Issues and Perspectives

Tagging Fish in the Field: Ethical and Procedural Considerations. A Comment to the Recent Paper of D. Mulcahy; *Legal, Ethical and Procedural Bases for the Use of Aseptic Techniques to Implant Electronic Devices*, (Journal of Fish and Wildlife Management 4:211–219)

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In the June issue of *Journal of Fish and Wildlife Management*, Dr. Mulcahy raised a moral finger toward biologists and researchers who frequently implant electronic tags in fish without the relevant veterinary training and without taking the ''necessary precautions'' to prevent infections. It is our opinion that the views of the author were not based on scientific evidence and thus serve to raise unwarranted doubt about a popular, productive, and well-described method that is widely used as the basis for important management decisions.

Dr. Mulcahy has an impressive professional record and has been working with wildlife tagging for most of his career and thus, without doubt, has extensive experience with field studies and how to maintain sterile or at least aseptic conditions when surgically implanting devices in animals. The problem here, however, is that apparently this experience comes from the tagging of birds and mammals. In the long list of publications from studies where Dr. Mulcahy was involved, not one involved tagging of fish, except two (review) papers (Mulcahy 2003, 2011) discussing the methods used in fish surgery. The recommendations of Dr. Mulcahy would carry more weight if he had been involved in direct studies of the effect of surgical implantation on fish or papers contributing to the refinement of tagging procedures for fish based on experimentation.

We would also argue that statements such as, ''few biologists have been formally trained in aseptic techniques,'' ''I maintain that biologists find it difficult to place the concept of asepsis into practice in their work because of confusion about what constitutes aseptic technique, a lack of surgical knowledge and training,'' ''Biologists do not know what microorganisms persist on the disinfected instrument and devices they use,'' and ''The privilege of using animals in research is accompanied by an obligation to minimize their pain and distress'' are not very fruitful and are potentially counterproductive to a constructive, scientifically based debate about

aseptic vs. non-aseptic tagging techniques. The first three quotes could equally apply to all personnel performing implantation on fish (including veterinarians). Improper training and confusion are always a problem and we have certainly witnessed otherwise skilled veterinarians confused about how to handle a fish operation. Even more provocative statements such as, ''The surgical implantation of a transmitters into the coelom of a fish is an inhumane act'' (Mulcahy 2003) is based on moral conjecture and in our opinion does not belong in a valid scientific discussion.

We will not discuss the legal issues, given that they extend beyond our realm of expertise, not to mention that they vary widely among jurisdictions. However, in most European Union countries, no person will be allowed to implant fish without following intensive courses including aseptic techniques. In any case, rules, regulations, and guidelines that are not based on scientific evidence, but on ''general feelings'' or experience from mammal and bird studies, may not be very relevant to field studies on fish and should be refined to become evidence-based. We do not dispute the need for additional research on surgical techniques for fish and indeed encourage more studies.

Mulcahy states the following: ''Besides legal and professional requirements, there are at least three additional and interrelated reasons for sterilizing devices and surgical instruments and using aseptic technique during implantation surgeries. These include 1) assuring the quality and reliability of the data collected, 2) being concerned for animal welfare, and 3) preventing transmission of infectious agents between individual animals and between populations.''

At first glance, these make intuitive sense. However, we will go through these three points in more detail with specific reference to fish and with particular attention to field scenarios.

1) If there had been documented indication that fish with implanted tags would perform even slightly better had they had been tagged under aseptic conditions, all researchers would strive to achieve such conditions, but there is no such documentation. After >25 y of widespread use of telemetry to study aquatic animals, the body of comparative literature is large (>100 studies; reviewed in Bridger and Booth 2003 and Cooke et al. 2011), including studies (almost all non-aseptic) evaluating the effects of various types of tagging as compared to control groups. Some of these report of negative effects of tagging, but rarely associated with infections. These studies include laboratory studies comparing ''nonaseptic'' tagged vs. untagged animals (e.g., Chomyshyn et al. 2011) and field studies demonstrating the same behavior of tagged vs. untagged fish (e.g., Aarestrup et al. 2002; Jepsen et al. 2008). In addition, many senior researchers have decades of practical experience and have been able to evaluate and modify the tagging techniques to minimize any bias in the collected data. It is imperative that data generated from tagging studies be unbiased, and the validation of the methods has been a cornerstone in the general acceptance of telemetry as a standard tool in fisheries management.
2) In our experience, fish researchers are very concerned about the welfare of their research subjects and go to great lengths to ensure that the tagged individuals are captured, handled, tagged, and released in the best possible way. Important here is that pre- and postoperative care are as important as the surgical procedure itself. We have led numerous training courses in handling and tagging fish, and participants have had many different perspectives on animal welfare. However, when there is no evidence that the use of aseptic protocols make any difference to the postsurgery well-being of the fish, it is meaningless to bring this issue into a discussion of animal welfare.
3) It is certainly important to avoid transfer of pathogens between populations. The potential spread of disease between populations and water bodies is the reason that researchers routinely clean and dry their equipment between episodes of field-work in different watersheds as part of routine biosecurity protocols. However, when we consider tagging of wild fish, animals are from the same population and are living in the same water with relatively free transfer of pathogens. Thus, sterilization of tagging equipment will not prevent transfer of pathogens among fish from the same water. When researchers move from one river or lake to another or start tagging fish from another population (or species), they should always make sure that all equipment is cleaned and dried between tagging events, including sterilization of surgical tools.

For warm-blooded animals, aseptic technique is required for any contemporary surgical protocol. However, for the fisheries researcher, practicing or maintaining asepsis while working in or around an aquatic environment is not as important. It does not mean we ''ignore the ongoing use of aseptic surgical techniques to implant electronic devices into marine mammals and birds that share the same aquatic environment with fishes.'' It just means fish are fundamentally different. Fish integument (tissue) is sensitive to most chemical disinfectants and sterilants and thus attempts of aseptic practice can be counterproductive or even harmful to fish. A study by Wagner et al. (1999) revealed that surgical site preparation with a povidone–iodine antiseptic did not provide any benefit relative to control fish when studying wound healing in rainbow trout *Oncorhynchus mykiss*. A study by Chomyshyn et al. (2011) revealed that attempts to maintain aseptic conditions in the field nearly doubled the time for the surgery relative to attempts that considered cleanliness but in a practical manner.

Importantly, there are no papers documenting the benefits of aseptic practices in the fisheries literature. Similarly, there is no evidence that pathogen transmission has actually occurred as a direct result of surgical tagging. Although infections in fish after tagging have been reported, these infections have been described as secondary in nature, rather than introduced due to a breach in asepsis (Mellas and Haynes 1985). Often such infections are equally prevalent on control fish, which emphasizes that they arise from the capture and handling component and not the surgery per se (e.g., Chomyshyn et al. 2011; Jepsen et al. 2013). The few studies that were designed specifically to evaluate the

risk of infection concluded that aseptic practices were without merit for fish tagged under ''normal'' conditions. Jepsen and Aarestrup (1999) surgically implanted wild fish with transmitters that required a trailing antenna; they implanted transmitters under dirty field conditions with no prophylactic or postoperative treatment and released the fish into a reservoir. After 1 y, all (100%) of the treatment fish were recaptured having demonstrated no observable negative effects related to either the surgery or to the surgical implants. Similar evaluations have been published, and none of these indicate a problem with infections caused by nonaseptic surgical implanting. Specifically, Chomyshyn et al. (2011) tested whether the intrusion of lake-water into the coelom had negative effects on survival and healing of bluegill *Lepomis macrochirus*. Results showed no positive effect of reducing water entry at the incision or of using sterile equipment. In a similar study, Jepsen et al. (2013) compared survival, growth, and healing of juvenile salmon *Salmo salar* tagged with ''dirty'' vs. ''clean'' techniques. This study also showed no positive effect of asepsis. For a more thorough review of evaluations of tagging effects, we can recommend Cooke et al. (2011) and Wargo-Rubb et al. (2014).

There is certainly a need for more reasoned interaction between veterinary professionals and field biologists to advance surgical procedures and training, as called for by Harms and Lewbart (2011). We recognize the important role of veterinary professionals in fisheries research, but there is a need for recognition that the standard veterinary principles with respect to surgery were not designed for fish nor to occur outside of an operating room. Surgery on fish may occur bent over in a canoe, standing in a river, or hanging off the side of a boat (e.g., with a shark in tonic immobility), and sometimes in windy and wavy conditions. Rarely are the conditions as ideal as Mulcahy (2013) would have us believe. As stated in the paper, even with aseptic techniques it is not possible to avoid introduction of pathogens into the surgical wound; this underlines that the various operating procedures should reduce the level of introduced pathogens below a threshold, and preferably to a level where there is no difference between tagged and untagged individuals. So even with aseptic techniques, the scale is a tradeoff between what is optimal and what is actually possible under the given scenario. Similarly, unless one creates an unnecessarily large incision, the tag will almost always touch the fish's skin while being inserted along with water. The skin must be kept moist during the procedure, so using a drape is ill-advised. This is not a matter of cost, as suggested by Mulcahy (2013)—it is a matter of evidence. Indeed, Mulcahy (2011) himself has used scientific evidence to determine that prophylactic antibiotics should not be provided to fish when they are tagged. We suggest that the same level of evidentiary basis should be applied to the issue of asepsis and sterility for fish in the field.

We fully wish to promote a wider awareness on animal welfare issues when working with aquatic animals, and continuously work on refining the methods for capture, handling, and tagging fish. This can be supported by technical manuals, guidelines, or standard operating procedures, but should always be based on the best available peer-reviewed documentation. In fish, it is well-known that ''surrogates'' should not be used for tagging-evaluation studies (Ebner et al. 2009), so drawing information from the mammalian and avian literature must be done with caution. The facts that fish live (and breathe and eat and defecate) in a pathogen-rich environment and that their integument (including mucus) differs markedly from mammals and birds emphasizes the issues with drawing lessons from other taxa.

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