

Shark tagging: a brief history of methods

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Abstract

The first large-scale shark tagging programmes were initiated during the 1940s using Petersen disc tags (or similar variants) wired through the relatively rigid first dorsal fin. During the same period in Australia, school sharks were tagged with internal Nesbit tags inserted into the body cavity. These tags, developed because of concerns over high shedding rates of early fin tags, still hold the record for the greatest time at liberty of any tagged fish, with some recaptures made 40 years after tagging. The 1960s saw the trialing and use of plastic cattle ear tags (rototags), applied to the first dorsal fin, that had much better retention qualities than the earlier fin tags. The same era saw the initiation of large-scale cooperative game fish tagging programmes, particularly in the US, and the development of dart tags that could be applied without removing the shark from the water. More recently, shark tagging has taken advantage of electronic technology to overcome some of the limitations of standard tagging methods. A number of species have been tracked with acoustic tags. Satellite tags have been used on blue and whale sharks and archival tags have produced exciting results on school sharks.

Conventional Tags

One of the main advantages in tagging sharks compared to similar-sized teleost species is that sharks have relatively rigid fins which offer a good attachment site for tags. The first large-scale tagging programmes on sharks were initiated in the 1940s (Foerster 1942;

Bonham *et al.* 1949) and used Petersen disc tags wired through the first dorsal fin. A hole was made with an awl and two circular plastic discs wired through the fin. Titanium wire was used to avoid corrosion. In the 1940s in southern Australia, Olsen (1953) started a large tagging programme on school sharks (*Galeorhinus galeus*). Olsen used a combination of Petersen disc and internal Nesbit tags. Internal tags were used because of concerns over high shedding rates of the Petersen discs, which were well above 50% per year, especially when applied to smaller sharks (Xiao *et al.* 1999). Internal tags were inserted into the coelomic cavity through a small incision made with a scalpel. One of these internally-tagged sharks was recaptured 42 years after tagging and holds the record for the longest time at liberty of any tagged fish (Anon 1991). Internal tags have very high retention rates but, unless accompanied by an external tag, are prone to low reporting rates as they can only be found during gutting and processing.

In the 1960s, plastic cattle ear tags (Rototags and Jumbo Rototags) were trialed and used on shark fins (Davies and Joubert 1967; Kato and Carvallo 1967). These had much better retention qualities than the earlier fin tags, especially when applied to the first dorsal fin. They are normally applied through a pre-punched hole, made with a leatherpunch, just in from the leading edge, and towards the base, of the fin. The tag is then punched together through the hole using special applicator pliers. Jumbo Rototags have been returned from sharks at liberty for up to 28 years (Kohler *et al.* 1998). Shedding rates have been

estimated at 6-8% per year when these tags are correctly applied (Xiao *et al.* 1999). Tags applied towards the thinner trailing edge of the fin are prone to tear out. When applied too close to the base, particularly on fast-growing species or size classes, the tags tend to dig in as the fin thickens and the tag can eventually work its way through the fin and be shed (Stevens *et al.* unpublished data). The fin tags on recaptured sharks are sometimes abraded and it is likely that the tags have irritated the fin and the shark has tried to rub them on the seabed.

The 1960s also saw the instigation of large-scale cooperative game-fish tagging programmes. The largest of these, run by the National Marine Fisheries Service in the North-west Atlantic, has seen some 106 000 sharks of 33 species tagged in its 30-year history (Kohler *et al.* 1998). The requirement for tagging sharks without taking them into the boat led to development of the 'M' type stainless steel-headed dart tag. This is applied using a tagging needle mounted on a pole, which is jabbed into the dorsal musculature of the shark below the first dorsal fin. Dart tags do not have as good retention qualities as the best fin tags but have the advantage that the shark is less likely to be damaged during removal from the water, which is particularly important for large individuals. Other types of dart tags have nylon heads. These have high shedding rates which can be in excess of 50% per year when inserted in the musculature, but are somewhat better when locked into fin-ray cartilages at the base of the dorsal fin (Xiao *et al.* 1999).

Other passive tags, or marking techniques, used on sharks have included rubber or metal collars slipped over the caudal peduncle, fin clipping and freeze-branding. However, these are only suitable for short-term studies.

Electronic Tags

The advent of electronic tags opened up new possibilities for fish tagging, and was particularly suitable for sharks as tag size was less of a problem

(some of the early tags were relatively bulky). Since the first tracking of a transmitter-equipped shark in 1965, at least 26 species of shark have been tracked. These include demersal, pelagic, reef and deep-sea species and range up in size to white sharks (*Carcharodon carcharias*), whale sharks (*Rhincodon typus*) and megamouth (*Megachasma pelagios*) (Nelson 1990; Nelson *et al.* 1997; Gunn *et al.* in press). Most of these studies have provided basic information on diel patterns of movement and space utilisation. Trackings have also used sensor-equipped transmitters to provide data on depth behaviour, body temperature, swimming speeds and other physiological parameters. Acoustic tags are usually tracked manually but can also employ automated fixed listening stations (Nelson 1990). Acoustic tags can be applied externally or internally. External attachment methods which have been used successfully include darting a stainless steel arrow-head (linked to the tag) into the musculature, either from a boat or underwater, attachment to a fin or fin-spine, or attachment *via* a body harness (Yano and Tanaka 1986; Nelson 1990). Alternatively, the tag can be placed internally either by feeding the tag hidden in a bait to a free-swimming shark, force-feeding to a captured shark, or surgically implanting the tag in the body cavity (Nelson 1990). The various advantages or disadvantages of these attachment methods include the degree of trauma caused by capture and any subsequent procedures, signal loss on internally placed tags, and the risk of tag loss through shedding or regurgitation. One of the challenges of attaching transmitters is that the sharks are often large and can pose a potential hazard to the tagger. However, one technique used on sharks is to put them into a state of tonic immobility. This has been done successfully with large tiger sharks (*Galeocerdo cuvier*) by inverting them in the water (Holland *et al.* 1999).

More recently, satellite and archival tags have been used on a few species of sharks. Satellite tags were attached to the dorsal fins of three blue sharks (*Prionace glauca*) in 1994, two of which provided positional data *via* the ARGOS system for one month. Basking (*Cetorhinus maximus*) and whale sharks have

been tracked by embedding the tag in a float which is towed by the shark via a tether (Priede 1984; Stevens *et al.* unpublished data). Assuming you have an animal you know will visit the surface (radio waves do not pass effectively through sea water), the main challenge, particularly with the towed system, is the attachment methodology. We have used archival tags successfully on school sharks (West and Stevens unpublished data). Some of these have been attached externally to the first dorsal fin, and some have been surgically implanted in the body cavity. A dummy tagging experiment showed that both attachment methods produced high return rates.

A final problem common to both conventional external and electronic tags, especially in coastal waters, is weed growth. In some cases this can be suppressed by antifouling, or in the case of tags which rely on re-sighting without recapture, by using large identification tags with cut-out letters.

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