

The Amazing Journey of Cod 017

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Atlantic cod (*Gadus morhua*) 017 started life in the early 2000s somewhere on the northeast Newfoundland Shelf (Fig. 1). As an egg and larvae he likely drifted southward where he “settled” in coastal waters, perhaps in Bonavista Bay. Over his first few years, he survived a gauntlet of predators and food shortages, so that at age 4 he migrated back offshore to join a rebuilding cod group in the Bonavista Corridor. Food was scarce, as capelin (*Mallotus villosus*) were in short supply (Rose and O’Driscoll 2002; DFO 2011) and the available shrimp (*Pandalus* spp.) provided insufficient lipids for quick growth or reproduction (Sherwood et al. 2007). Poor feeding and an abundance of predatory seals meant that few of his cohort survived past age 6 (DFO 2010). But by 2010, environmental conditions were improving (Pepin et al. 2011). Temperatures were warming, and capelin, while still far from abundant, were once again a major food source. Cod 017 matured at age 5 and began spawning in the Bonavista Corridor each year, after which he migrated shoreward in search of the capelin, following the long-established migration highway that followed the warm Atlantic Ocean water shoreward (Rose 1993). By age 10 cod 017 was a very large fish, dominant in his group, with few enemies. He was now over a metre long and weighed more than 10 kg.

The above describes a likely but speculative background for cod 017.

In the spring of 2012, cod 017 was schooled with the growing aggregations of cod in their prespawning grounds in

the outer reaches of the Bonavista Corridor (Fig. 1). He was now at least 10 years old, and one of the largest males in the aggregation, measuring 117 cm from nose to tail and weighing in at over 15 kg. He was not quite ready to spawn, but others in his group had already begun, forming the spawning columns (Fig. 2) first observed in this region in the early 1990s (Rose 1993).

On May 30th of 2012, the research vessel *Celtic Explorer*, under charter by the Centre for Fisheries Ecosystems Research at the Marine Institute of Memorial University (CFER), was near the end of a project which had taken her from home port in Galway, Ireland to the cod grounds of the Flemish Cap, the St. Pierre and southern Grand Banks, and finally to the northeast coast of Newfoundland and the Bonavista Corridor. Cod had been surveyed in all areas, but cod were also tagged with a new generation of “pop-up satellite tags” (X-tags from

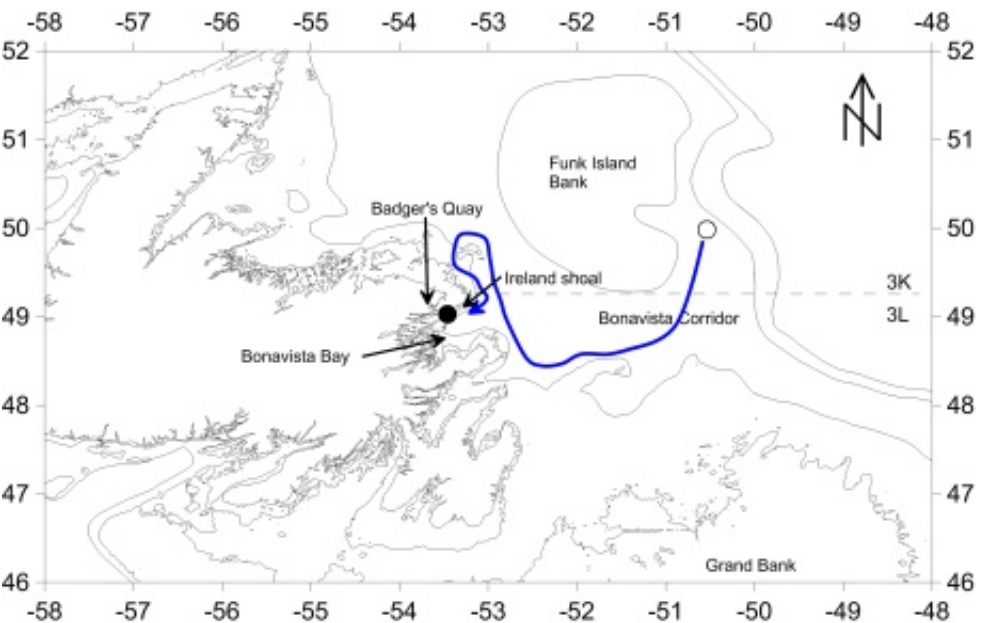


Fig. 1. Map showing the tagging site of cod 017 (open circle) and recapture site (closed circle) at Ireland shoal in Bonavista Bay, and tentative approximate migration track of the fish during June, July and August of 2012.

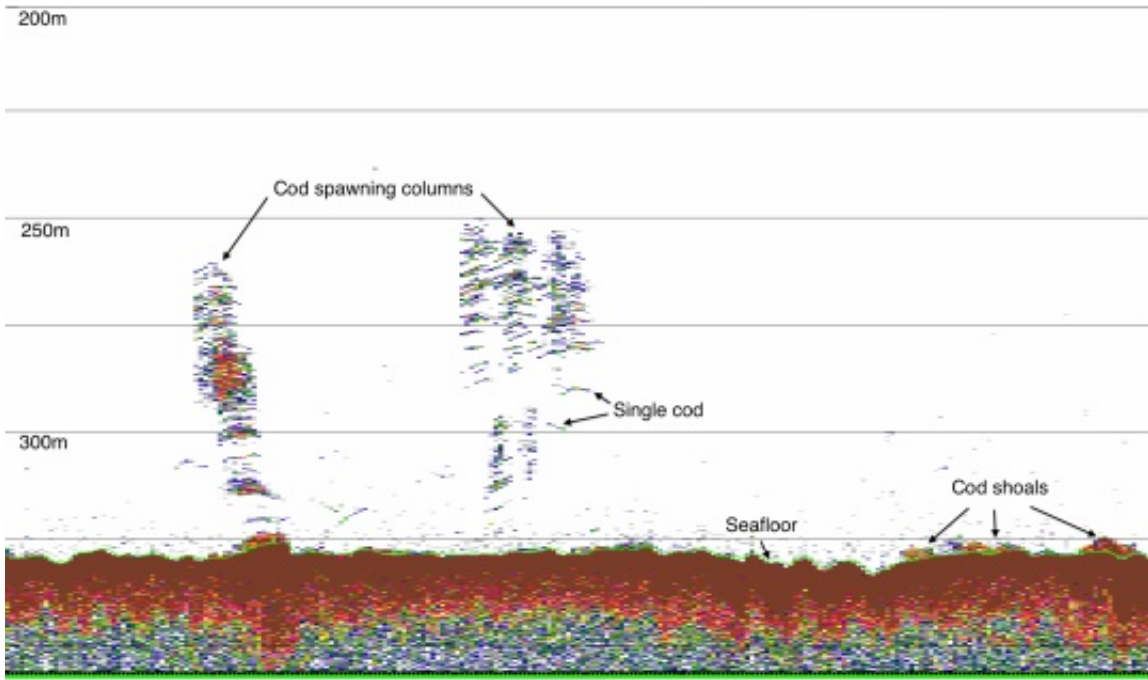


Fig. 2. Echogram of cod "spawning columns" from May 30th, 2012 in the Bonavista Corridor near the site of cod 017's capture. The span of the echogram is about 1,500 m and the depth 330 m. Note that columns range up to 75 m off bottom.

Microwave Telemetry, MD, USA), which were being placed on cod for the first time (Fig. 3). These tags stored depth and temperature information every two minutes, and measured light levels that could help determine latitude and longitude each day. The tags were programmed to stay on the fish for up to one year, then release themselves, pop to the surface, and automatically transfer their stored data to ARGOS satellites then back to the CFER lab. Months of preparation and trial tagging of captive cod had gone into this project, most importantly to develop a "backpack" that would hold the tag for a year but not interfere with the movements or behavior of the fish.

May 30th started out as just another day for cod 017, although he had joined up with a fairly large and dense aggregation of his kind in preparation for the spawning season. The cod were settled in across the flat plain of the Bonavista Corridor at a depth of about 330 m, but many were 10s of metres above the

bottom chasing their favorite food, the capelin (Fig. 4). Their bellies were full, mostly with capelin that were abundant just inshore and south of where the main cod groups were aggregated (Fig. 4). Among the cod were many fish nearly as large as cod 017, but the majority were much smaller. Perhaps group and prespawning behavior left him a bit distracted, but cod 017, along with hundreds of fish from his aggregation, were caught in a research trawl fished from the Celtic Explorer just after noon that day.

Scientists aboard the Celtic Explorer had observed cod 017's shoal on scientific echosounders (Fig. 2) and wanted to learn about their condition and abundance. But of prime importance was to tag one final fish.

Cod 017, along with many of the large cod caught, survived the catching with little apparent injury. They were immediately put into seawater tanks and given a rest from the ordeal of capture. Cod 017 was not the largest fish caught - at least one or two were even larger - but cod 017 was judged to be in the best condition. The others were measured then released back to the sea.

The tagging procedure took about two minutes. Cod 017 now had a backpack with satellite X-tag attached (Fig. 5). After a brief rest in the seawater tank, he was gently released back to the sea. With a well-timed flick of his tail he disappeared into the deep.

The bathymetry of the Bonavista Corridor is near featureless, with only slight depressions beneath a



Fig. 3. X-tag from Microwave Telemetry, Maryland, USA. A Canadian loonie is used for size comparison.

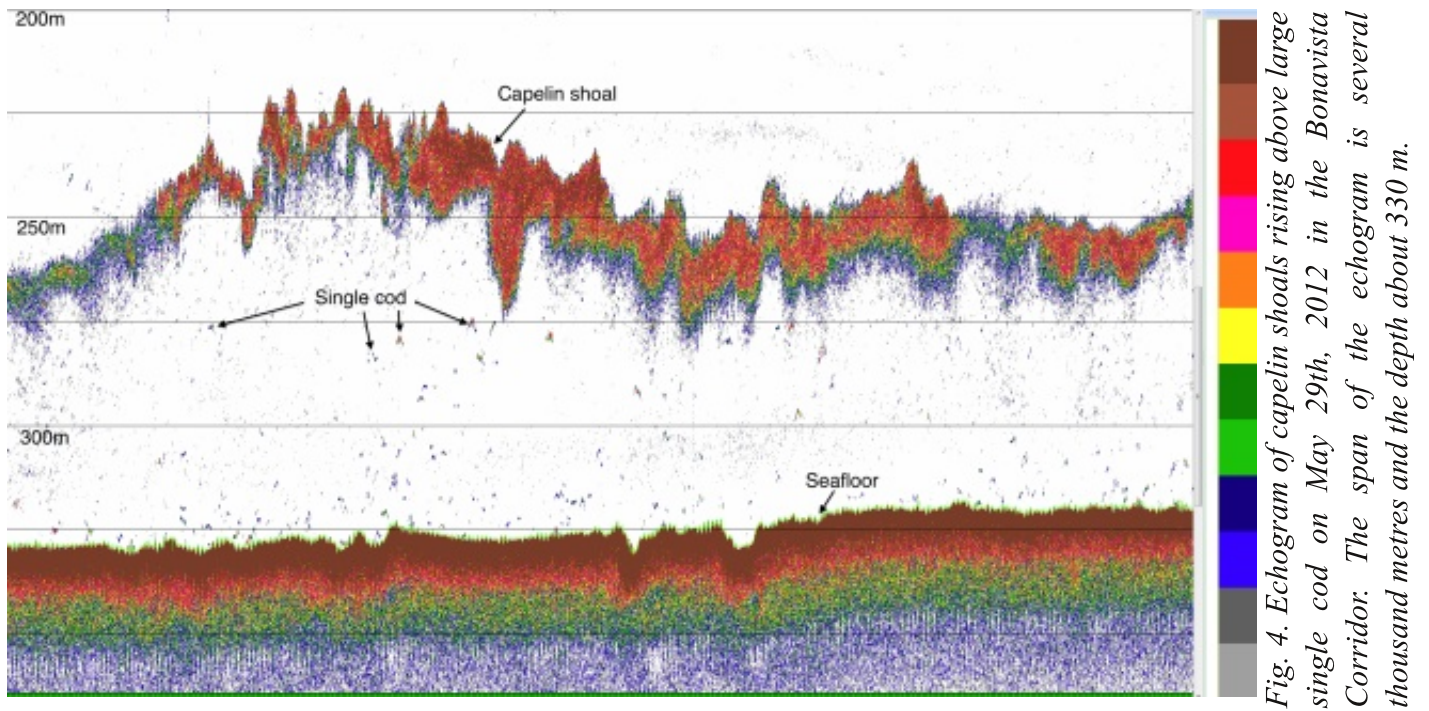


Fig. 4. Echogram of capelin shoals rising above large single cod on May 29th, 2012 in the Bonavista Corridor. The span of the echogram is several thousand metres and the depth about 330 m.

monotonic plain ranging in depth from about 300-335 m. Water temperatures were around 4°C in the near bottom Atlantic Ocean waters, but nearer the surface the cold waters of the Labrador Current flow southward at less than 0°C (Fig. 6). The Labrador Current intersected the shallower depths of the Funk Island Bank to the northwest and the Grand Bank to the south, so bottom temperatures there were much cooler. For the time being at least, cod 017 and his aggregation were content to stay in the warmer Atlantic Ocean waters, waiting for the spawning urge, and with capelin prey available in close proximity, the location was near ideal. They would feed right through the prespawning and spawning period (Krumsick and Rose 2012).

Cod 017 spent the first few days after his release not moving much and recovering from the ordeal of being tagged. Recovery came quickly, however, and within a week he began making short vertical excursions in search of prey (Fig. 6). As the capelin schools moved shoreward to spawn, the cod followed. Prey and predator moved with increased urgency shoreward along the Bonavista Corridor. By early June the spawning urge was relentless, and cod 017's gonads were swollen with milt. His vertical excursions became more pronounced, and with others took the form of spawning columns (Knickle and Rose 2012). As he rose in the water, at times to more than 75 m off bottom (Fig. 2), he vied for mates with other males near his own size (Rowe et al.

2007). He spawned several times, rising in the water column, and all the time moving shoreward. As he had done 10 years earlier, it is likely that the eggs he fertilized drifted into the near surface zone and then southward and with luck, and time, into a safe nearshore habitat.

By June's end, cod 017's vertical migrations took him upwards as far as 200 m off bottom, more than halfway to the surface where water temperatures cooled rapidly as the Labrador Current was approached (Fig. 6).

As cod 017 moved shoreward, his vertical movements became more pronounced and exposed him and his companions to the very cold waters (subzero) of the Labrador Current. But more was to come. The inshore migration in chase of the migrating capelin meant passage through the coldest waters, below -1.5°C (Fig. 6). After a few false starts, perhaps to acclimate themselves somewhat, the cod pushed on through the cold waters as quickly as possible. As cod 017 approached the northeast coast of Newfoundland in mid-July, now spent and hungry, he found coastal waters that had warmed considerably, and were now well above 2°C. Cod 017 moved northward along the coast, keeping in the warmer waters as much as was possible, always searching for the moving capelin.

Cod 017 spent the summer in and around Bonavista Bay, moving to the shallowest waters by the end of July then slowly backing off to deeper

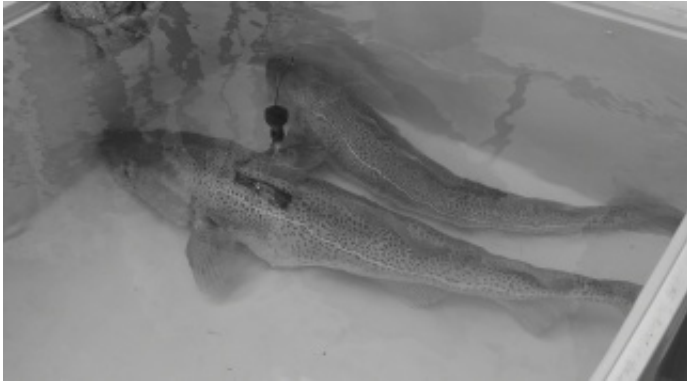


Fig. 5. Cod 017 with backpack and tag in place. A smaller cod is still in the tank to be released unmarked back to the sea.

waters as the capelin declined after spawning. By August he had travelled well over 150 nautical miles (ca. 270 km) with his backpack and was near a small outer bank called Ireland Shoal, not far from the fishing community of Badger's Quay. He had been carrying his backpack and X-tag now for over three months.

On Aug. 31, 2012, Gerry King was fishing his normal grounds off Ireland Shoal, some 20 nautical miles from his homeport of Badger's Quay (Figs. 1 and 7). The fishing was good, and he had high

prospects of catching his quota quickly. Among his catch that day was a very large cod with a strange device attached to its back. The cod was in prime condition, the largest Gerry had caught, but the device on its back was a real mystery. He suspected, nonetheless, that this device, with its rounded body and antennae, was of some importance, and after a small dose of seawater to clean it off, saw clearly markings that read "REWARD - G. Rose, Marine Institute, St. John's, Newfoundland, Canada" and a phone number. The backpack and tag were carefully removed from the fish and placed in a small box, kept cool and away from any magnets, all to prevent damage. Details of the date, time and location of the capture, and the length, weight and sex of the fish were recorded.

On returning to port with his catch and the mystery tag, Gerry immediately arranged for a phone call to George Rose. Arrangements were made to ship the tag back to St. John's with the information Gerry had recorded. This return was of prime importance, as was the data that Gerry had collected when the fish was caught. These tags communicate directly with ARGOS satellites after surfacing, but

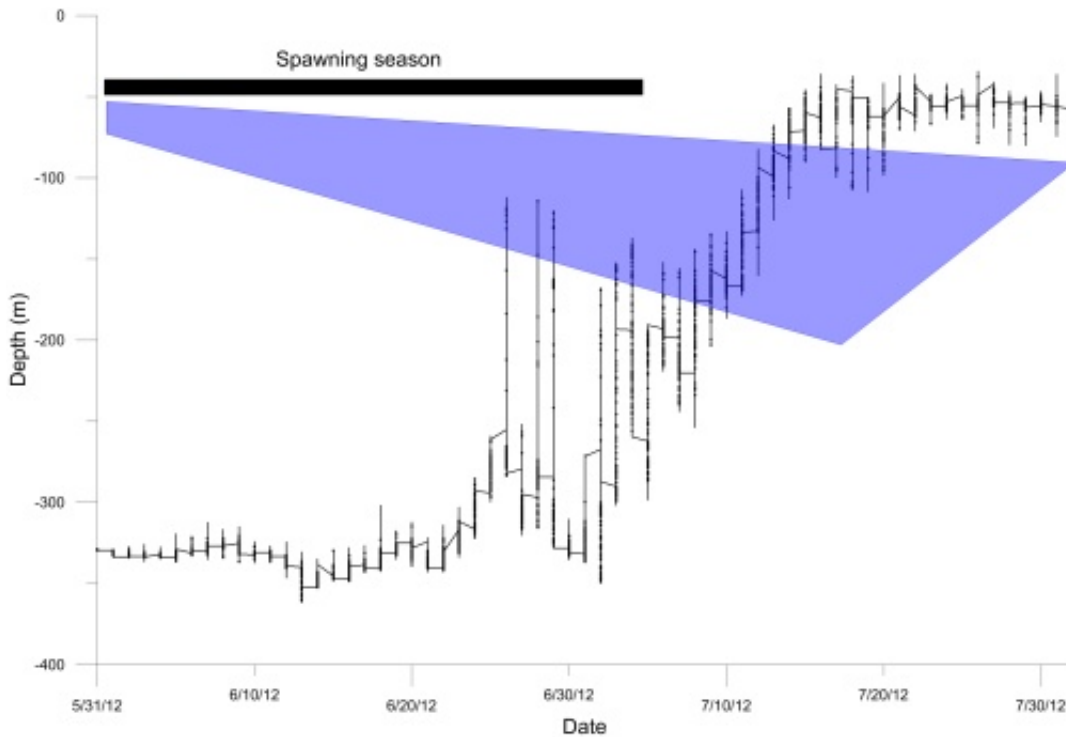


Fig. 6. Depth track of cod 017 from time of release on May 30th, 2012 until August 1st, 2012. Each vertical bar represents daily measures with dots indicating two minute measures. The vertical migrations are clearly shown, up to 200 m off bottom near the end of June. The blue region indicates the approximate depth of the Labrador Current water with subzero temperatures along the migration path (drawn from data in Pepin et al. 2011).

transmission rate limitations restrict the amount of data that can be recovered even if conditions are perfect. With the tag in hand, however, all of the 2-minute data stored in the tag can be recovered. The data that Gerry had recorded at the time of capture would make this information even more valuable.

Cod 017's journey was now over, but the analyses of the information garnered from his life and last migration was only beginning. Other cod X-tagged from the *Celtic Explorer* in the Bonavista Corridor and the other areas remain at liberty, recording invaluable scientific data. They will report by satellite in the spring of 2013, when their tags will surface and communicate with ARGOS satellites. It is unlikely that many of these fish will be caught (except on the Flemish Cap where there is a directed cod fishery), and the tag returned, giving access to the full 2-minute time series of the conditions the fish experienced. Cod 017 was the first to enable this, and the data has given the first detailed account of the behavior and location of an individual male "northern" cod from the time of prespawning, through the spawning period and onshore migration. In the early 1990s, the migrations of cod through the Bonavista Corridor were first described by the senior author of the present work, but it took over 20 years, and a whole new generation of tagging technology, to track a fish continuously over the whole inshore migratory route. In the spring of 2013, the remaining tagged fish at liberty in the Bonavista Corridor and in the other areas are expected to report in by satellite, and given the success of cod 017, the data they will provide are almost certain to further unlock some of the secrets of cod movements that have come to light with the amazing journey of cod 017.

PS – In the spring of 2013 over two dozen X-tagged cod will be released in the Bonavista Corridor. Fishermen will be rewarded with up to \$500 for the return of the tag and the fish in good condition.

Acknowledgements

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Fig. 7. Gerry King and Tammy Hoyles aboard the CC Venture in Bonavista Bay.