cattle Creek	54.2	12	4.5	1
Repulse Bay	Myrtle Creek	99.1	25	4.0	1
Seaforth Coast	Reliance Creek	11.2	3	3.7	1
Sandringham Bay	Alligator Creek	43.3	13	3.3	1
Sandringham Bay	Sandy Creek	175.2	64	2.7	1
Sarina Inlet	Plane Creek	47.1	21	2.2	1
Carmila Coast	Carmila Creek	44.8	22	2.0	1
Sandringham Bay	Bakers Creek	40.3	25	1.6	1
Whitsunday Coast	Whitsunday Coast	5.1	4	1.3	1
Sarina Inlet	Sarina Beaches	3.3	3	1.1	1

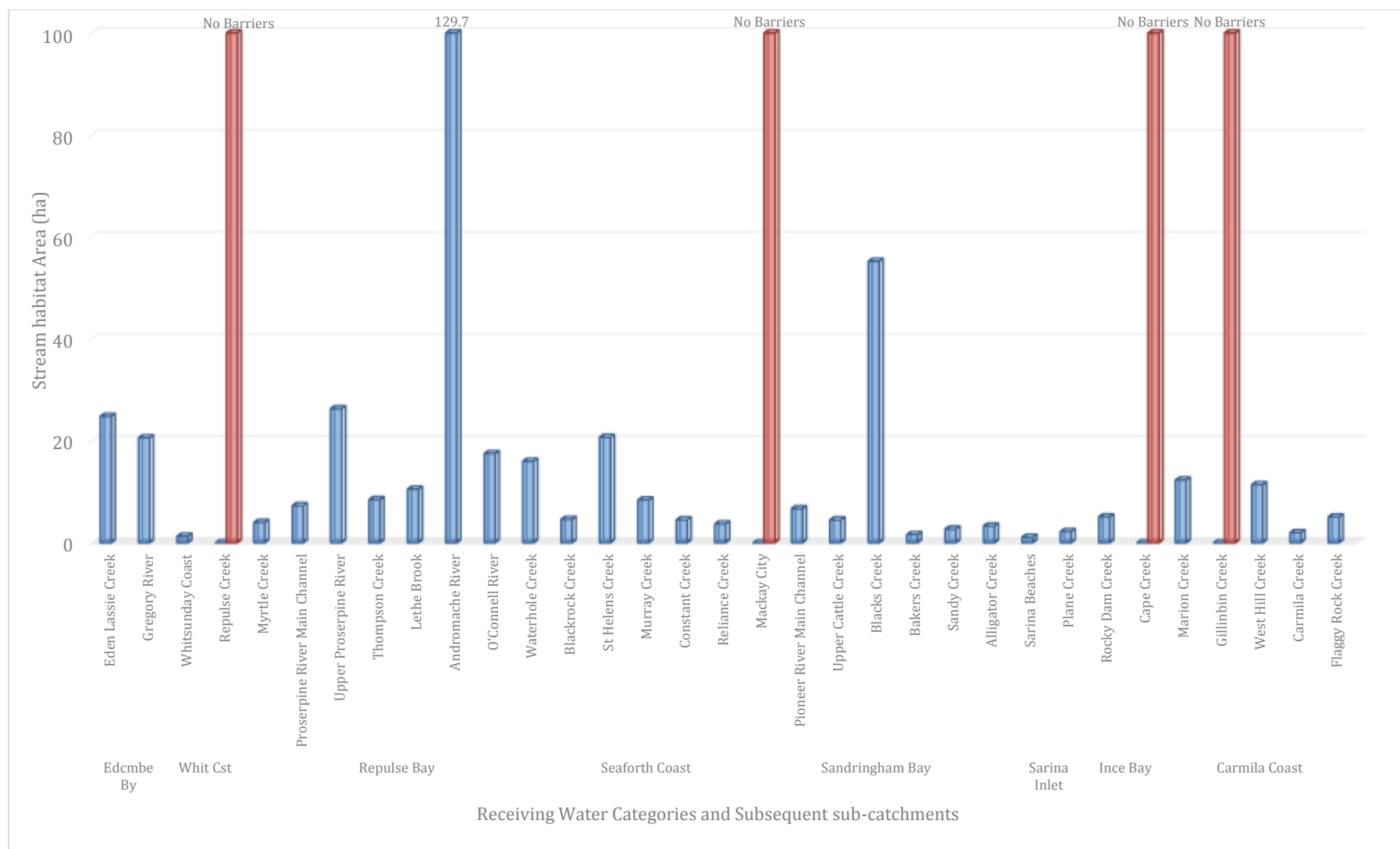


Figure 2. Showing the amount of stream habitat (ha) in each sub-catchment per barrier to fish migration. Sub-catchments are grouped into receiving water categories. Note: Sub-catchments with no barriers to fish migration are represented with a 'red bar'.

Diadromous connectivity - Stream length to 1st barrier as a proportion (%) of total catchment stream length

The amount of longitudinal in-stream habitat available to diadromous fish species in undisturbed, connected habitats is determined by a number of naturally occurring factors, such as: habitat availability and condition, gradient, refuge areas, water temperature and food resources. However anthropogenic factors such as man-made barriers to fish passage and habitat destruction often have a far greater impact in determining the amount of connected upstream habitat available to fish. One large low transparency barrier close to the freshwater/estuarine interface has the potential to alter upstream fish communities, particularly the number of diadromous fish species more than any other naturally occurring factor. Therefore, the stream length (amount of available in-stream habitat) to the first barrier in each 'High' and 'Major' classified stream is an important proxy in determining the health of aquatic ecosystems (Figure 3).

Fish barriers located on waterways classified as 'High' (red coloured streams) and 'Major' (purple and grey coloured streams) by the Fisheries QLD spatial data layer 'Queensland waterways for waterway barrier works' were identified and assigned a unique geo-spatial identification number. A spatial GIS stream networking tool 'RivEx' (Hornby 2015) was then used to calculate the distance (stream length) to the first barrier in each sub-catchment. Due to the large variance in catchment sizes and associated 'High' & 'Major' stream lengths, i.e. Andromache River 116.7 km's & Whitsunday Coast 7.3 km's, stream length to the first barrier was divided by the total sub-catchment stream length and multiplied by 100 to calculate the proportion (%) of stream length within the catchment not impacted by barriers (Table 5). Scores were then assigned based on the proportional stream length distance to the first barrier (Table 4) in each sub-catchment. Sub-catchments with a high proportion of stream length before the first barrier, score high. Sub-catchments with a low proportion of stream length before the first barrier, score low.

Table 4. Scoring range and subsequent score for catchment condition metric: 'Stream length to the first barrier as a proportion (%) of total catchment stream length'.

Available Connected Habitat - Stream length to 1st barrier as a proportion (%) of total catchment stream length.	
Scoring Range (%)	Score
No Barriers	A
50% - 99.9%	B
30% - 49%	C
10% - 29.9%	D
0% - 9.9%	E

Table 5. Showing the distance to the first barrier in each sub-catchment and subsequent scores.

*Denotes sub-catchment is located upstream from another sub-catchment, and is therefore affected by that sub-catchments barriers.

Receiving Waters	Sub Catchment	Available Connected Aquatic Habitat		Score
		Stream length (km) to 1st Barrier	Stream length to 1st barrier as a proportion (%) of total catchment stream length	
Repulse Bay	Repulse Creek	No Barriers	No Barriers	5
Sandringham Bay	Mackay City	No Barriers	No Barriers	5
Ince Bay	Cape Creek	No Barriers	No Barriers	5
Carmila Coast	Gillinbin Creek	No Barriers	No Barriers	5
Repulse Bay	Waterhole Creek	26	90.9	4
Edgecumbe Bay	Gregory River	46.2	85.7	4
Edgecumbe Bay	Eden Lassie Creek	83	71.3	4
Repulse Bay	Whitsunday Coast	4.5	61.8	4
Carmila Coast	West Hill Creek	28.8	60.6	4
Repulse Bay	Proserpine R Main Channel	16	55.4	4
Repulse Bay	Thompson Creek	12.8	50.0	4
Sandringham Bay	Alligator Creek	19.5	47.5	3
Carmila Coast	Flaggy Rock Creek	13.5	47.0	3
Sarina Inlet	Sarina Beaches	1.6	44.2	3
Ince Bay	Rocky Dam Creek	48	42.7	3
Seaforth Coast	Constant Creek	16	35.4	3
Seaforth Coast	Blackrock Creek	21.9	34.5	3
Seaforth Coast	St Helens Creek	11.3	30.2	3
Repulse Bay	Myrtle Creek	16.4	29.9	2
Seaforth Coast	Murray Creek	37.3	28.0	2
Sandringham Bay	Bakers Creek	5.8	15.4	2
Repulse Bay	Lethe Brook	13.3	15.3	2
Sandringham Bay	Pioneer River Main Channel	23.3	11.3	2
Sandringham Bay	Sandy Creek	11.1	9.2	1
Carmila Coast	Marion Creek	2.2	6.2	1
Carmila Coast	Carmila Creek	1.9	5.2	1
Sarina Inlet	Plane Creek	1.1	3.1	1
Seaforth Coast	Reliance Creek	0.2	2.2	1
Repulse Bay	O'Connell River	0.7	0.6	1
Repulse Bay	*Upper Proserpine River	0	0.0	1
Repulse Bay	*Andromache River	0	0.0	1
Sandringham Bay	*Upper Cattle Creek	0	0.0	1
Sandringham Bay	*Blacks Creek	0	0.0	1

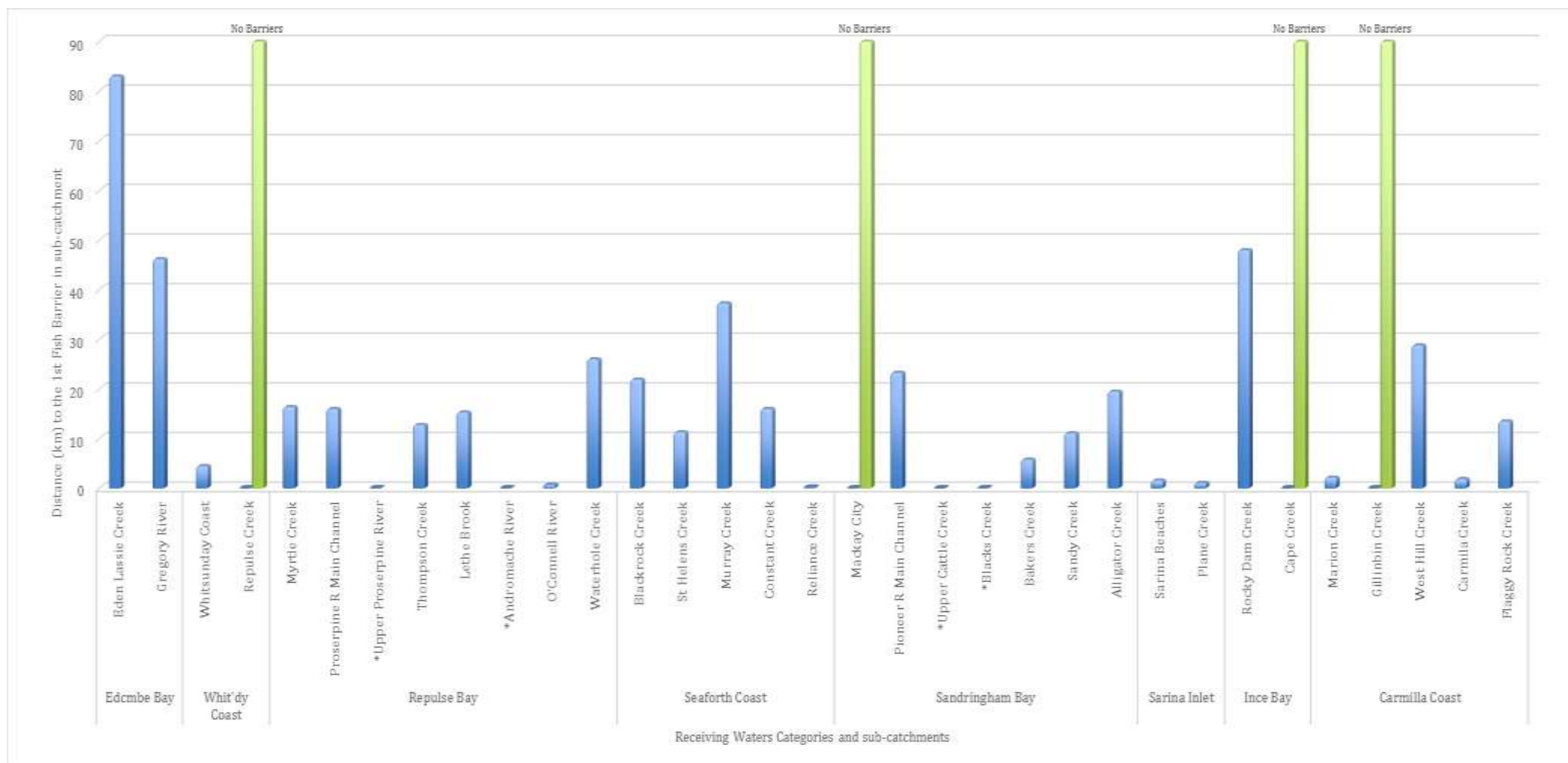


Figure 3. Showing distance (km) to the first barrier in each-subcatchment, grouped by receiving waters. Sub-catchments with a green bar have no barriers.*Denotes sub-catchment is located upstream from another sub-catchment, and is therefore affected by that sub-catchments barriers.

Overall Sub-catchment Barrier Condition

Scores for the two barrier metrics 'Area (ha) of stream habitat per barrier to fish migration' and 'Stream length to first barrier as a proportion of the total sub-catchments stream length' were added together to acquire an overall barrier condition score (Table 6). The overall barrier condition score was then assigned to each sub-catchment depending on what scoring range the total score fell within (Table 7). A score of 'A' represents a sub-catchment with no barriers and excellent connectivity. A score of 'E' equates to a sub-catchment that possesses multiple barriers, including one or more close to the estuarine interface and poor longitudinal connectivity. The Andromache River with only two barriers (Figure 4) located in a large catchment scored well (4) for the barrier metric 'Stream habitat (ha) per barrier', but poorly (1) for the barrier metric 'Distance to the first barrier' due to a barrier located close to the freshwater/estuarine interface.

Table 6: Overall sub-catchment barrier condition scoring range and overall barrier condition rating.

Scoring Range & Subsequent Overall Barrier Condition Rating	
Scoring Range	Overall Barrier Condition Rating
10	A
7 - 9	B
5 - 6	C
3 - 4	D
0 - 2	E



Figure 4. One of only two barriers located on 'Major' and 'High' impact streams within the Andromache sub catchment; 1 pipe causeway on the perennial Mares Nest Creek. This causeway acts as both a 'velocity' and 'water surface drop' barrier to fish migration.

Table 7. Sub-catchment scores for each fish barrier metric and subsequent overall fish barrier condition rating.

Receiving Waters	Sub Catchment	Stream Habitat (ha) per barrier	Stream length to 1st barrier as a proportion (%) of total catchment stream length	Overall Score	Overall Fish Barrier Condition Rating
		Score	Score		
Whitsunday Coast	Repulse Creek	5	5	10	A
Sandringham Bay	Mackay City	5	5	10	A
Ince Bay	Cape Creek	5	5	10	A
Carmila Coast	Gillinbin Creek	5	5	10	A
Edgecumbe Bay	Eden Lassie Creek	3	4	7	B
Edgecumbe Bay	Gregory River	3	4	7	B
Repulse Bay	Waterhole Creek	3	4	7	B
Carmila Coast	West Hill Creek	3	4	7	B
Seaforth Coast	St Helens Creek	3	3	6	C
Repulse Bay	Thompson Creek	2	4	6	C
Repulse Bay	Proserpine R Main Channel	2	4	6	C
Repulse Bay	Andromache River	4	1	5	C
Sandringham Bay	Blacks Creek	4	1	5	C
Repulse Bay	Upper Proserpine River	4	1	5	C
Repulse Bay	Lethe Brook	3	2	5	C
Ince Bay	Rocky Dam Creek	2	3	5	C
Carmila Coast	Flaggy Rock Creek	2	3	5	C
Whitsunday Coast	Whitsunday Coast	1	4	5	C
Repulse Bay	O'Connell River	3	1	4	D
Carmila Coast	Marion Creek	3	1	4	D
Seaforth Coast	Murray Creek	2	2	4	D
Sandringham Bay	Pioneer R Main Channel	2	2	4	D
Seaforth Coast	Blackrock Creek	1	3	4	D
Seaforth Coast	Constant Creek	1	3	4	D
Sandringham Bay	Alligator Creek	1	3	4	D
Sarina Inlet	Sarina Beaches	1	3	4	D
Repulse Bay	Myrtle Creek	1	2	3	D
Sandringham Bay	Bakers Creek	1	2	3	D
Sandringham Bay	Upper Cattle Creek	1	1	2	E
Seaforth Coast	Reliance Creek	1	1	2	E
Sandringham Bay	Sandy Creek	1	1	2	E
Sarina Inlet	Plane Creek	1	1	2	E
Carmila Coast	Carmila Creek	1	1	2	E

Actual and Target Barrier Condition Rating

After assigning each sub-catchment with an overall barrier condition rating further analysis was undertaken to determine the type and extent of barrier remediation required in each sub-catchment to reach the 'Target Rating'. The target rating for each sub-catchment was determined to be one rating position higher than the sub-catchment's current rating, i.e. resulting in an increase from an overall score of C to B. Table 8 shows the number of barriers required to be remediated in each target sub-catchment to reach the target rating, and an approximate cost associated with remediation. Barrier remediation generally consists of the installation of a fishway, i.e. nature-like rock ramp fishway, pre-cast concrete cone, but may also involve the complete removal of the barrier.

Mackay Whitsunday Fish Barrier Prioritisation

Barriers to fish passage in the Mackay Whitsunday region were prioritised during a three stage rapid assessment process undertaken across a two year period (2014-15). The fish barrier prioritisation process utilised GIS to score and rank each barrier based on a number of key biological, geographic, economic and social questions. The top 40 barriers to fish migration in the Mackay Whitsunday region identified through the prioritisation process (including barrier location and indicative cost of remediation) is shown below in Table 9. Further detailed information regarding the prioritisation process can be found in Moore 2015, 'Mackay Whitsunday Fish Barrier Prioritisation'.

Indicative Fishway Remediation Costs

Indicative fishway remediation costs (Table 8) to improve current barrier condition rating to the target rating are based on a number of factors. These include but are not limited to:

- **Head loss** - (height of the fish barrier), i.e. the difference between headwater (upstream water level) and tailwater (downstream water level). This measurement fundamentally determines the type and size of the fishway. Greater the head loss, the larger and more technical the fishway and indicative cost.
- **Barrier location** - (top or bottom of catchment), Bottom of catchment fishways require 'drops' between pools to be smaller than top of catchment fishways, i.e. lower catchment streams: drops between 60 – 80 mm and higher catchments streams between 80 – 120 mm. This is because fish community's that occupy lower catchment habitats comprise high proportions of diadromous and juvenile fish species. These fish generally possess weaker swimming abilities than potamodromous (wholly freshwater species) and adult fish. Therefore lower catchment fishways comprise more 'pool' and 'drop' sections, consequently these fishways are longer and require more materials which increases cost.
- **Substrate** - Sandy substrate streams require a greater amount of rock and/or concrete to lock and secure the fishway in place than substrates comprised of bedrock. Additional construction materials represent higher fishway construction costs.

- **Infrastructure** - Barriers located on strategic infrastructure such as roads or water storage weirs, generally require a greater degree of engineering and consultation than barriers on private property or disused infrastructure. The greater the engineering and consultation, the greater the cost.
- **Approvals** - Under the Fisheries Act, waterway barrier works approvals are required depending on the size and type of stream the barrier is located on. Barriers located on 'Major' and 'High' impact streams according to Fisheries QLD spatial data layer 'Queensland waterways for waterway barrier works' comprise approval costs up to ~\$9k. The larger the stream order, the higher the approval cost to construct the fishway.

Table 8. Individual barrier metric scores, including overall barrier condition rating, target rating, number of barriers remediated to acquire target rating and the indicative cost to implement actions.

Receiving Waters	Sub Catchment	Stream Habitat (ha) per barrier	Distance to 1st barrier as a (%) of total catchment strm length	Overall Score	Overall Fish Barrier Condition Rating	Target Rating	Number of remediated barriers	Indicative Cost
		Score	Score					
Whitsunday Cst	Repulse Creek	5	5	10	A			
Sandringham Bay	Mackay City	5	5	10	A			
Ince Bay	Cape Creek	5	5	10	A			
Carmila Coast	Gillinbin Creek	5	5	10	A			
Edgecumbe Bay	Eden Lassie Creek	3	4	7	B			
Edgecumbe Bay	Gregory River	3	4	7	B			
Repulse Bay	Waterhole Creek	3	4	7	B			
Carmila Coast	West Hill Creek	3	4	7	B			
Seaforth Coast	St Helens Creek	3	3	6	C	B	1	\$20k
Repulse Bay	Thompson Creek	2	4	6	C	B	1	\$80k
Repulse Bay	Proserpine R Mn Chl	2	4	6	C			
Repulse Bay	Andromache River	4	1	5	C	A	2	\$120k
Sandringham Bay	Blacks Creek	4	1	5	C			
Repulse Bay	Upper Proserpine River	4	1	5	C			
Repulse Bay	Lethe Brook	3	2	5	C	B	3	\$150k
Ince Bay	Rocky Dam Creek	2	3	5	C			
Carmila Coast	Flaggy Rock Creek	2	3	5	C	B	1	\$40k
Whitsunday Cst	Whitsunday Coast	1	4	5	C			
Repulse Bay	O'Connell River	3	1	4	D	B	2	\$150k
Carmila Coast	Marion Creek	3	1	4	D	B	2	\$100k
Seaforth Coast	Murray Creek	2	2	4	D	C	2	\$80k
Sandringham Bay	Pioneer R Main Chnl	2	2	4	D			
Seaforth Coast	Blackrock Creek	1	3	4	D	C	2	\$80k
Seaforth Coast	Constant Creek	1	3	4	D	C	2	\$140k
Sandringham Bay	Alligator Creek	1	3	4	D			
Sarina Inlet	Sarina Beaches	1	3	4	D			
Repulse Bay	Myrtle Creek	1	2	3	D			
Sandringham Bay	Bakers Creek	1	2	3	D	C	2	\$105k
Sandringham Bay	Upper Cattle Creek	1	1	2	E			
Seaforth Coast	Reliance Creek	1	1	2	E	D	2	\$60k
Sandringham Bay	Sandy Creek	1	1	2	E	D	2	\$60k
Sarina Inlet	Plane Creek	1	1	2	E			
Carmila Coast	Carmila Creek	1	1	2	E			
Total barriers remediated and associated cost							24	\$1185k

Table 9. Top 40 barriers to fish migration in the Mackay Whitsunday region, including barrier location and indicative cost of remediation. Detailed information regarding the prioritisation scoring criteria, methodology and scores for all three stages can be found in Moore 2015, 'Mackay Whitsunday Fish Barrier Prioritisation'.

Final Rank	Barrier ID	Waterway	Receiving Water	Barrier Description	Total Score (Stages 1-3)	Indicative Cost
1	3931	O'Connell River	Repulse Bay	Tidal Interface Sand Dam	74	\$150k
2	2769	Flaggy Rock Ck	Carmila Coast	Tailwater of Cone fishway	69	\$30k
3	3792	Cedar Ck	Repulse Bay	Vitanza Rd Causeway - 4 Pipes	66	\$30k
4	111	Sandy Ck	Sandringham Bay	Palm Tree Rd Causeway	65	Allocated
4	2630	Constant Ck	Seaforth Coast	Freds Lower Weir - 1 m	65	\$70k
4	3573	Marion Ck	Carmila Coast	1 Pipe Causeway	65	\$100k
7	2588	Blackrock Ck	Seaforth Coast	Old Bowen Rd Causeway	64	\$80k
7	2593	St Helens Ck	Seaforth Coast	Russels Crossing Road Causeway	64	\$20k
7	2614	Jolimont Ck	Seaforth Coast	Mulherin Rd Weir - 2 m +	64	\$200k
7	2631	Constant Ck	Seaforth Coast	1938 Weir UStrm of Freds weir - 1 m	64	\$70k
11	3574	Marion Ck	Carmila Coast	Marion Settlement Rd Causeway - 2 Culverts	63	\$40k
11	3965	Carmila Ck	Carmila Coast	Gauging Weir behind school	63	\$40k
13	327	Goorganga Ck	Repulse Bay	Creek Crossing under train bridge	62	\$30k
13	3120	Tedlands Ck	Ince Bay	Tidal Bund	62	\$80k
13	3174	Cherry Tree Ck	Ince Bay	East Inneston Rd Causeway - 3 Culverts	62	\$15k
13	3933	Mares Nest Ck	Repulse Bay	Station Rd 1 Pipe Causeway	62	\$40k
13	3981	Boundary Ck	Ince Bay	Borg Tidal Bund - 1 m - Main Channel fwy site	62	\$60k
18	2610	Macquarie Ck	Seaforth Coast	Large Weir - 2 m	61	\$200k
18	2616	Jolimont Ck	Seaforth Coast	Narpi Rd Causeway - 2 Pipes	61	\$60k
18	2636	Reliance Ck	Seaforth Coast	Neills Rd Causeway - 2 Culverts	61	\$15k
18	3331	Hay Gully	Edgecumbe Bay	Weir 20 m U/S Hwy - 1 m +	61	\$40k
18	3881	Lethe Brook	Repulse Bay	Fausts Causeway - 2 Culverts + 1 m Apron drop	61	\$60k
18	3942	Boundary Ck (OC)	Repulse Bay	Dougherty's Rd Causeway - 2 Culverts	61	\$30k
18	3988	Boundary Ck	Ince Bay	Borg Tidal Bund DS	61	\$60k

Table 9 continued.

Final Rank	Barrier ID	Waterway	Receiving Water	Barrier Description	Total Score (Stages 1-3)	Indicative Cost
25	2750	Carmila Ck	Carmila Coast	Jacksons Crossing Rd Causeway - 1 m Weir	60	\$60k
25	3999	Andromache River	Repulse Bay	Gauging Weir	60	\$70k
27	83	Bakers Ck	Sandringham Bay	Weir - 1.5 m - Irrigation 1900s	59	\$100k
27	2575	Macquarie Ck	Seaforth Coast	Mackays Rd C/Way - 3 Culverts + 1 m apron drop	59	\$40k
27	3127	Tedlands Ck	Ince Bay	Tedlands Dougall Property 1 sml Culvert	59	\$15k
27	3673	Proserpine River	Repulse Bay	WRC illegal barrier - 1 m C/way - Up River Rd	59	Remove
27	3928	Thompson Ck	Repulse Bay	Wetland Riser + pipe + bund - 1.5 m +	59	\$70k
32	10	Pioneer River	Sandringham Bay	Marian Weir - large 4 m +	58	\$2 m +
32	3990	Sandy Ck	Sandringham Bay	Gauging Weir	58	\$60k
34	2544	Plane Ck	Sarina Inlet	Brooks Rd Tidal Causeway - 2 Pipes	57	\$70k
34	2734	West Hill Ck	Carmila Coast	4 Pipe Causeway off Browns Rd	57	\$50k
34	2744	Carmila Ck	Carmila Coast	Streeters Rd Causeway - 0.5 m	57	\$40k
34	3980	Proserpine River	Repulse Bay	Spruces Causeway - 4 Culverts	57	\$40k
38	1214	Leila Ck	Seaforth Coast	Sants Rd Causeway - Pipes	56	\$30k
38	2601	Murray Ck	Seaforth Coast	Clewes Rd Causeway - 1 m	56	\$70k
38	1316	McReady's Ck	Sandringham Bay	Golf Links Rd C/way - 2 sml Culverts + Apron	56	\$25k

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