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St Lawrence Wetland Fish Passage Improvement

St Lawrence

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Queensland Government
Department of **Primary Industries and Fisheries**

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Introduction

St Lawrence Wetland

Located on the Central Queensland coast, the St Lawrence wetland is a moderate size wetland system that drains part of the lower portion of the St Lawrence Catchment (Figure 1). In the upper reaches the wetland encompasses several permanent waterholes on the floodplain and in the lower portions an expansive marsh.

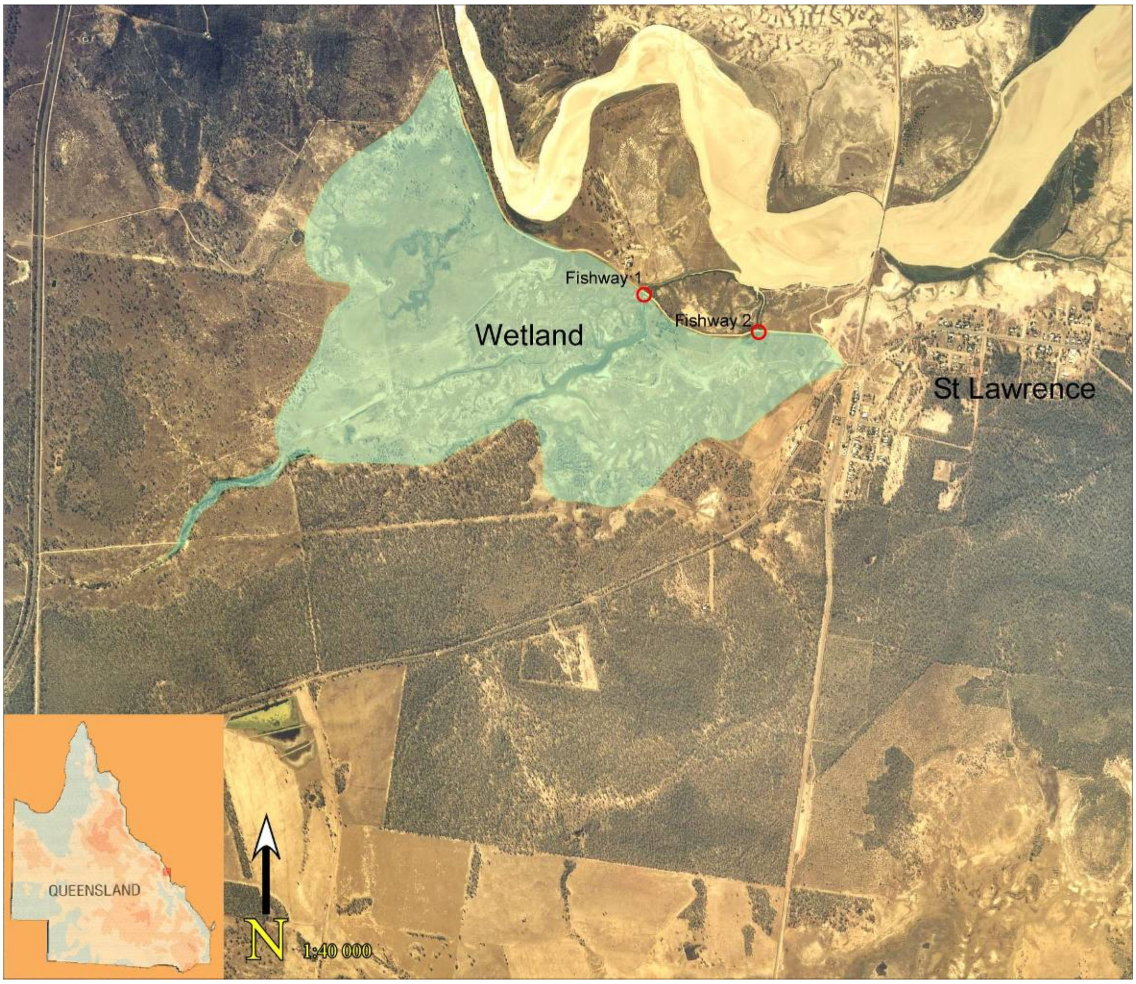

Figure 1. Aerial photo of St Lawrence displaying location of wetland and fishways in relation to the township and estuary.

Emergent vegetation and aquatic macrophytes dominate the wetland with riparian vegetation consisting primarily of pandanus, palms, *melaleuca* spp. and eucalyptus trees in the upper portions and native and introduced grasses surrounding the marsh.

The St Lawrence wetland supports a wide variety of wildlife including insects, amphibians, reptiles, birds and fish. The system features a vast array of habitats that support numerous fish communities and valuable nursery grounds for a number of catadromous species, including commercially and recreationally important species such as barramundi.

Prior to construction of the St Lawrence northern access road, the surrounding marsh area was once smaller. The access road effectively created a bund wall cutting the wetland off from St Lawrence creek and backing water up over the surrounding mangroves and salt pans. To permit fish passage beyond the road barrier into the expanded wetland, the construction of two fishways was required.

Connectivity of the wetland system with the estuarine reaches of St Lawrence Creek is seasonal, via several pre-existing waterways downstream of the road. During the dry season (April-November), waters contract and connecting creeks often cease to flow, leading to the isolation of the wetlands and waterholes from one another and the estuarine system. In periods of high rainfall, the wetland expands across the floodplain, spilling over the road into the fishways permitting fish passage between the systems.

St Lawrence Wetland Fishways

Two partial width rock ramp fishways were constructed at the St Lawrence Wetland (Fishway 1 and Fishway 2 (Figure 1)). Rock ramp fishways are a common design in Australia as they permit passage of a wide range of species and size classes and are relatively cheap to build in comparison to the more highly engineered vertical slot and lock fishways. They are constructed on barriers up to 2m high and consist of a series of rock ridges within the waterway channel to create a succession of pools and falls that fish are able to negotiate.

Rock ramp fishways are built in a number of forms, either partial or full-width and with high or low ridge rocks. Partial width and full-width designs are built depending on the morphology of the channel, with partial-width designs dominating in wide streams as they are both passage efficient and cost-effective. In Australia, high ridge rocks are more common (ridge rocks stand more upright) as it allows the rock ramp to withstand a greater range of flows.

Fishway 1 consists of a 13 ridge, four metre wide switchback construction chosen to fit between the road and existing mangroves, and fishway 2 consists of a 17 ridge, four metre wide switchback construction. The ridges in both fishways are designed to create small 100mm falls between pools with the topmost ridge acting as a control point to back up 100mm of water over the road. To funnel water exiting the wetland toward the rock ramps, small concrete walls were installed parallel to the roadway.

The construction of the fishways took 10 days to complete, with an excavator used for the entire period (figures 2 and 4). Materials used included:

- 200m^3 of 1000mm diameter rock
- 50m^3 of 600mm rock
- 50m of 4 metre wide 900R geofabric
- 11.2m^3 of 20mm aggregate concrete
- 11.2m^3 of 10mm aggregate concrete

Some difficulties were encountered during the construction of these fishways, including extended construction time due to excavator site access and the location of the rock (excavator had to travel back and forth some distance), increased costs owing to the large quantity of concrete required to seal the fishways (due to rock and concrete nature of the base material), and lack of available clay material to form the slope. Some of the other difficulties associated with construction were overcome with the assistance of Broadsound Shire Council (provision of fill material and manpower) and QR (provision of extra rock).

There are a number of references from Australia and overseas that outline the design construction and monitoring of rock ramp fishways. These include Clay 1995, Thorncraft and Harris 1996, Harris et. al. 1996, Thorncraft and Marsden 2000, Thorncraft and Harris 2000, McGill and Marsden 2001, Baumgartner and Lay 2002, Zampatti et. al. 2003 and Marsden et. al. 2003 and 2003a.

Figure 2. Construction of St Lawrence Fishway 1

Figure 3. St Lawrence Fishway 1 during flow event, February 2008.

Figure 4. St Lawrence Fishway 1 during flow event, February 2008.

Figure 5. St Lawrence Fishway 2 during flow event, February 2008.

Methods

Fish Community sampling

Wetland Sampling

Electrofishing was conducted using a Smith-Root 2.55 GPP electrofisher unit mounted on the 3.7 m aluminium vessel (Hypnos II) with two boom arms with 4 dropper anode arrays and hull cathode. Current varied from 10 to 15 amps at 170 to 500 volts. A single dip-netter was employed during all sampling activities on Hypnos II.

The survey consisted of three separate rounds of electrofishing within the wetlands above the fishways. Round 1 was conducted in September 2007 prior to construction of the fishways, round 2 in Februrary 2008 during wet season flows and fishway operation, and round 3 was in May 2008 after flows had ceased. Electrofishing surveys apportioned a half day electrofishing for each round and was performed in shallow water to 5m depth, encompassing all habitat types for optimum catch results and species representation.

The elecrofishing sampling method used in the present study consisted of a maximum of six 300 second 'shots' at each of the four chosen sites. A 'shot' included two passes mid stream along a 50 m section of bank consisting of a multiple of 12 seconds power-on followed by 12 seconds power-off, as well as ten runs into the bank at 5 m intervals along the 50 m section. A run into the bank consisted of a total of 24 seconds power-on including 10 seconds motoring into the bank, hold for 4 seconds at the bank then 10 seconds reversing from the bank. In areas where a 50 m stretch of bank was not available a 'shot' consisted of multiples of power-on, power-off for a total of 300 seconds. These techniques allow the thorough sampling of an area whilst preventing fish herding effects of boat electrofishing.

Fishway Sampling

Fishway sampling was conducted over a 5 day period during February 2008 when the fishways were functioning during high flows (figures 3 and 5) to show how effectively fish were ascending. Sampling included setting fish traps both morning and night in the flow path at the exit (top) of each fishway. A barricade of sediment mesh was set up adjacent to each trap to direct any wayward fish back toward the traps.

To determine if any fish ascending the fishway were bypassing the trap, fishway 2 was additionally electrofished in the cells of the fishway and on the road between the top of the fishway and the trap. Here, a Smith-Root Model-12B-POW Backpack Electrofisher operating a 500-volt Pulsed-DC current and a standard pulse setting (1ms).

All fish captured during electrofishing and trap surveys were identified to species level, counted and measured to the nearest millimetre (fork length for forked-tailed species, total length for all other species) and released live into the area from where they were captured. When more than 50 individuals of a single species were captured in any single 'shot', randomised sub-samples of 50 fish were measured and the remainder counted. Fish observed as affected by the electric field and positively identified, but not captured, were recorded and have been included in any abundance analyses.

Results

Community Structure

The two different classes of freshwater fish found in the St Lawrence wetland were primarily potamodromous (agassiz's glassfish, fly-specked hardyhead, spangled perch, eastern rainbowfish, midgley's carp gudgeon, rendahl's catfish, marbled eel, purple-spotted gudgeon, western carp gudgeon and bony bream) and diadromous (empire gudgeon, barramundi, sea mullet).

A total of 235 individual fish representing eight species were captured during round 1 sampling (figure 6). Spangled perch was the most numerous fish captured with 79 individuals caught representing 34% of the total catch. Fly-specked hardyheads, empire gudgeons and agassiz's glassfish were the next most numerous species caught.

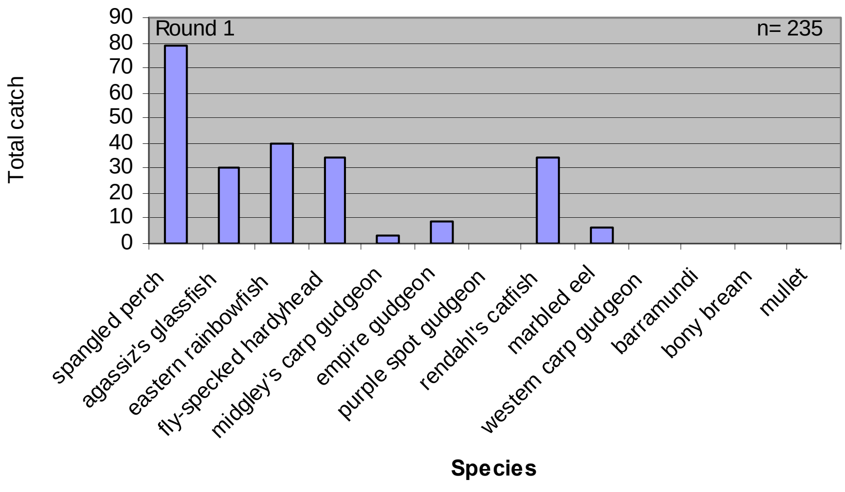

Figure 6. Round 1 total catch for each species identified from St Lawrence Wetland

During round 2, a total of 894 individual fish of eight species were captured in the wetland (figure 7). The most abundant species was fly-specked hardyheads, with 367 individuals (41% of catch) captured, followed by 227 empire gudgeons (25% of catch). No spangled perch or rendahl's catfish were captured in round 2; however, two new species were caught, western carp gudgeons and purple spot gudgeons.

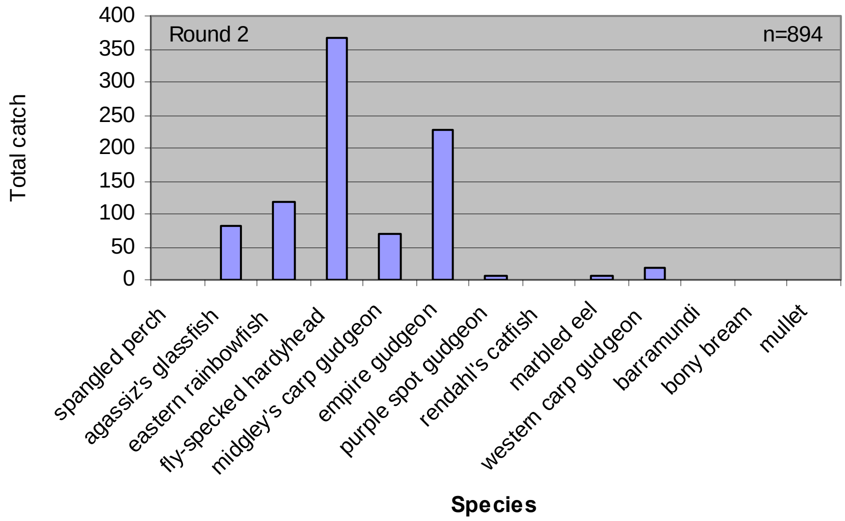

Figure 7. Round 2 total catch for each species identified from St Lawrence Wetland

Additionally during the wet season, sampling of the fishways captured 4751 individual fish of 12 species (figure 8). Agassiz's glassfish were the most abundant with 2228 individuals (47%) followed by fly-specked hardyheads and empire gudgeons. Fishway sampling also captured two diadromous species, barramundi and mullet.

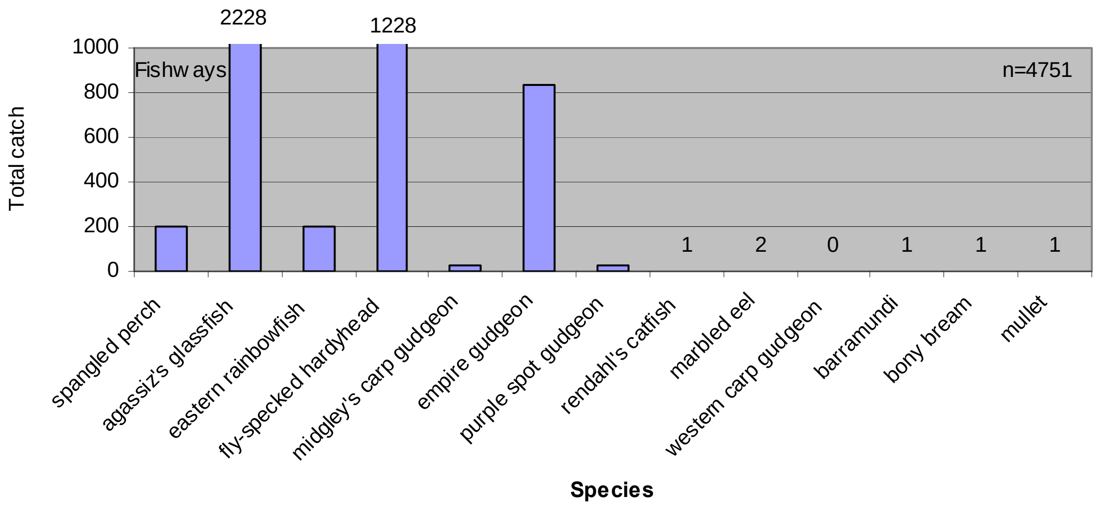

Figure 8. Fishways sampling total catch for each species identified from St Lawrence Wetland

Following the wet season, round 3 sampling captured nine species comprised of 1358 individual fish (figure 9). With 581 individuals captured (43% of catch), fly-specked hardyheads were the most numerous fish closely followed by 548 agassiz's glassfish (40% of catch).

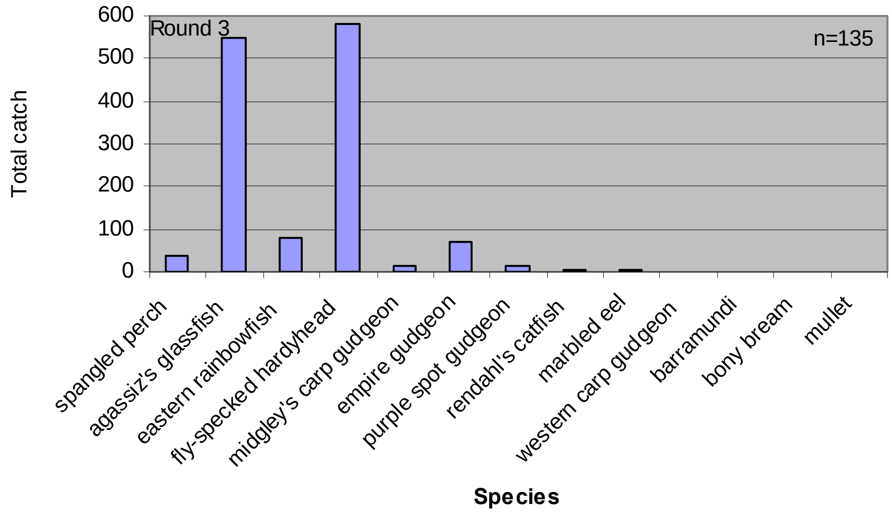

Figure 9. Fishways sampling total catch for each species identified from St Lawrence Wetland

Round Comparison

In total, 2487 individuals from 10 species were captured during the surveys of the St Lawrence wetland. Total catches varied displaying a progressive increase in species abundance from round 1 to round 3 with the majority of fish (55%) captured during round 3 sampling, 36% during round 2 and 9% in round 1 (figure 10). Catch rates for 8 of the 10 species increased in round 2 and/or round 3 season sampling (figure 4). Abundances of fly-specked hardyheads and agassiz's glassfish catch rates increased significantly during round 2 and 3 corresponding with the high abundances of these species captured during fishway sampling.

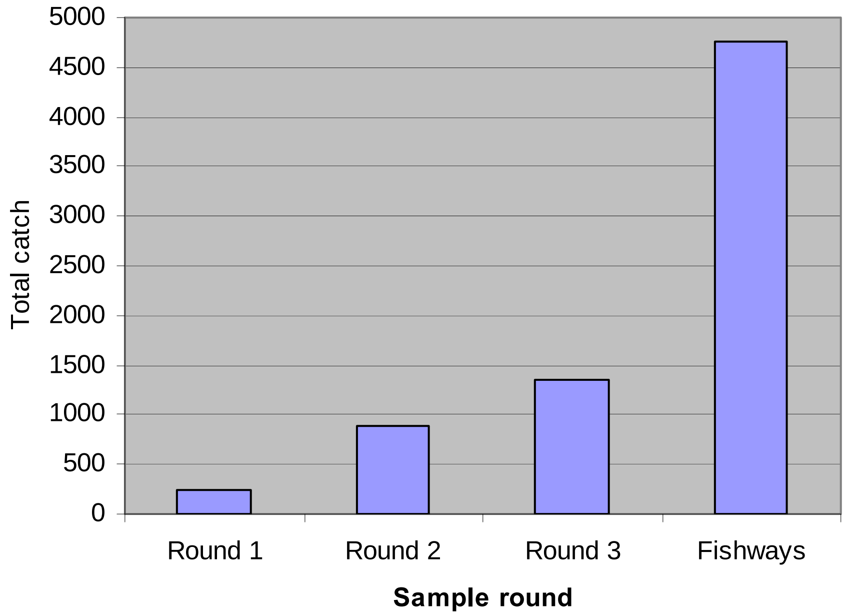

Figure 10. Total catches for each sample round at St Lawrence Wetland

Length frequency data was analysed for the six most abundant species sampled in the wetland and fishways, to compare the size range of fish before and after the installation of the fishways to determine if fish were successfully ascending. Analyses indicate that the fishway passed fish of all sizes from 10mm – 165mm contributing to increasingly wider size ranges across the species in the St Lawrence Wetland. Additionally, 12 species, including barramundi and mullet, were captured ascending the fishways indicating that they are also contributing to overall species diversity.

During round 1 sampling, agasssiz's glassfish size range was found to be between 24mm and 40mm, increasing to a range of 10-46mm in round 3 (figure 11). This increase in abundance throughout the size ranges corresponds with those captured in fishway sampling (10mm-70mm).

Fly-specked hardyhead size ranges during round 1 sampling were between 24mm and 68mm, broadening to 12mm-85mm in round 3 corresponding closely with the sizes ascending the fishways (figure 12).

Empire gudgeon sizes captured in round one ranged between 22-33mm while round three surveys found size ranges from 15mm – 98mm (figure 13). This corresponds with the size range of empire gudgeons caught on the fishways (18-95mm).

Round 1 size distribution for eastern rainbowfish was 30-65mm. Ascending through the fishways were rainbowfish ranging from 17mm through to 82mm contributing to an increased size range of 30-90mm in round 3 sampling (figure 14).

Midgleys carp gudgeon (figure 15) was not captured during round 1 sampling, but during round 2 individuals were found to be between the size ranges of 27-46mm. Round 3 size ranges were simililar to round 2, but with a greater abundance of smaller fish (22-43mm).

Size ranges of spangled perch in round 1 where between 62mm and 145mm. During round 2 sampling, no spangled perch were captured but fishway sampling revealed high abundances of juveniles ascending the fishways (figure 16). Round 3 sampling captured larger sized spangled perch (79-224mm).

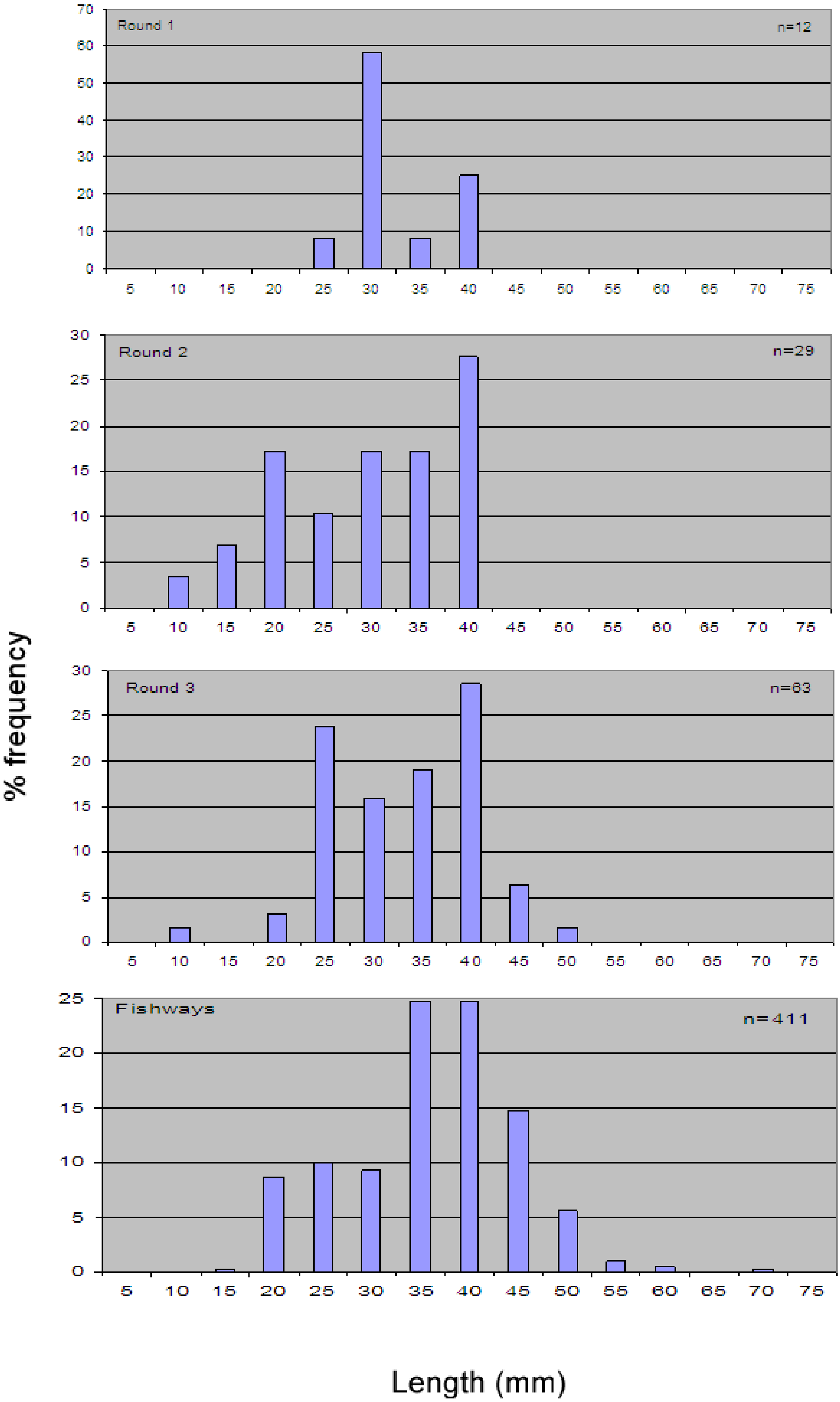

Figure 11. Agassiz's glassfish size distributions for sampling of St Lawrence Wetland.

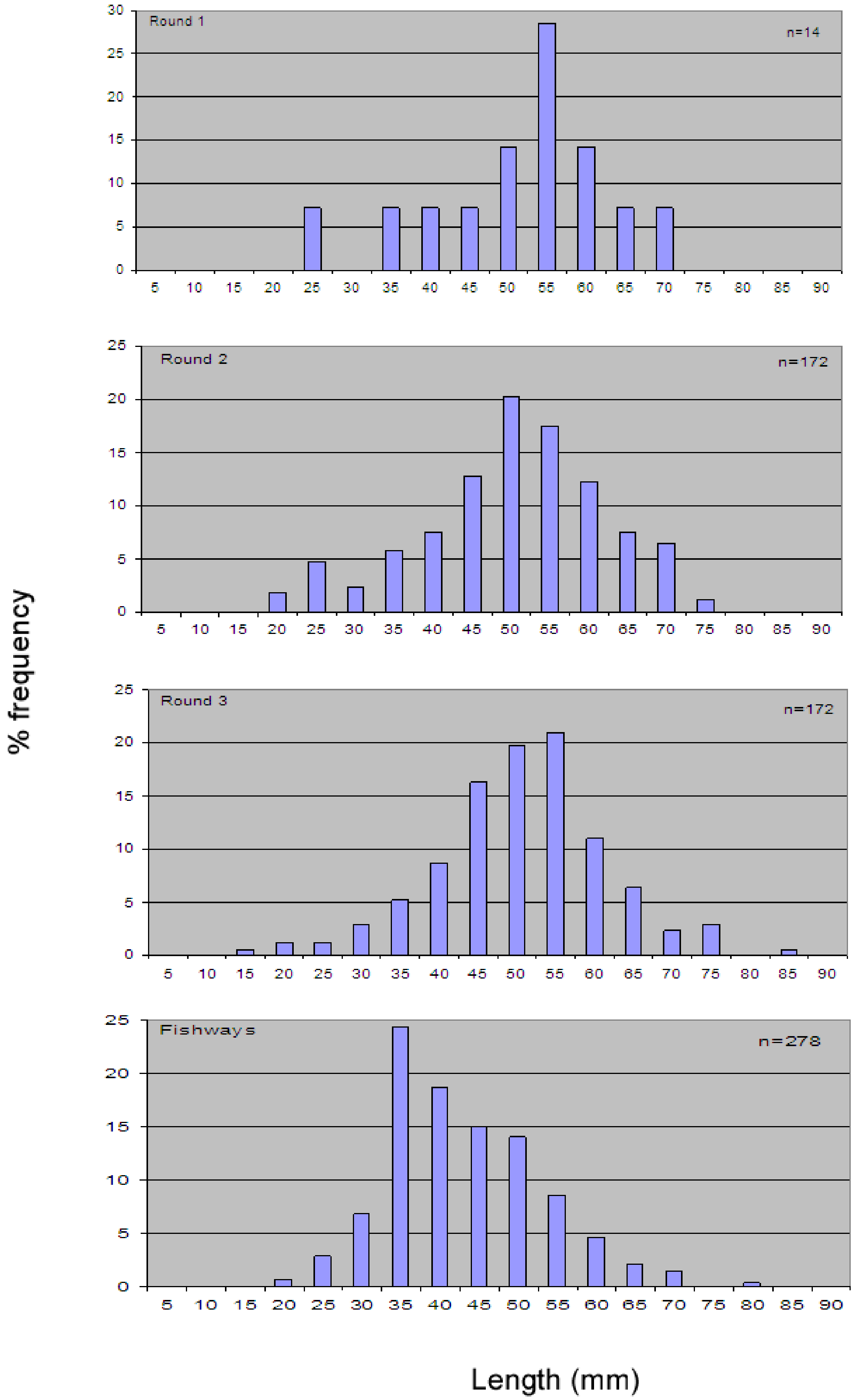

Figure 12. Fly-specked hardyhead size distributions for sampling of St Lawrence Wetland.

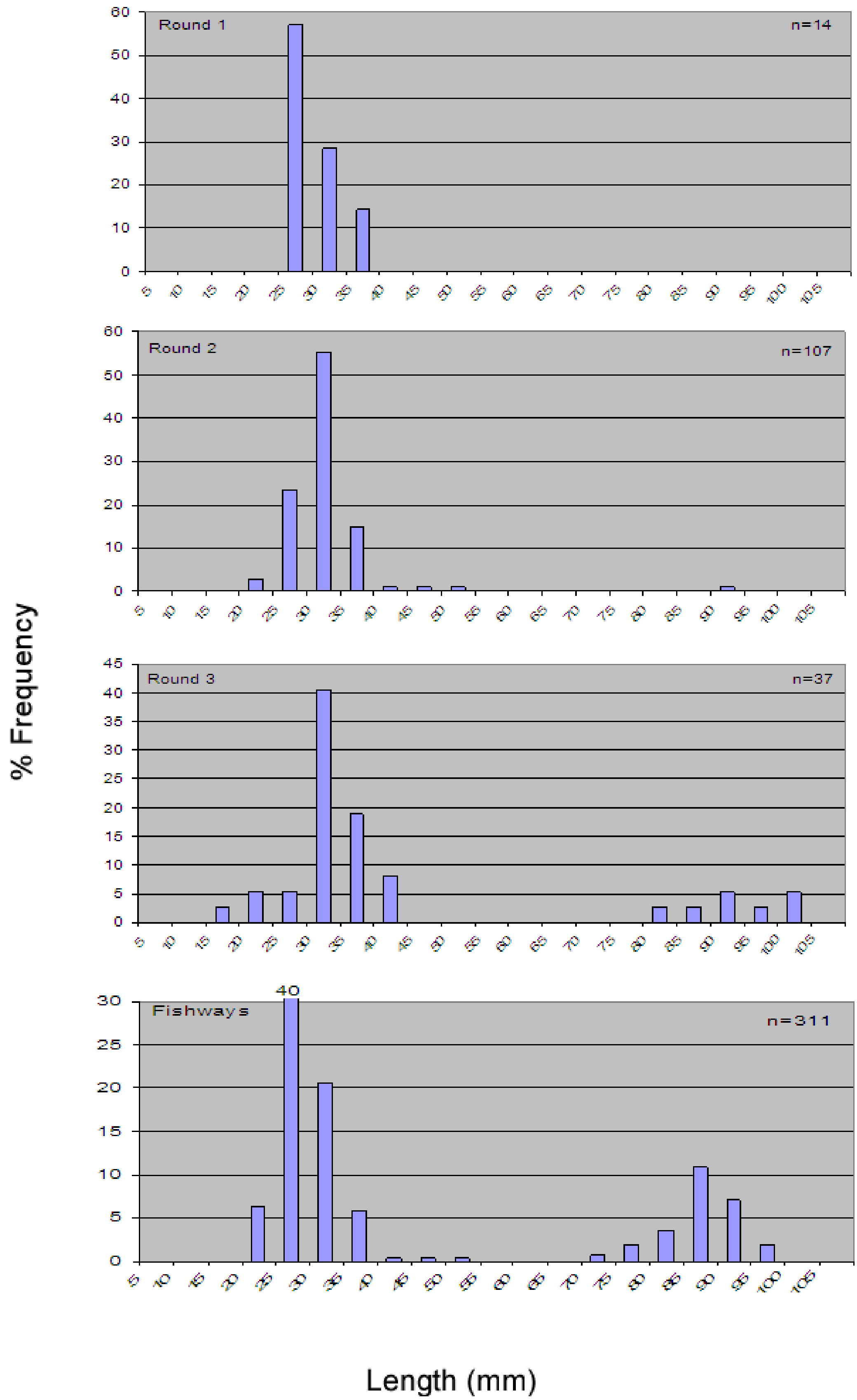

Figure 13. Empire gudgeon size distributions for sampling of St Lawrence Wetland.

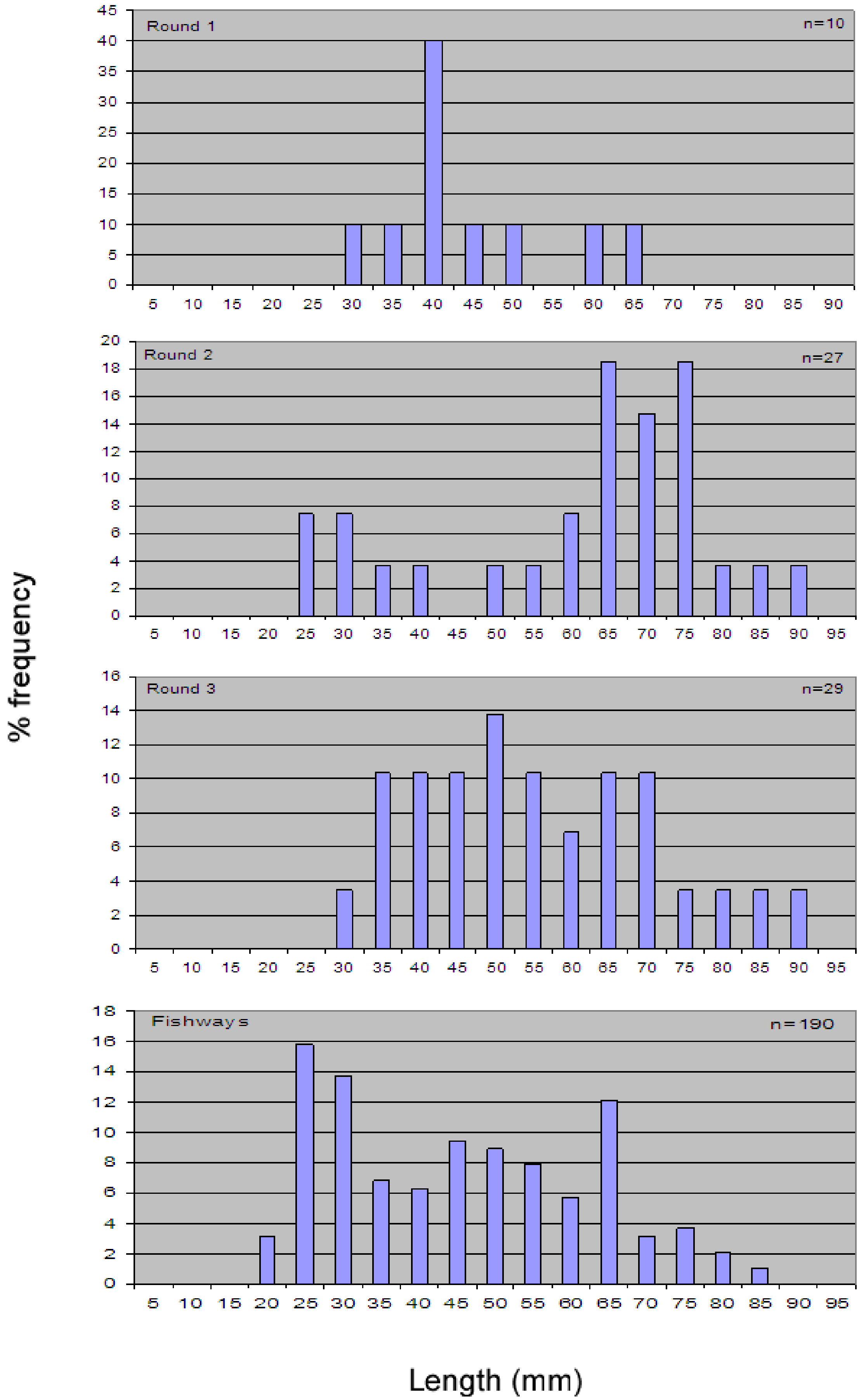

Figure 14. Eastern rainbowfish size distributions for sampling of St Lawrence Wetland.

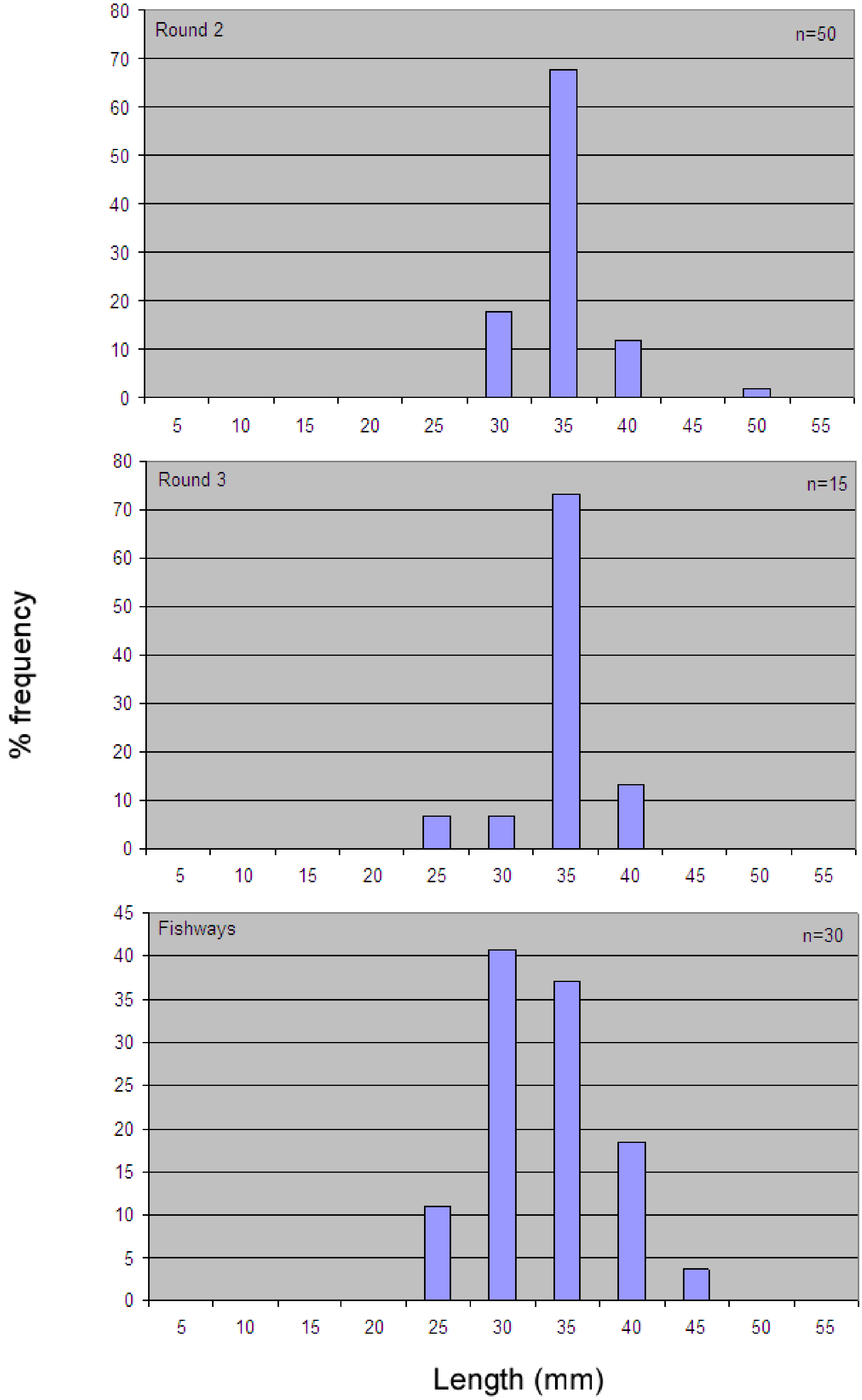

Figure 15. Midgley's carp gudgeon size distributions for sampling of St Lawrence Wetland. (note: none captured during round 1 sampling)

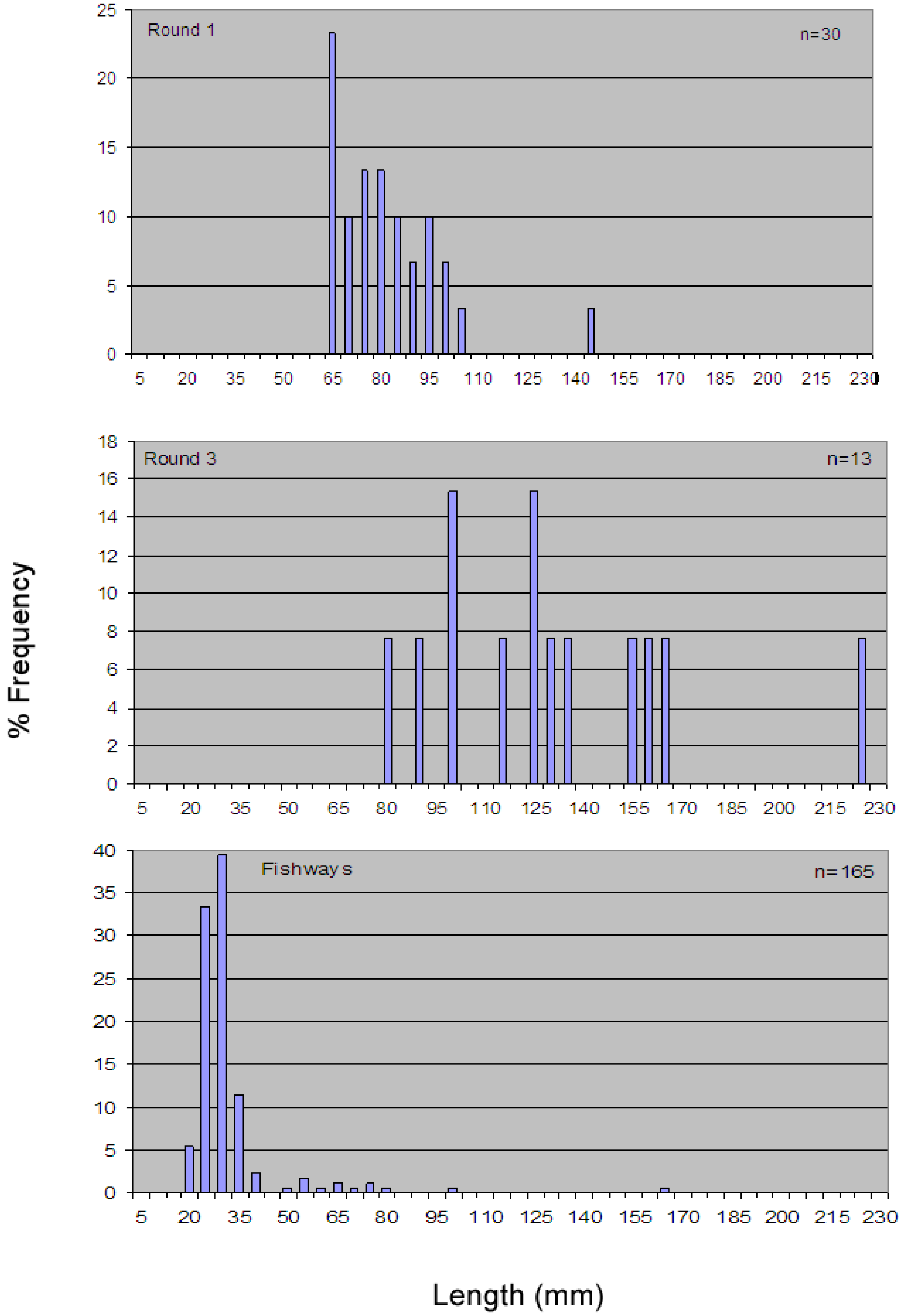

Figure 16. Spangled perch size distributions for sampling of St Lawrence Wetland. (note: none captured during round 2 sampling)

Discussion

The freshwater fish found in the St Lawrence wetland were primarily potamodromous. Potamodromous fish, although strictly freshwater species still migrate throughout freshwater creeks and rivers. These species often migrate upstream during times of flow for reproduction, but also in search of new habitat and food. In this case many of the fish which were found utilising the fishways may have been washed downstream during the first flows and were simply returning to the lagoon.

The fish communities of the St Lawrence wetland appear to be in a state of transformation. The construction of the northern access road saw the wetland severed from the St Lawrence Creek estuary ceasing almost all fish migration opportunities for several years. The annual flooding of the wetland with wet season rains, potentially washed many fish out, which were then unable negotiate the barrier formed by the road to re-enter the wetland. This lack of connectivity is reflected in the round 1 composition of the fish community which displays low abundances and relatively low species diversity. Additionally, failure to capture larger catadromous species such as sea mullet and barramundi particularly indicates a lack of connectivity with the estuary.

Since the construction of the fishways, the wetland has been reconnected to the St Lawrence Creek estuary, and during periods of high rainfall, the fishways are permitting the passage of many species. This is reflected in the massive increase in species abundance and diversity from round 1 through to round 3, as well as in the capturing of a juvenile sea mullet and barramundi and large numbers of juvenile and adult empire gudgeons during fishway sampling.

Round 1 sampling in the St Lawrence wetland was during the dry season and prior to the installation of the fishways restoring connectivity. The overall species diversity was relatively low and so too was relative abundance, reflecting the extended period that this wetland had been isolated from the estuary. The species captured in round 1 are potamodromous and most likely would have been present in the system prior to the construction of the northern access road. Low abundances and the absence of larger adult sizes within these round 1 species (notably empire gudgeons, spangled perch and agassiz's glassfish), points to the possibility that the fish were flushed out of the wetland during wet season flows, with only juvenile fish able to negotiate the falls created by the road to re-enter the wetland.

The installation of the two fishways was completed before the arrival of wet season rain in February 2008 and both fishways were functioning during round 2 sampling. A four-fold increase in total catches from round 1 to round 2 corresponds directly with the successful implementation of the fishways (figure 10). Relative abundances of agassiz's glassfish, eastern rainbowfish, fly-specked hardyheads, midgley's carp gudgeons and empire gudgeons increased in round 2 with greater representation across a range of size classes.

Fishway sampling at the same time as round 2, revealed both increases in species diversity and relative abundances in comparison to round 1. Agassiz's glassfish, fly-specked hardyheads and empire gudgeons were the most numerous fish utilising the fishway. Fish across all size ranges were found to be using the fishway including juveniles that had potentially hatched at the onset of the wet as well as adults that were unable to re-enter the wetland prior to fishway installation. Three new species were captured at the fishways including bony bream and catadromous sea mullet and barramundi.

Round 3 sampling at the end of wet season flows indicate the establishment of new species diversities and abundances. Nine species were captured in round 3 but it is possible to assume that the three new species captured in the fishways have increased the species diversity of the wetland to 12 species. Abundances of some species, particularly agassiz's glassfish and fly-specked hardyheads increased from the two previous rounds and the size ranges of all species expanded.

Conclusion

Overall, 12 species of fish were sampled collectively from the St Lawrence wetland and fishways during this study. Connectivity of the wetland with the estuary is essential to allow migration of various fish species including commercially and recreationally significant species such as barramundi, to restore and maintain healthy fish populations within the aquatic ecosystem. The construction of an access road to the town of St Lawrence, along with natural environmental factors such as drought, has reduced the connectivity of the wetland with the estuary, affecting fish populations. The construction of two fishways has reconnected the wetland with the St Lawrence Creek estuary enabling fish to migrate between the two habitats to restore species diversity and abundance. Continued monitoring of the wetland will further determine the effectiveness of fishways for fish passage and restoring natural fish populations in the wetland.

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