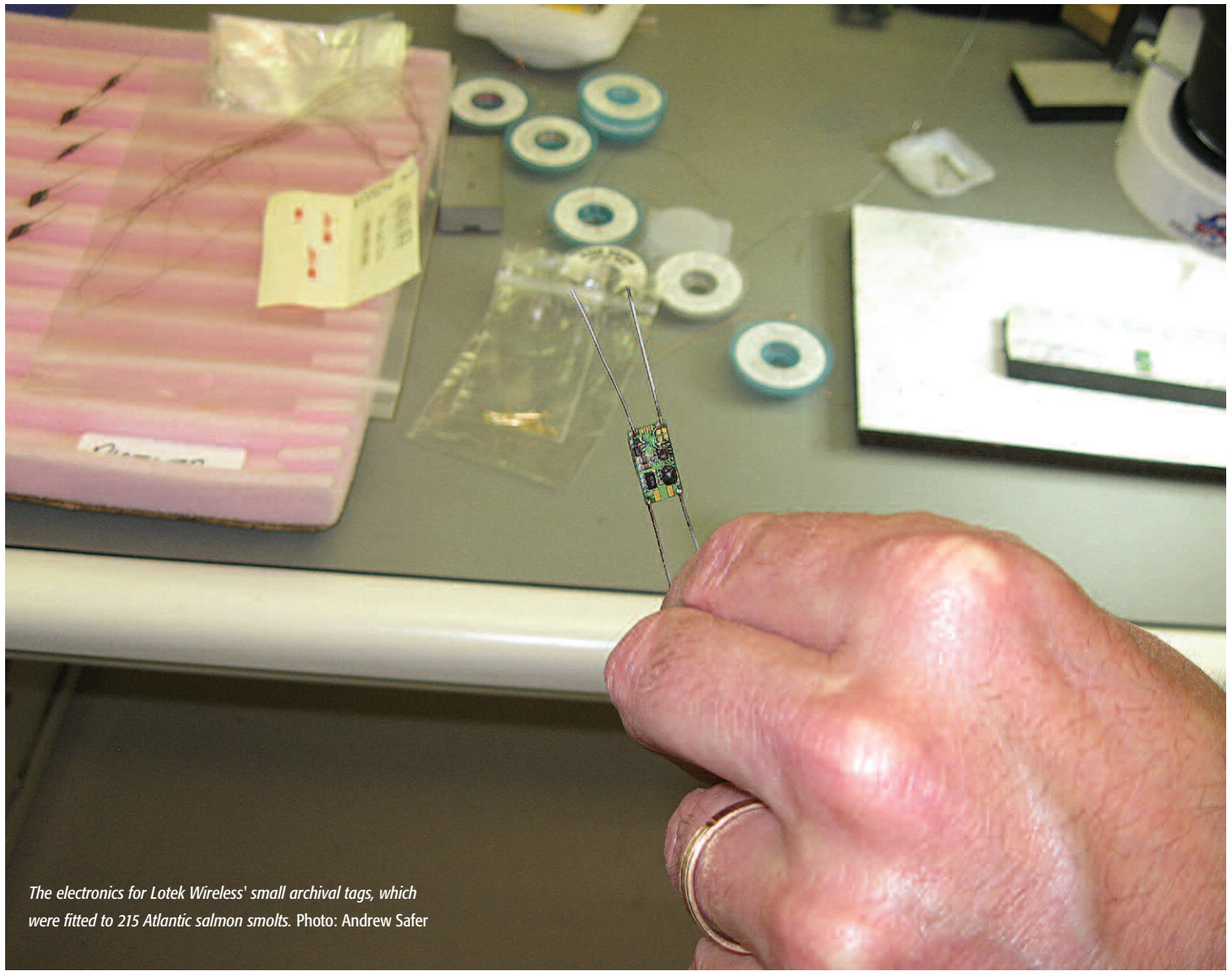
A milestone in miniaturisation

Archival tags small enough to be attached to Atlantic salmon smolt are expected to significantly increase our understanding of the migration patterns, habitat and survival of the juvenile fish, leading to improved management of the species. Andrew Safer reports

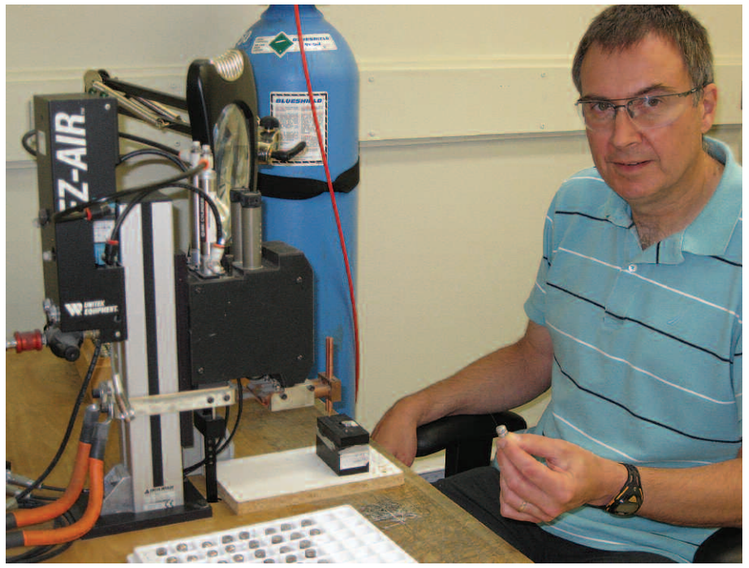


The electronics for Lotek Wireless' small archival tags, which were fitted to 215 Atlantic salmon smolts. Photo: Andrew Safer

Reducing the size and weight of the electronics in an archival tag so it can be attached to an Atlantic salmon smolt (juvenile) has been a top priority for Lotek Wireless of St John's, Newfoundland, since 2006. In May 2011, the company's newly produced two-gram tag was fitted onto 215 smolts that were released from the Campbellton River into the North Atlantic. This spring, five per cent of them are expected to swim back to the river where they will be collected in the counting fence trap. In addition to continuously logging their location and a summary of the daily data, the tiny tag will allow detailed recording of sensor data for three-day periods. This is the first time a light-based geolocation archival tag has been fitted onto a smolt of any species that has been released into the wild. It is expected that by outfitting juveniles with these tags, scientists will be able to significantly increase their knowledge about the migration patterns, habitat and survival of the juvenile fish, leading to improved management of the species. Once the data is recovered, this will be the first time an Atlantic salmon smolt has been followed from the point it leaves fresh water to the time it returns for its first reproduction.

GPS doesn't operate underwater, and the maximum range for signal transmission via acoustic transmitter is typically one kilometre. Because of this, light-based geolocation has become the method of choice for recording the location of a fish whose migration patterns exceed this distance. The latitude and longitude estimate of the location of the tag at any point in time is determined with reference to the length of the day, and when noon occurs relative to its internal clock in GMT. An optic fibre on the tag, positioned outside the fish, collects light and sends it into the electronics inside the tag. The light detector has the ability to detect the presence of sunlight from a depth as low as 400 metres.

When Lotek set up shop in Aurora, Ontario, in 1984, it began designing and manufacturing collars to track terrestrial animals. When the company opened the St John's office in 1996 it entered the marine market. Its first products were acoustic transmitters. In 1998 Lotek manufactured its first archival tag, and in 2002 produced its first geolocator tag which was 16 millimetres in diameter by 76 millimetres. In 2003 the company reduced the size to 14 millimetres by 35 millimetres, which was further reduced to eight millimetres by 35 millimetres in 2007. The availability of smaller component packages, particularly memory chips, has been a key enabler of this process, says Lotek general manager Mark Ploughman. In addition, resistors and



Lotek's general manager, Mark Ploughman, at the battery pack station where the company produces its own silver oxide battery packs. Photo: Andrew Safer

capacitors take up one-quarter of the area they did ten years ago, the functionality of some of the components has significantly increased, printed circuit boards are more densely populated, components require less current, battery size has been significantly reduced, and improved understanding of new and existing materials has enabled further reductions in weight and size. "We're a niche industry taking advantage of all the miniaturisation efforts of the big players," says Ploughman. "Everyone's looking to miniaturise, which happens to be a specialty of ours."

There is a strong business case to miniaturise because the smaller the tag, the more species are available to be tagged, adds Ploughman. In addition, from a conservation and fisheries management point of view, there is a great deal of interest in learning more about what happens at the juvenile life stage of fish, when there is the greatest risk of predation and when the adverse effects of habitat damage have the greatest impact.

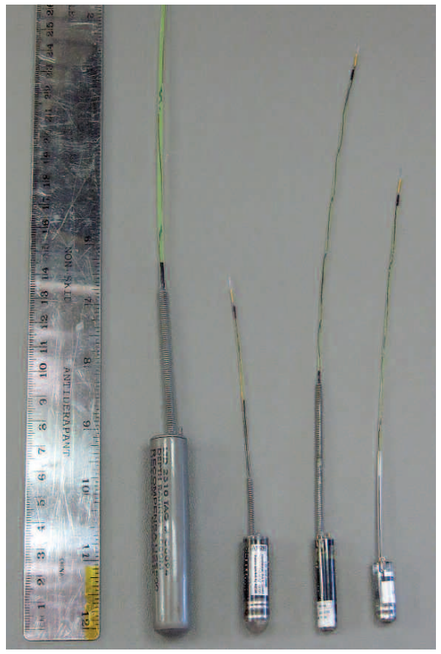
For animals that can be fitted with larger tags, such as tuna or sharks, miniaturisation enables Lotek to add features that weren't feasible before, such as a pop-up satellite archival tag with an Argos transmitter and a slightly bigger battery. With this addition, scientists can retrieve data via satellite rather than having to wait until the tag is recovered.

The development of the tag for Atlantic salmon smolts was a collaborative effort between Lotek, Dr Ian Fleming, an evolutionary and behavioural ecologist at Memorial University's Ocean Sciences Centre, Newfoundland, and the Canadian Department of Fisheries and Oceans (DFO). Lotek first collaborated with Dr Fleming in 1998 on a project focused on the conservation of an endangered fish species in Italy. Dr Fleming spent ten years in Norway and four years in Oregon, USA, conducting research on the wild salmon populations there before returning to the Ocean Sciences Centre. "We work really closely with key groups of researchers to develop the products," says Ploughman. "The technology doesn't evolve without a really strong connection with the market."

As the principal investigator on the Atlantic salmon smolt archival tag project, Dr Fleming worked with Lotek to develop the attachment mechanism. In 2009 he conducted experiments to determine if the tag should be implanted internally or externally. The internally-tagged fish either extruded the tags or became emaciated and the externally-mounted tags didn't allow enough room for the fish to grow from 15 centimetres to 70 centimetres from the time of release until their return a year later. After conducting further tests in the tanks at the Ocean Sciences Centre, he determined that a tag tethered near the dorsal fin and mounted at an angle, with the smallest possible area in contact with the fish, would provide the best performance. "We were careful to see if we could find a tagging method that minimised the detrimental impact on fish through their lifetime at sea," reports Dr Fleming. By November, 2010, he had the scientific evidence required to support a wild release.

Lotek's archival tag technology development over the years has been supported by the Atlantic Canada Opportunities Agency's Atlantic Innovation Fund, the National Research Council Canada (NRC) Industrial Research Assistance Program and the Government of Newfoundland and Labrador's Department of Innovation Trade and Rural Development. Lotek's collaboration with Dr Fleming and DFO was supported by the Ocean Tracking Network through the Canadian Foundation for Innovation and Natural Sciences and Engineering Research Council.

Today, Lotek's push towards miniaturisation continues. Since Pacific salmon are a lot smaller than Atlantic salmon, Ploughman says they are preparing to produce a half-gram tag for the smolts. "We can produce tags at close to one gram now," he says. "We plan to be the first ones with a half-gram tag." ■



Lotek's four generations of archival tags. Photo couresy Lotek Wireless

Andrew Safer is a freelance writer, editor and communications consultant based in St John's, Newfoundland; email: asafer@nf.sympatico.ca, website: www.andrewsafer.com