IMPACTS OF BARRIERS AND FISHWAYS ON SAWFISH – WHEATSTONE SAWFISH OFFSET 2014 ANNUAL REPORT

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Cover photo: Catch list and a drawing of a sawfish at the Camballin Barrage, Fitzroy River, Western Australia. *This is a common place for fishers to document what they have caught and/or observed during their stay at the barrage.*

Impacts of barriers and fishways on sawfish – Wheatstone sawfish offsets
Annual report to Western Australian Marine Science Institution

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Important abbreviations: rkm – river kilometre; distance (km) from the river mouth.

SUMMARY

This is the first annual report of the study that is investigating the impacts of barriers to sawfish migrations in Western Australia. The Largetooth (or Freshwater) Sawfish (*Pristis pristis*) is the only species of sawfish (Pristidae) to inhabit the freshwater reaches of rivers, and thus is likely to be the sawfish species that is most impacted by instream barriers. As such, *P. pristis* is the primary subject of this study. This study is separated into multiple milestones or phases, with the general findings of Phase I and II, and status and preliminary findings of Phase III being discussed in this report. In depth analyses and discussions of all phases will available in the final report.

Phase I and II of this study explored the presence of human constructed instream barriers in northern Western Australia (the Pilbara and Kimberley regions), and assessed the potential for these barriers to impact juvenile *P. pristis* migration. A comprehensive desktop review of the database on potential barriers to fish movement maintained by the Department of Water (Government of Western Australia) revealed that of the 62,013 barriers identified, only six met the two criteria of being located in a catchment known to house *P. pristis*, and being adjudged likely to impact on juvenile sawfish migration. The results of this desktop review will be complimented by site visitation where necessary.

Phase III of this study is investigating the occurrence, movements and habitat use of *P. pristis* in association with the 'high impact' barriers that were identified during phase I and II. Phase III of this study commenced in August 2013. Between August 2013 and June 2014, three field trips have been undertaken to sample the Fitzroy and Ashburton Rivers for sawfish, as these rivers were assessed as having human-constructed barriers with the greatest potential for impacting *P. pristis* migrations. These trips resulted in the capture of 12 *P. pristis* in the Fitzroy River, 10 of which were tagged with acoustic transmitters. No *P. pristis* were captured in the Ashburton River in part due to sampling efforts being hindered by a storm event.

During the October 2013 field trip, three VR2W acoustic receivers were added to the Fitzroy River acoustic receiver array in pools just upstream of the Myroodah Road Crossing (n = 1) and the Camballin Barrage (n = 2). These receivers will work with previously installed receivers downstream of these barriers in monitoring the movements of sawfish up and

downstream of these barriers. Acoustic detection data acquired by the receivers will be downloaded in July 2014. Due to the lack of captures in April, deployment of receivers was delayed in the Ashburton River until the following 2014 field trip.

INTRODUCTION

The Largetooth (or Freshwater) Sawfish (*Pristis pristis*) is a critically endangered euryhaline batoid that occurs in tropical and subtropical fresh, estuarine and marine waters throughout the world. In Australia, *P. pristis* is pupped in or near river mouths during the wet season (December to May), and the species uses these rivers as nursery areas for between four to five years before emigrating to estuarine and then marine waters (Thorburn *et al.* 2007; Whitty 2011). Juvenile *P. pristis* have been found up to 400 km upstream in riverine environments throughout northern Australia (Taniuchi *et al.* 1991; Morgan *et al.* 2004; Thorburn *et al.* 2007; Last and Stevens 2009; Morgan *et al.* 2011).

Like the other four species of sawfish, *P. pristis* has experienced a global decline in range and numbers due to fishing (typically caught as bycatch) and habitat modifications (Thorson 1976; Simpfendorfer 2002; Stevens *et al.* 2005; White and Kyne 2010). This has led to the extirpation of this species in various regions of its historic geographic range, leaving viable populations to exist in only a few select regions worldwide (Stevens *et al.* 2000; Cavanagh *et al.* 2003; Last and Stevens 2009; White and Kyne 2010). Northern Australia appears to be one of the last secure habitats for *P. pristis*. Within northern Western Australia, the Fitzroy River is a known nursery for *P. pristis* (the only known nursery in Western Australia), and arguably contains one of the largest known assemblages of juvenile *P. pristis* in the world (Thorburn *et al.* 2004, 2007; Morgan *et al.* 2011; Whitty 2011). The relatively high numbers of *P. pristis* in the Fitzroy River is likely due to the size and remoteness of the river, the relatively small human population in the area and the relatively pristine condition of the river. The Fitzroy River is not completely undisturbed however, with cattle grazing, sand mining, water abstraction and three human-made barriers (i.e. two road crossings and a small weir) impacting on the river.

The dependence of *P. pristis* on riverine environments places this species at a high risk of being impacted by anthropogenic disturbances such as land development, dredging, mining, water abstraction, flow regulation and damming of waterways. However, little is known with regard to how such modifications impact *P. pristis* and how these impacts can be mitigated. In light of the absence of such knowledge, the Freshwater Fish Group and Fish Health Unit, Murdoch University was contracted to assess the impacts of barriers on sawfish in Western Australia through an offset of the Wheatstone LNG Project near Onslow, Western Australia. It was the aim of this project to conduct a comprehensive desktop study to investigate the presence of human-constructed instream barriers in northern Western Australia (namely the Pilbara and Kimberley regions), and rank the barriers in accordance with their potential degree of impact on *P. pristis*. In addition, this study aimed to monitor the occurrence, movements and habitat use of *P. pristis* in association with the potentially 'high impact' barriers. This report documents the general findings of Phase I and II of this study: Barrier assessment and prioritisation, and the status and preliminary data of Phase III: Monitoring of sawfish.

MATERIALS AND METHODS

Barrier assessment and prioritisation

The barrier assessment and prioritisation methods used in this study were adapted from those outlined in Beatty *et al.* (2013). This process consisted of a desktop review of the distributional data of Largetooth Sawfish in fresh waters of Western Australia and a review of geospatial data on potential human-made barriers to their migratory movements. The identification of barriers relied exclusively on a database maintained by the Department of Water, Government of Western Australia (DoW). This database includes information on infrastructure that disrupts longitudinal stream connectivity completely (e.g. dams, weirs) or partially (e.g. culverts, bridges, fords, floodgates, levees, etc.) (Norton and Storer 2011). The DoW uses an automated process to assign a potential level of impact on fish movement for each listed barrier according to its structural characteristics and various criteria of the river in which it is located (e.g. major vs minor river, perennial vs ephemeral system). This process produces an impact code for each barrier that ranges from 1 (nil priority) to 6 (very high

priority). However, much of the information used to assign these scores has not been validated in the field (Norton and Storer 2011).

All potential fish barriers in the target area (i.e. major coastal drainage systems of northern Western Australia from the Ashburton River northwards which lie in the Pilbara Province, Kimberley Province and Northern Province (see Unmack 2013)) were initially mapped using the ArcGIS 10.2 software package (Esri, California, USA) and categorised by impact code. The total number of barriers was extremely large (n = 62,013); however, a visual assessment of the mapped data revealed that the vast majority of lower priority barriers (i.e. impact code ≤3) were located off the main channel of rivers and were thus unlikely to substantially inhibit sawfish migration. The majority of these data points were nil priority 'false positives'; an artefact of the automated process used by the DoW to generate the fish barrier database, whereby any point of intersection between a road/railway and a river (including a floodplain boundary) is designated as a potential barrier (Fig. 1; see also Norton and Storer 2011). The lower priority barriers also included other structures unlikely to impede sawfish migration, such as bridges (Norton and Storer 2011). Therefore, barriers with an impact code ≤3 were excluded from further assessment, as were any higher priority barriers (i.e. impact code >3) located in watersheds not known, either historically or anecdotally, to house sawfish (see Thorburn *et al*. 2004; Last and Stevens 2009; Morgan *et al.* 2011, 2012).

Geospatial and structural data on the remaining barriers were then closely scrutinised in conjunction with a visual assessment of aerial imagery from Google Maps (2014; Google, California, USA) and Landgate (Landgate, Western Australia, Australia) to eliminate any erroneous or duplicate data points (see for example Fig. 2) and identify all barriers likely to have a significant impact on *P. pristis* migration. A barrier was judged 'likely' if it met the following criteria: 1) located on the main channel of a known or probable sawfish migration route; and 2) with a head loss >0.2m during periods of flow, when sawfish are known to migrate in rivers.

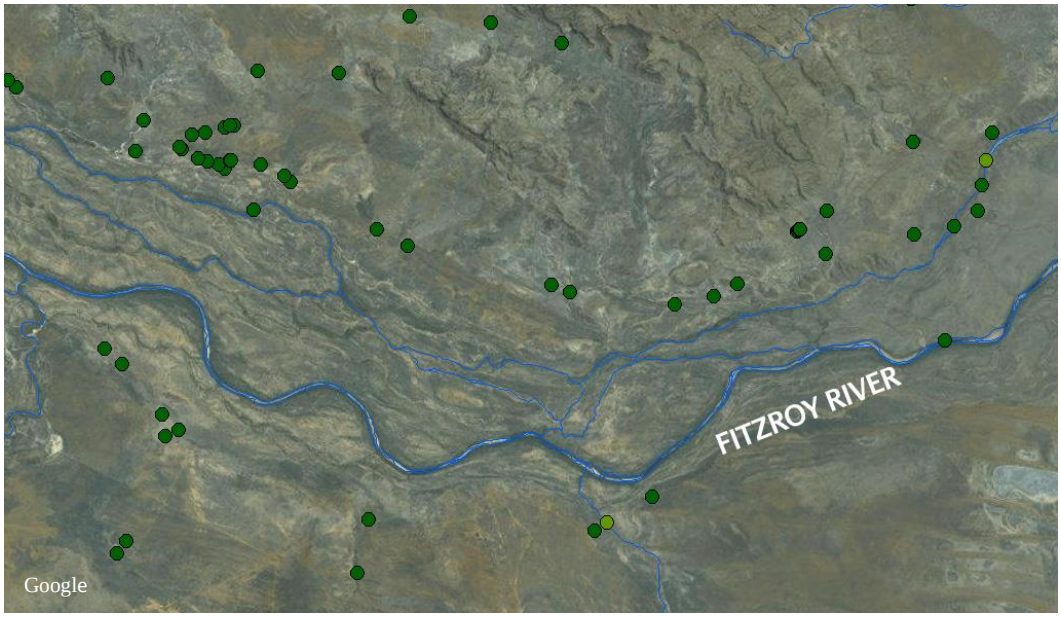

Figure 1. An example of the many nil priority 'false positive' barriers (green dots) in the DoW database. These data points are generated automatically wherever a road/railway intersects a stream, floodplain boundary, or area of inundation. These barriers are unlikely to impact *Pristis pristis* migration.

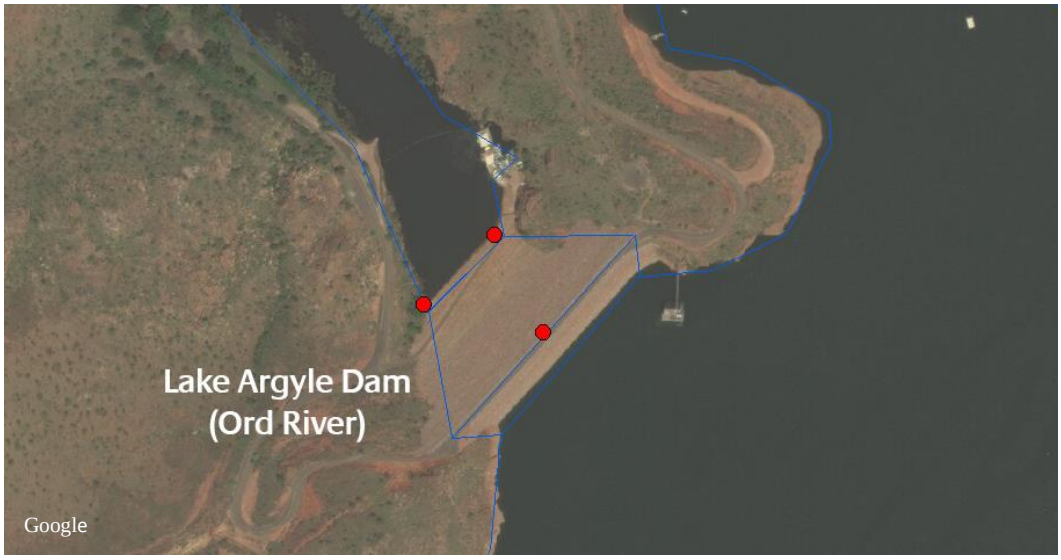

Figure 2. An example of data point duplication (red dots); another artefact of the automated process used to populate the DoW database of potential fish barriers.

Monitoring of sawfish

Sampling of rivers with high impact barriers (i.e. the Fitzroy and Ashburton Rivers) was conducted in August and October 2013, and April 2014. Sampling efforts in 2013, consisted of over 160 h of 20 m gill net sets (152 mm stretched mesh) within the Fitzroy River, specifically in Telegraph (13 rkm), Lower Myroodah Crossing (126 rkm; name given by authors), Camballin (160 rkm; name given by authors), Lower Barrage (164 rkm; name given by authors) and Upper Barrage (165 rkm; name given by authors) Pools, between 18 August and 29 October (Fig. 3). Additional effort including hook and line methods were opportunistically employed during gill net sampling.

Sampling in 2014, consisted of over 20 h of 20 m gill net sets (152 mm stretched mesh) in the Ashburton River Mouth (0 rkm) and the Lower Ashburton Pool (16.5 rkm; name provided by the authors) (Fig. 4). The Lower Ashburton Pool is the first pool upstream of the lower road crossing and small weir on the Ashburton River (11.5 rkm) (Fig. 4). Additional effort including hook and line methods were opportunistically employed during gill net sampling.

Captured sawfish were moved to the river banks and inverted onto their dorsal surface to induce tonic immobility. Slight pressure was applied to the caudal peduncle and base of the rostrum to further reduce movement by the sawfish. The majority of the sawfish, including the spiracles, mouth and gills remained submerged during handling to allow for continued respiration. Morphometric measurements, including stretched total length (TL), sex, stage of maturity and presence of scars (yolk-sac and predation) and fishing hooks were also noted. An individually numbered Rototag (Dalton Supplies, New South Wales, Australia) was externally attached to the rear dorsal fin of each sawfish using similar methods to those described by Heupel *et al.* (1998) and Whitty *et al.* (2009). Vemco V13-TP acoustic tags (VEMCO Division, AMIRIX Systems, Inc., Halifax, Nova Scotia, Canada) were also externally fitted to sawfish. Acoustic tags were secured to Rototags via cable ties and black marine-grade silicone. Modified Rototags were attached externally to the first dorsal fin of captured sawfish.

In 2013, three Vemco VR2W acoustic receivers were added to the Fitzroy River acoustic array (Figs 3, 5). These receivers were deployed in two pools (i.e. Upper Myroodah Crossing and Upper Barrage Pool) located directly upstream of two high impact barriers (i.e. the Myroodah Crossing and Camballin Barrage) to monitor timing of fish movement up and

downstream of these barriers (Fig. 3) during the wet season. This data is to be downloaded in July 2014 and is thus not presented here.

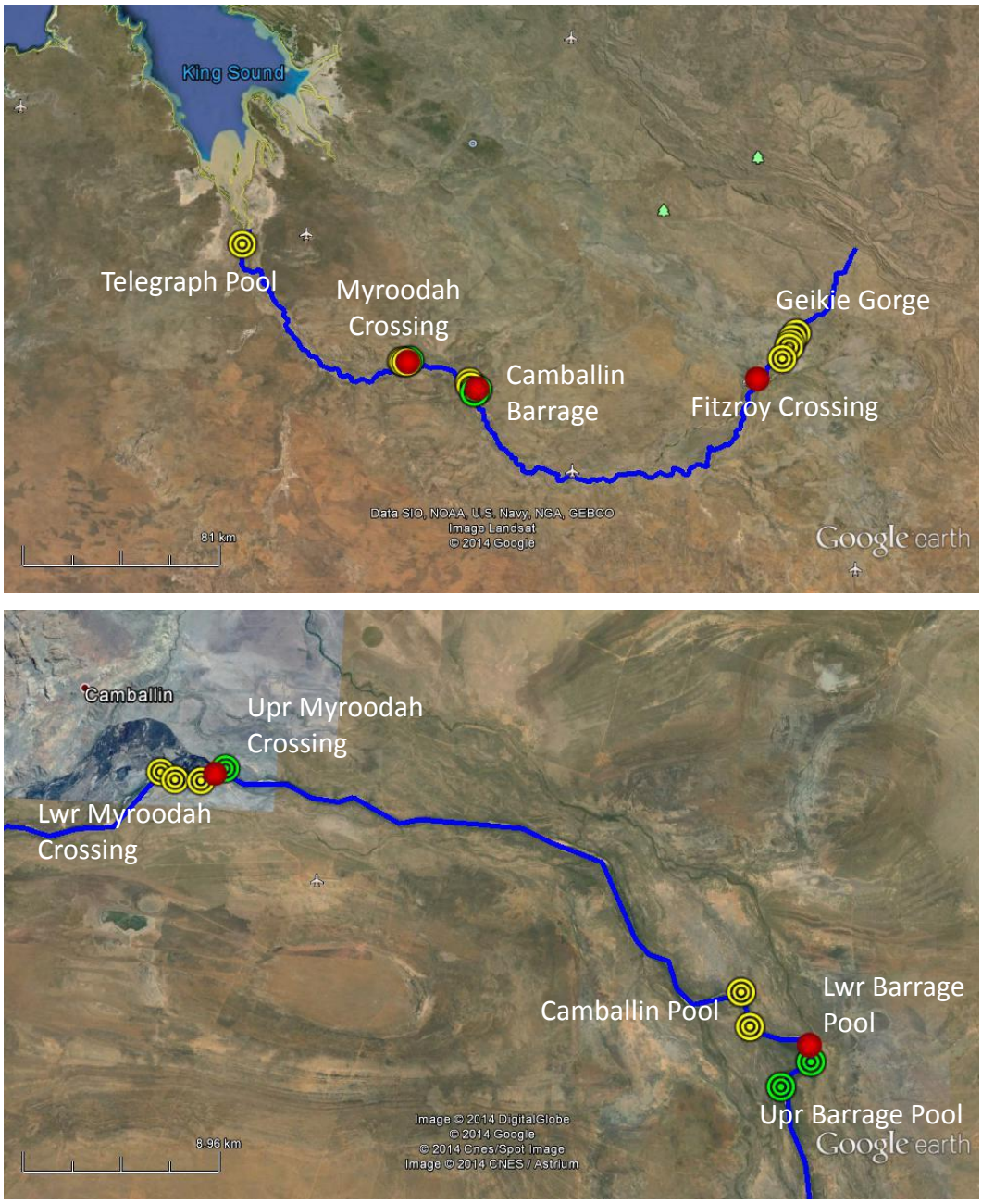

Figure 3. (top) Mainstem (blue line) of the Fitzroy River, Western Australia showing acoustic receiver (concentric circles) and barrier (red dots) locations, and (bottom) magnified view of locations within the Camballin region. Green concentric circles indicate locations of receivers added in 2013, and yellow circles indicate locations of previously installed receivers.

Figure 4. April 2014 survey sites (yellow dots) and high impact barriers (red dot) in the Ashburton River, Western Australia.

Figure 5. Nyikina-Mangala Rangers deploying a new VR2W receiver in the Upper Barrage Pool, Fitzroy River.

RESULTS AND DISCUSSION

Barrier assessment and prioritisation

A total of 62,013 potential fish barriers in the Pilbara and Kimberley regions of Western Australia were identified in the DoW database and assessed in this desktop review. The vast majority of data points were categorised as low to nil priority barriers (i.e. impact code ≤3). Less than 2% were categorised as medium, high or very high priority (i.e. impact code >3). Of this 2%, only six were considered likely to have a significant impact on the migration of *P. pristis* (Table 1; Fig. 6).

The application of a rigorous score and rank prioritisation method (see for example Beatty *et al.* 2013) was considered; however, such a process would be constrained by the patchiness of the available distribution and abundance data on sawfish across the three river systems. Whilst there are extensive datasets available from the Fitzroy River, the same is not true for the Ashburton and the Ord Rivers. We recommend that targeted sampling in both of these systems be conducted over the next 12 months to redress this imbalance, thus improving the rigour of the data underpinning the prioritisation of barriers for remediation. A summary and short discussion of the shortlisted barriers follows.

Table 1. Details of shortlisted barriers in the Pilbara and Kimberley regions of Western Australia located in catchments housing *Pristis pristis*.
(FID, site identification number)

FID	Catchment	Lat.	Long.	Site name	Barrier type
61639	Ashburton	-21.7568	114.949	Lower Ashburton Crossing and Weir	Causeway and weir
61890	Fitzroy	-18.1867	124.492	Camballin Barrage	Minor Dam (3 m crest)
61951	Fitzroy	-18.0798	124.223	Myroodah Crossing	Causeway
59004	Ord	-15.6895	128.689	Ivanhoe Crossing	Causeway
61894	Ord	-15.7917	128.696	Lake Kununurra Diversion Dam	Major Dam (20 m crest)
61892	Ord	-16.1218	128.739	Lake Argyle Dam	Major Dam (68 m crest)

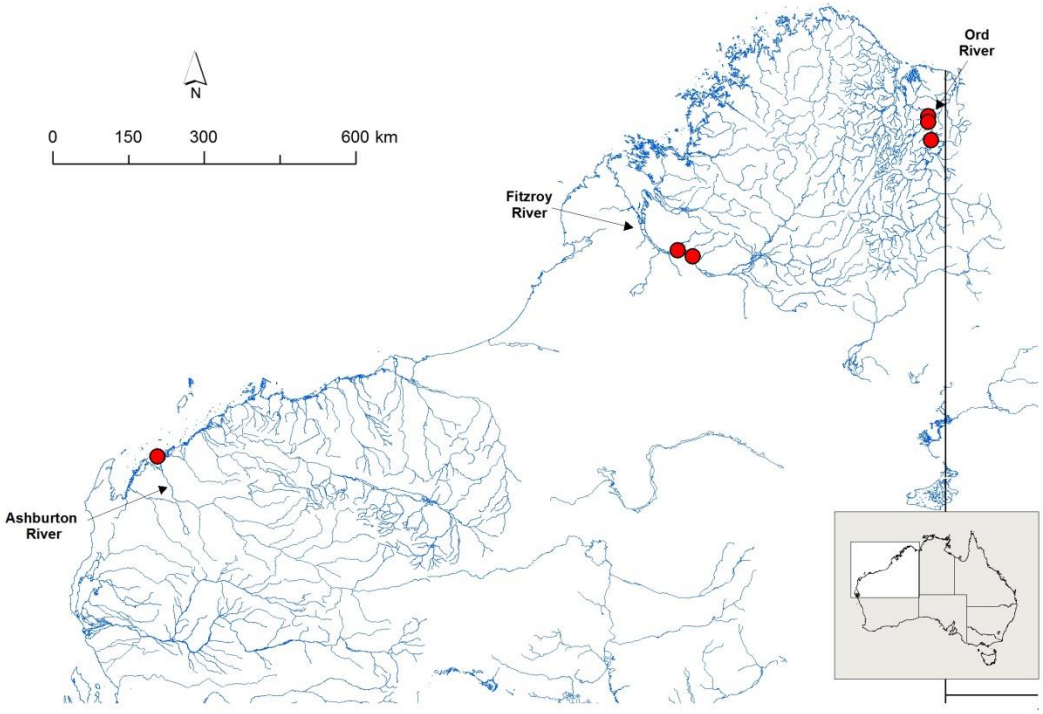

Figure 6. Location of shortlisted barriers in the Pilbara and Kimberley regions of Western Australia.

Lower Ashburton River Crossing and Weir (Fig. 7)

This site contains two concrete barriers located within a 200 m section of the lower Ashburton River (12 rkm; Fig. 7). Whilst these barriers are relatively minor (i.e. crest height < 3m), the stochastic flow regime of the Ashburton River and the close proximity of the barriers to the river mouth renders them a potentially large impediment to sawfish migration. Previous surveys of the lower Ashburton River in 2011, observed two maturing *P. pristis* (both of which were tagged with acoustic transmitters) during the late wet season (i.e. April). However, this species was not captured from the system during the late dry season (i.e. October) (Morgan *et al.* 2012) or during a more recent survey in April 2014.

Although no *P. pristis* have been captured in the Ashburton since April 2011, telemetry data obtained from the two *P. pristis* tagged in 2011, revealed that juvenile *P. pristis* do utilise the monitored area within the lower section of the Ashburton River throughout the majority of the year (i.e. at least April to January) (see Figs 8 and 9). No detections of these tagged *P. pristis* were recorded by receivers in neighbouring tidal creeks. This indicates that the

Ashburton River offers a preferable habitat to *P. pristis* in this region. Nonetheless, it still remains unclear whether the Ashburton River is utilised by this species as a nursery, as no small juveniles have been recorded from the system. Further survey effort of the permanent refuge habitats in the Ashburton catchment is recommended to determine if this area is a nursery for this species and thus whether or not mitigation of these barriers would benefit sawfish.

Figure 7. Two barriers across the lower Ashburton River

Figure 8. Locations of a 2830 mm male *Pristis pristis* in the Ashburton River between April 2011 and January 2012.

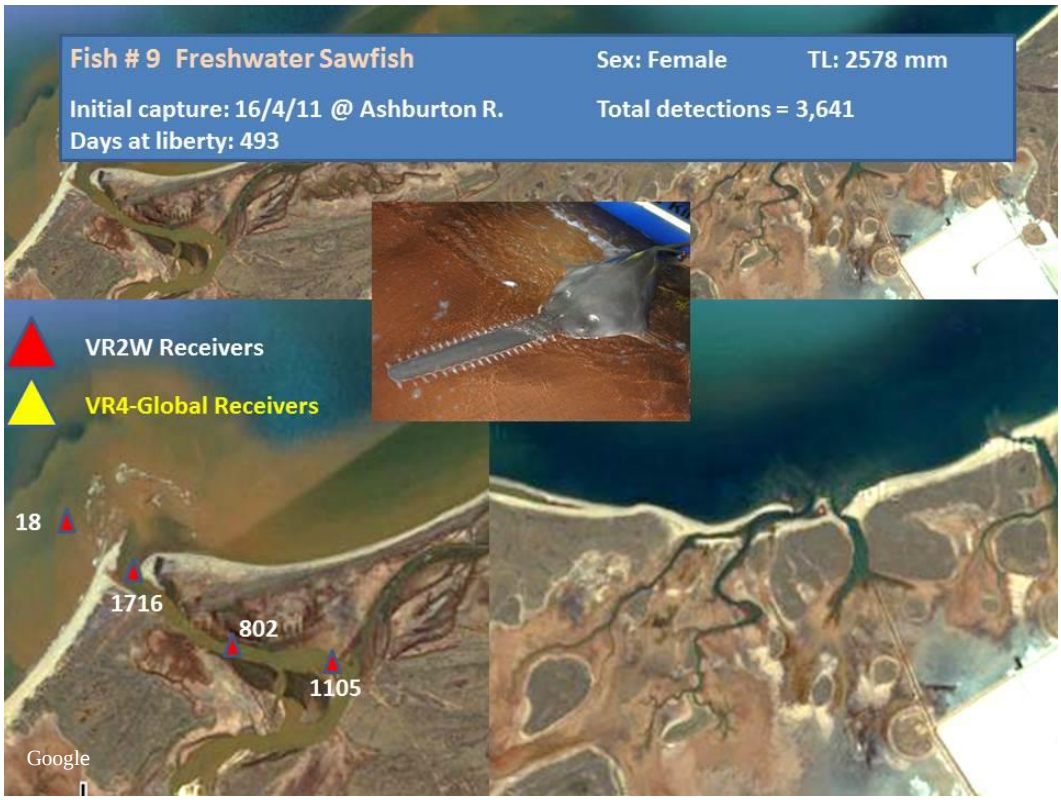

Figure 9. Locations of a 2578 mm female *Pristis pristis* in the Ashburton River between April and June 2011.

Myroodah Crossing, Fitzroy River (Fig. 10)

Myroodah Crossing is a concrete causeway, located at 128 rkm, which has similar structural characteristics as the Ashburton River causeway (e.g. a relatively minor crest height of <3 m). *Pristis pristis* have frequently been captured immediately downstream of this barrier during regular sawfish surveys over the past 12 years. Myroodah Crossing is an effective barrier, mostly to upstream fish migration (due to the greater head loss on the downstream side of the causeway), as flows subside during the annual dry season. Installation of a fishway, or modification of the causeway to include a bridge or large box culvert would allow sawfish to bypass this barrier during the shoulder flow period in the late wet/early dry season each year, opening up access to an additional 36 km of the river (i.e. up to the Camballin Barrage).

Figure 10. Myroodah Crossing, a concrete causeway across the main channel of the Fitzroy River, Western Australia.

Camballin Barrage, Fitzroy River (Fig. 11)

The Camballin Barrage is a small (crest height 2.6 m) concrete dam across the Fitzroy River main channel located at 164 rkm, about 36 km upstream of Myroodah Crossing. The dam was installed in the 1950s as part of a now defunct irrigation scheme. Currently it is leased to the Liveringa Pastoral Company, and is used to divert water through Uralla Creek (or Snake Creek), a constructed off-take channel, for the purpose of growing feed for livestock. Morgan *et al.* (2005) discussed the impacts of the barrage on fish and suggested it to be an effective barrier for at least nine months of the year to migratory species such as sawfish, barramundi and cherabin. Fish sampling over the past decade below the barrage has shown sawfish to regularly occupy the pool immediately downstream and 2.5 km downstream (i.e. Camballin Pool) of this barrier. The highest abundances of *P. pristis* in Western Australia have been recorded in Camballin Pool.

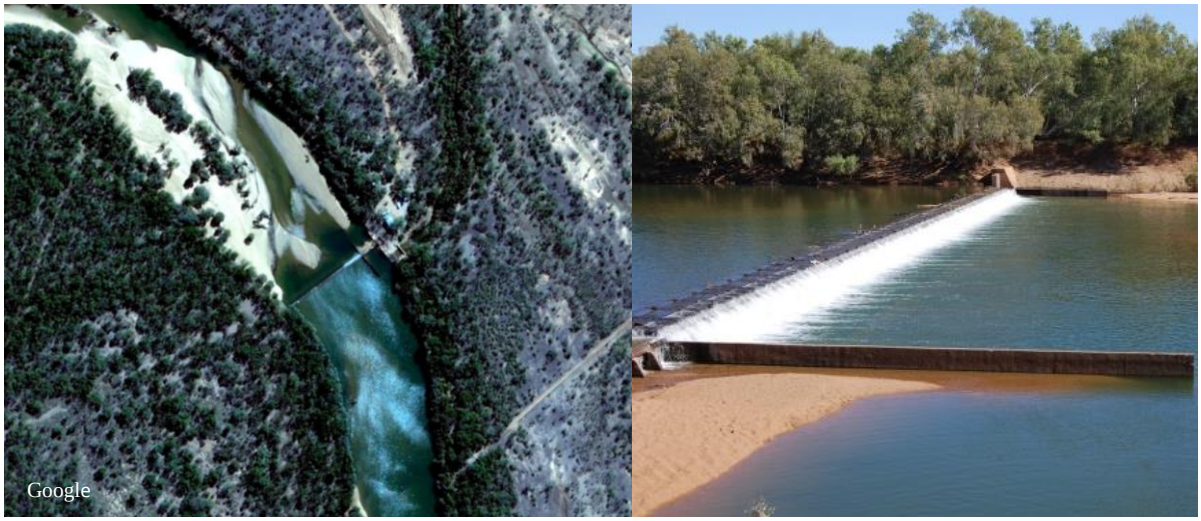

Figure 11. Camballin Barrage, a 3 m high concrete dam across the main channel of the Fitzroy River, Western Australia.

Ivanhoe Crossing, Ord River (Fig. 12)

The Ivanhoe Crossing is a small relief concrete causeway located approximately at 130 rkm. This barrier is likely to be passable during times of high flows, but would be a barrier to sawfish in the late wet and dry seasons. This causeway was constructed with numerous pipe culverts along its length that may allow smaller fish to bypass the barrier. However, the small diameter of the pipe culverts is likely to prevent large-bodied sawfish from doing the same. Modification of the causeway to include a bridge or large box culvert section may provide sawfish with an extended temporal window to move beyond this barrier during the shoulder flow period (i.e. late wet/early dry) each year.

Figure 12. Ivanhoe Crossing, a concrete causeway across the main channel of the lower Ord River, Western Australia.

Lake Kununurra Diversion Dam, Ord River (Fig. 13)

The Lake Kununurra Diversion Dam is a major dam (crest height 20 m) across the Ord River, near the town of Kununurra. The dam was completed in 1963 as part of the Ord River Irrigation Scheme. Construction of this dam and the upstream Lake Argyle Dam has resulted in decreased wet season flooding, increased siltation, reduced water depth, and a hydrological regime shift from intermittent to permanent flow (Wolanski *et al.* 2001). The impoundment formed upstream of the dam not only provides irrigation water for horticulture/agriculture, but is also utilised recreationally for boating and fishing and is an important tourist drawcard. The impoundment supports a diverse array of wildlife including over 20 freshwater fish species and is a Ramsar listed wetland of global significance for migratory bird species.

Pristis pristis has been observed in the Ord River (discussed by Thorburn *et al.* 2004; Last and Stevens 2009). Anecdotal information from fishers also suggests *P. pristis* has been captured in Lake Argyle and Emu Creek (a tributary of Lake Argyle) (Thorburn *et al.* 2004). However, this is likely to be a rare event as research surveys have not recorded this species above the Lake Kununurra Dam (Thorburn *et al.* 2004; Gill *et al.* 2006) and reports from fishers of sawfish from this area are infrequent. Similar to the Ivanhoe Crossing, the benefit of providing sawfish access to habitats above this barrier may be limited without the installation of a fishway or other mitigation plan at the much larger Lake Argyle dam located 50+ km further upstream. There have been a number of studies that have investigated the benefits of a fishway at Lake Kununurra (e.g. Doupé *et al.* 2005).

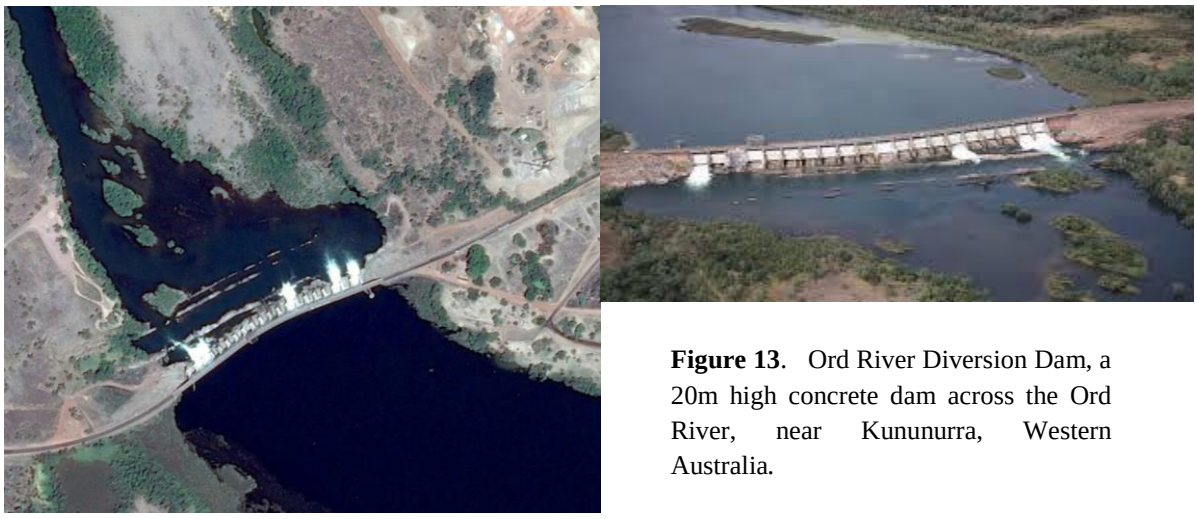

Figure 13. Ord River Diversion Dam, a 20m high concrete dam across the Ord River, near Kununurra, Western Australia.

Lake Argyle Dam, Ord River (Fig. 14)

Currently this dam is unlikely to be a major barrier to sawfish migration due to the combined impediment to migration of the two downstream barriers (i.e. Ivanhoe Crossing, Lake Kununurra Diversion Dam). However, if any decisions are taken in the future to mitigate the impacts of the downstream barriers, Lake Argyle would undoubtedly become a significant impediment to sawfish movement.

Providing a fish passage facility for sawfish over this 68 m high rockfill dam looms as a major logistical challenge; however, a potential pathway for sawfish to bypass the Lake Argyle Dam already exists in the form of Spillway Creek (Fig. 14). This narrow channel drains from the northernmost extension of the impoundment (north-northeast of the dam wall) and stretches *ca* 15 km before re-connecting with the Ord River main channel downstream of the dam. Some modifications (e.g. channel widening/dredging of the bypass creek and flow supplementation via pumping from the reservoir) would likely be required in order to attract migrating sawfish towards the bypass and to allow them to traverse the bypass channel into the impoundment. Anecdotal evidence discussed in Thorburn *et al.* (2004) suggests that *P. pristis* have been captured in Spillway Creek. However, it is unclear as to the frequency that *P. pristis* use this anabranch.

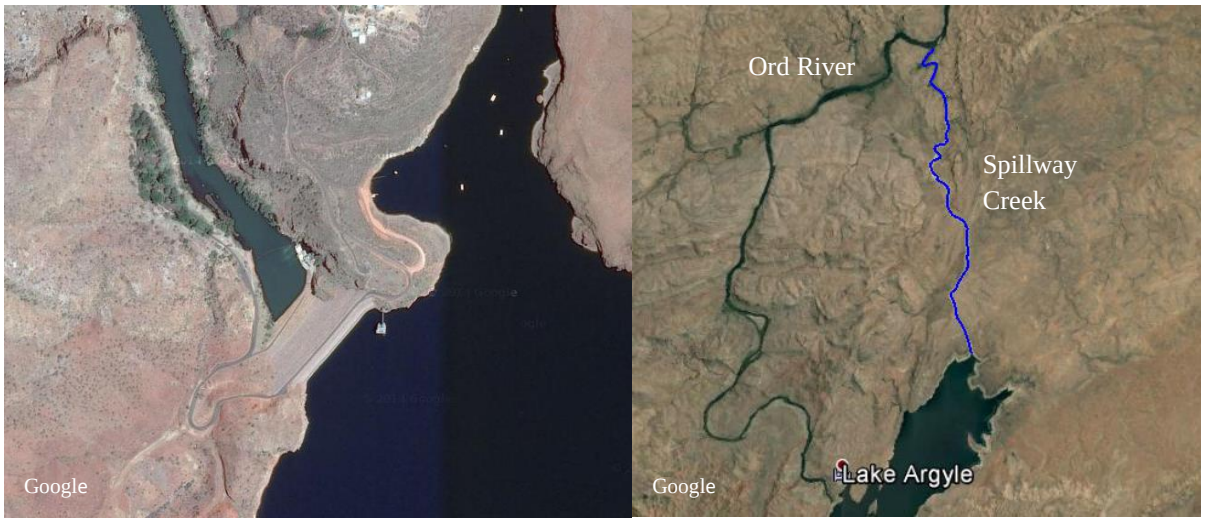

Figure 14. (left) Lake Argyle Dam on the main channel and (right) the potential bypass (Spillway Creek) of the Lake Argyle Dam on the Ord River, Western Australia.

Monitoring of sawfish

Twelve juvenile *P. pristis* were captured during the 2013 Fitzroy River sampling efforts (Table 2). An additional *P. pristis* was recaptured and reported by a recreational fisher in June 2013 (originally tagged in June 2011). All sawfish ranged in size between 1701 and 2510 mm TL (males: 1701 to 2510 mm TL; females: 2063 to 2345 mm TL). Captured *P. pristis* were estimated to be between 1+ and 3+ years of age (following Thorburn *et al.* 2007; Peverell 2008), with the majority belonging to the 2011 year class (2+ years of age). In 2011, nearly 200 members of this year class were estimated to have occupied the Camballin Pool after their upstream movements were blocked by the Camballin Barrage (Morgan *et al.* unpublished data). This may suggest that the 2011 year class had a higher recruitment of individuals into the river and/or higher rate of survival in comparison to more recent year classes. The lack of captured young of the year (YOY) is likely due to the lower than average discharge during the wet season of 2012-2013 (Fig. 15), as the catch per unit effort (CPUE) of YOY in the sampled freshwater pools is positively correlated with river discharge (Whitty 2011).

Ten of the 12 newly captured *P. pristis* were externally fitted with Vemco V13-TP acoustic transmitters (Table 2). Five of these 10 were captured and released in Camballin Pool, which is the nearest large (i.e. >1 km in length) pool located downstream of the Camballin Barrage. Additionally, one of the acoustically tagged *P. pristis* was captured and released in Lower Myroodah Crossing Pool. Future logged telemetry data for the tagged sawfish in these locations should provide evidence of the directionality of the movements undertaken by each size class during the wet season, and the timing of such movements in relation to flow. This information will provide the evidence needed to better understand when and how barriers impact sawfish movements.

Sampling efforts in the Ashburton River system in April 2014 were constrained by a storm event that disrupted accessibility to sites. No sawfish were captured in the Ashburton River during this period. This may have been an artefact of the level of sampling that occurred and may not necessarily reflect the true abundance of sawfish within the river at that time.

Whilst the road crossing and weir in the lower Ashburton River generally form an effective barrier to upstream migration of fishes, this area was inundated by tidal waters just prior to the commencement of sampling in April 2014 (Fig. 16). Further investigations are required to

determine if the extent of this tidal inundation allows sawfish to bypass these barriers and what temporal window exists during high flow events in which sawfish have the ability to pass over these barriers.

Table 2. Catch data of *Pristis pristis* captured in the Fitzroy River in 2013.

Date	Location	Rototag #	Acoustic Tag ID #	Sex	TL
3-Jun-13	Telegraph	M1118 R*	-	F	-
18-Aug-13	Camballin Pool	M332	9734	M	1885
18-Aug-13	Camballin Pool	PMMN0813	9732	F	2280
20-Aug-13	Camballin Pool	M418	9746	F	2063
20-Aug-13	Myroodah Crossing	M432	9752	F	2310
21-Aug-13	Telegraph Pool	M318	9726	F	2345
22-Aug-13	Telegraph Pool	M294	9736	F	2247
22-Aug-13	Telegraph Pool	M423	9748	M	1925
22-Aug-13	Telegraph Pool	M433	9750	M	2093
22-Aug-13	Telegraph Pool	M322	-	M	1701
22-Aug-13	Telegraph Pool	M365	-	F	2190
30-Oct-13	Camballin Pool	M366	9740	M	2510
30-Oct-13	Camballin Pool	M1101	9742	M	1780

*** Recapture**

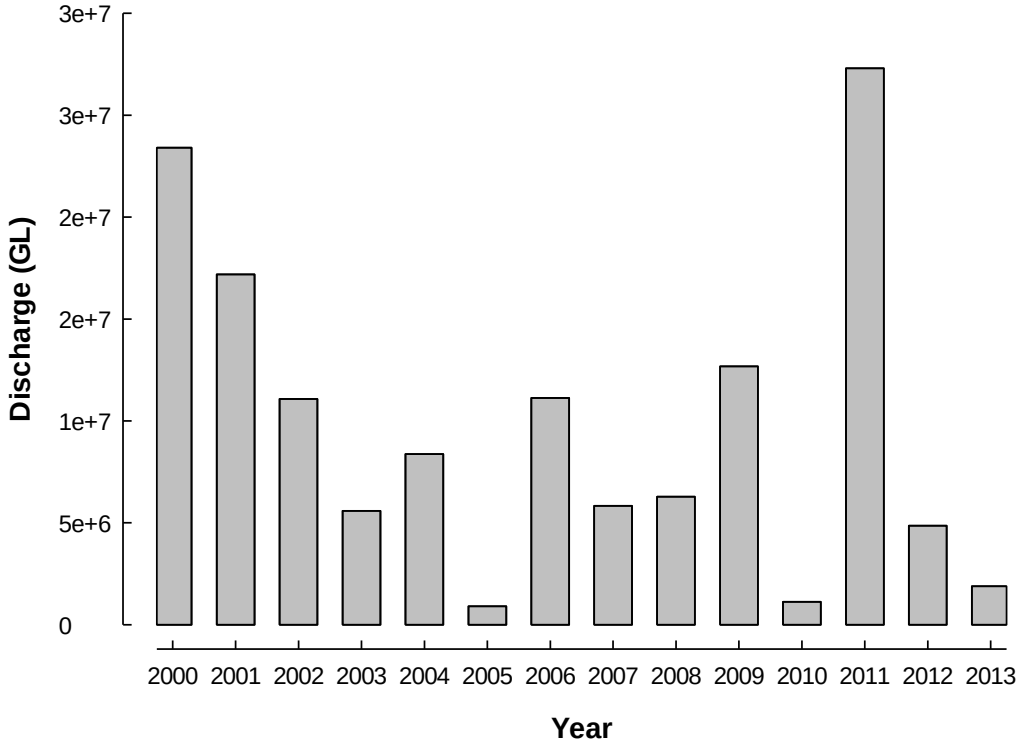

Figure 15. Total wet season (December to May) discharge (GL) for each year in the Fitzroy River.

Figure 16. The Ashburton Crossing (a) after high tide and (b) during a high flow even in April 2011.

CONCLUSION

This study found six barriers in Western Australia that are likely to substantially impact juvenile *P. pristis* in Western Australia, and warrant further investigation. Results from the desktop study suggest that sawfish would only be able to bypass these barriers when the structures or surrounding areas are drowned out during periods of peak flow (i.e. the wet season). Installation of sawfish-appropriate fishways could benefit *P. pristis* (as well as other migratory aquatic species) by facilitating access to refuge habitats upstream of the listed barriers over a longer temporal window each season. Simple culverts may be of use to further the access of sawfish beyond small head loss barriers such as the various causeways identified in this study. However, larger barriers such as the two dams on the Ord River would require much more elaborate structures and/or alterations to surrounding landscapes.

The planned aerial surveying of instream barriers has been delayed given the paucity of significant barriers to sawfish migration in the target area, and the availability of high quality aerial imagery. We propose to use the budget allocated for aerial surveying towards visiting shortlisted barrier sites, including those that were deemed unlikely to have an impact on juvenile sawfish migration. The surveying of these barriers will allow us to ground truth these assessments to better inform the barrier mitigation prioritisation process.

This project aims to proceed with investigating the occurrence, movements and habitat use of juvenile *P. pristis* in the Fitzroy and Ashburton Rivers and to also sample the Ord River for sawfish. As the tagging of sawfish for this project was commenced in late 2013, no data is

available to comment on the movements of sawfish and/or to assess the impact of barriers or their habitat use at this time. However, the infrastructure for the monitoring of their movements is in place in the Fitzroy River and is ready for deployment in the Ashburton River, and further work will allow for such analyses and comments within the next year.

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