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Development of a Peduncle Belt as a Medium to Long-Term Tag Attachment Platform for Cetacean Studies

Becky Woodward
University of Maine
219 Boardman Hall
Orono, ME 04469-5711
phone: (207) 581-2149 fax: (207) 581-2379 email: becky.woodward@maine.edu

Michael Moore
Woods Hole Oceanographic Institution
266 Woods Hole Road, MS #50
Woods Hole, MA 02543
phone: (508) 289-3228 fax: (508) 457-2089 email: mmoore@whoi.edu

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http://umaine.edu/mecheng/faculty-and-staff/becky-l-woodward-ph-d/

LONG-TERM GOALS

To develop a recoverable, noninvasive medium to long-term tag attachment platform which would enable detailed data sets to be collected over extended periods of time (multiple days to multiple months) and would aid in understanding natural whale behaviors and assessing anthropogenic impacts on vulnerable populations.

OBJECTIVES

- To develop a peduncle style tag and tag deployment system as a means of attaching medium to long-term tags to free swimming whales. Two different systems are currently under development:

    1) a net gun deployed peduncle "charm" tag for large whales
    2) a pole deployed peduncle saddle pack tag for small whales

- To demonstrate the potential of the peduncle style tag as a benign medium to long-term, noninvasive tag attachment platform either through field trials or in a captive animal setting

APPROACH

Net gun deployed peduncle "charm" tag for large whales
A loose belt about the peduncle will serve as the attachment point for an electronics tag package. To eliminate the potential entanglement risk associated with a towed buoy configuration, the tow tether has been shortened until the electronics package attaches directly to the padded harness encircling the whale, forming a peduncle "charm" tag (Figure 1). A net gun deployment system will be used to remotely deploy a rectangular loop of line over the tail of a fluking whale (Figure 2). The regular net

used with the net gun has been replaced with a custom designed 6 ft x 10 ft open rectangular lasso with a trailing line running back to the tagging boat (Figure 3). Half pound cylindrical weights are attached to each of the lasso's four corners and loaded into the four barrels of the gun using an o-ring seal. The net gun uses a blank .308 cartridge to propel the weights out of its four barrels, and the splay of the gun barrels ensures that the corners of the lasso are widely spread to fully deploy the loop. Once the lasso clears the fluke tips, a spring powered retraction device starts the cinching process. As the loop closes, a custom designed carabiner clips onto the eye ring of the lasso, latching the 6 ft padded harness closed into a loose loop around the peduncle. Continued pressure on the trailing line to the boat triggers a lightweight breakaway on the carabiner, releasing the weighted lasso line from the whale and leaving only the charm tag attached to the padded harness encircling the peduncle. Multiple redundant release systems (electronic timed release, galvanic timed release, and breakaway link) are incorporated in the harness to ensure that the harness releases from the whale allowing the whale to go gear free should a problem arise.

Peduncle saddle pack tag for small whales
For small whales, a form-fitting, hydrodynamically fared, semi-rigid saddle pack tag will sit on the dorsal ridge of the peduncle just before the fluke insertion and house the tag electronics (Figure 4). The saddle pack tag is modeled after a typical equestrian saddle. Just as a rider's weight is distributed to either side of the horse's spine, the whale saddle incorporates a gullet space over the dorsal ridge and "bars" to distribute the weight and pressure of the saddle pack onto the sides of the peduncle rather than the dorsal ridge itself. The fore and aft portions of the gullet are also slightly rockered to give even more room for the body to flex without the dorsal ridge coming in contact with the saddle. To provide protection against chafe, the underside of the saddle and the girth will be lined with ultra-soft, shear-resistant padding. A small lower saddle unit will also be used to protect the ventral ridge of the peduncle. To deploy the saddle, a cantilevered pole mounted on the bow of a small inflatable will drop a spring loaded armature on the caudal terminus of the whale. Once triggered, the armature's sickle shaped arms will close, latching a buckle under the whale's belly. As the arms lift away, the elasticized belt is cinched to snugly secure the saddle to the dorsal ridge of the peduncle. An electronic timed release combined with a backup corrosive galvanic release form a redundant release system for reliably removing the harness and tag system at a pre-set time. A breakaway link will also be included to minimize entanglement risk and ensure that the belt releases from the whale should the harness become fouled on any gear or other debris in the water.

System designs will be done in-house at the University of Maine and Woods Hole Oceanographic Institution. B. Woodward will lead the project working with J. Winn to design, fabricate and test the two tagging systems. M. Moore will provide veterinary expertise, advising during the tag development process and evaluating potential impacts of the tag once in the field.

WORK COMPLETED

- Continued the development of a large whale peduncle tag as a potential non-invasive tagging option by modifying the 2009 towed tag into a "charm" tag configuration
    - Re-designed the lasso and deployment system to launch the tag package with the harness using the net gun
    - Developed a rope retraction system to cinch the loop closed around the peduncle before the whale drops out of the loop

- Developed custom carabiner clip to latch the padded harness closed about the peduncle and release the lasso deployment line
- Miniaturized a programmable electronic timed release and integrated it with the carabiner clip to provide a method of releasing the harness after a pre-set time
- Developed a helmet-mounted wireless range finding system for determining distance to the whale tail during tag deployment

- Conducted field trials of net gun deployed peduncle "charm" tag on humpback whales in the Bay of Fundy
- Refined the net gun deployment system based on field season results to increase the retractor capability and lasso size and improve lassoing success potential
- Continued the development of a peduncle saddle pack tag
    - Established collaborations with the Hawaii Institute of Marine Biology and Mystic Aquarium for captive animal testing of small whale peduncle saddle pack tag
    - Developed small whale saddle pack prototype and conducted first round of testing on false killer whale in Hawaii

RESULTS

Net gun deployed peduncle "charm" tag
In 2009, the net gun deployment system was taken to the field for a first round of testing. Initially, tagging attempts were made with a 24 x 20 ft rectangular loop, and the whale was approached from the rear. Video review of the tagging sequence indicated that the loop was fully deploying, but was too large relative to the whale to close quickly enough before the whale swam out of the loop. The lasso size was subsequently reduced to a 10 x 15 ft loop with a side approach to the animal. However, even with the smaller lasso on a high fluke out with the flukes fully encircled in the lasso, the whale was able to simply slip out the bottom of the loop before it closed.

These initial field efforts highlighted the need for an active cinching mechanism to close the loop. Rather than relying on the whale's motion away from the boat to pull the loop in as was initially anticipated, it was determined that an active quick cinching mechanism was required to draw the lasso down. Video review suggested that on a high fluke out there was sufficient time to draw the loop closed before the fluke tips go under.

For the 2010 field effort, a spring powered line retraction device was developed. This unit is capable of pulling in 22ft of line in less than a second. The lasso sized was further reduced to a 6 ft x 10ft rectangular loop. It was anticipated that the combination of the smaller loop plus the line retraction device would enable the lasso to close quickly enough to prevent the flukes from slipping out of the loop when the whale dove.

The framework used to mount the net gun on the bow of the soft bottomed inflatable used in 2009 was transferred to a 17 ft runabout for 2010, providing a tagging platform that was workable farther off-

shore and in rougher sea conditions. Figure 5 shows the net gun deployment system mounted on the boat. The sides of the lasso pack into the four compartments of the green bucket while the excess line from the retractor tube coils in the red tray below. The line retraction system lies at the base. A one-way controller allows the rope to suck into the retractor tube but prevents the whale from pulling it back out. An emergency rope cutting device was installed on the bow of the boat should the lasso line fail to break free of the whale.

This system was taken to the field and tested on humpback whales in the Bay of Fundy in August 2010. Weather and whale behavior limited tagging opportunities, and only 7 attempts were made this year (compared with 18 attempts last year). Unfortunately there were no successful tag deployments. The two primary causes of missed lasso attempts were: 1) small lasso size limiting the potential capture area of the loop and 2) bucket interference with the gun mount frame restricting the gun aiming capability.

Lasso size is a delicate balance between being large enough to reliably catch the flukes and small enough to pull closed before the tail slips out as the whale dives. In an effort to ensure the ability to cinch the lasso sufficiently to prevent the whale from slipping out, a very small loop – only 6 ft x 10 ft – was selected for this year's field season On land, the 6ft x 10ft loop could reliably loop a full scale wooden tail model. However, on the water, this small of a lasso gave a very small margin of error. In many cases, tagging attempts were very close, but never quite caught the tail (Figure 6a). With a slightly larger loop, the margin of error would increase as would the probability of success. With a larger loop, however, the capacity of the retraction device would also need to be increased to ensure that the whale did not slip out of the lasso before it could close.

The other limiting factor highlighted by the field effort was the range of motion of the gun. With the side approach to the whale, it is necessary for the gun to rotate to approximately 120 degrees on either side of forward to allow for shots when the tail is directly in line or slightly behind the bow of the boat.

In the current configuration, the lasso bucket is mounted in front of and below the gun itself. The gun can swivel approximately 75 degrees in either direction, covering a sweep of 150 degrees, before it contacts the frame on which the gun is mounted. During the tagging process, the boat is generally paralleling the whale's track at the time of the fluke out. However, a slight change in relative position between the whale and the boat can result in the tail being directly beside or slightly behind the bow of the boat when it is time to fire. In this instance, the gun would need to turn at least 90 degrees to center the flukes within the loop. With the limited turning radius, even with the gun hard over, the bucket would confine the gun's rotation, and the lasso would pass just ahead of the fluke (Figure 6b).

The field season results suggest that with a few minor modifications the net gun shows real promise for a tag deployment device. To address the lasso size issue, the retractor system has been re-designed to double its capacity. Correspondingly the lasso size had been increased into a 15ft top & sides loop with a 10 ft padded bottom. On the water tests with the new loop shows that it flies extremely well, opens wide, hangs in the air and lands in the water in a wide open rectangle. With the increased retraction capability, the loop pulls down very quickly into an elongated oval. It does not pull it in as tightly as the 6 x10ft loop could cinch, and it is not impossible for the whale to slip out. However, unless the whale is directly 90 degrees to the side of the boat and tilts his flukes on the way down, it is unlikely that the whale will pull out of the loop.

The net bucket and frame have also been modified to accommodate a larger range of motion of the gun. The front-mounted bucket has been replaced with tubes that nestle between the barrels of the gun. Each side of the lasso tucks into its own individual tube to prevent any possibility of tangling on deployment. The frame mount for the gun has been adjusted to reduce the size of the back bar brace, allowing a complete 360 degree swing of the gun. A tilt feature has also been enabled on the gun mount to allow the gunner more ability to adjust moment to moment in the field to accommodate the whale's position relative to the boat.

The new system modifications are ready for a field trial.

Small whale peduncle saddle pack tag
Two prototype small whale saddle pack tags were developed using the mold of a pilot whale peduncle as a model. The first saddle houses a WHOI DTAG, an ARGOS satellite transmitter and VHF beacon while the second mini-saddle only holds a small time-depth recorder and VHF beacon. These units were tested at the Hawaii Institute of Marine Biology using their false killer whale in Nov. 2009. The use of captive animals allowed the saddle to be evaluated in a controlled situation to examine saddle fit, animal reaction to the saddle, chafe, and performance of the attachment mechanism under high energy maneuvers (fast swim or breach).

The whale adjusted to the saddle pack fairly quickly with a short period of acclimation. However, the morphology of the false killer whale differed significantly from that of the pilot whale used as a model during the saddle construction. As such, the larger saddle pack extended too far down the sides of the peduncle and tended to rub the top of the fluke blade when the animal swam. The mini-saddle pack was a much better fit for the false killer whale's body form (Figure 7).

One of the primary concerns during the saddle design was potential chafe on the knife-edge of the dorsal and ventral ridge of the peduncle, and the prototype saddle pack was effective at eliminating this chafe point. However, the saddle did tend to slide back slightly at higher swim speeds and the girth started to chafe at the juncture of the peduncle and fluke. A foam sleeve over the girth greatly reduced the skin chafe on the leading edge of the fluke, but some polishing/exfoliation of the outer skin cells was evident even after a short swim period (Figure 8). Over time, it was anticipated that this polishing may overcome the skin's ability to regenerate.

The saddle is currently undergoing refinement to address the issue of girth chafe on the fluke junction. Additional testing is planned with the false killer whale as well as with the beluga whales at Mystic Aquarium in Connecticut to look at how species-specific variations in skin characteristics (thickness, abrasion resistance, etc.) and peduncle morphology may affect the saddle fit and performance.

IMPACT/APPLICATIONS

It is anticipated that the peduncle belt (either as a "charm" tag or saddle pack) will provide a versatile tag attachment platform that is applicable to many medium to long-term cetacean tagging studies. The system is designed to be easily adjustable to accommodate a wide variety of species (beaked whales to baleen whales), tag electronics packages (satellite/GPS location tags to multi-sensor data loggers with acoustic recording capabilities), and tag deployment lengths (weeks to months to years) to meet the desired experimental design. From long term migration pattern studies to controlled exposure behavioral response studies, the peduncle belt shows great potential as an alternative noninvasive, recoverable tag attachment platform.

RELATED PROJECTS

There are no related projects.

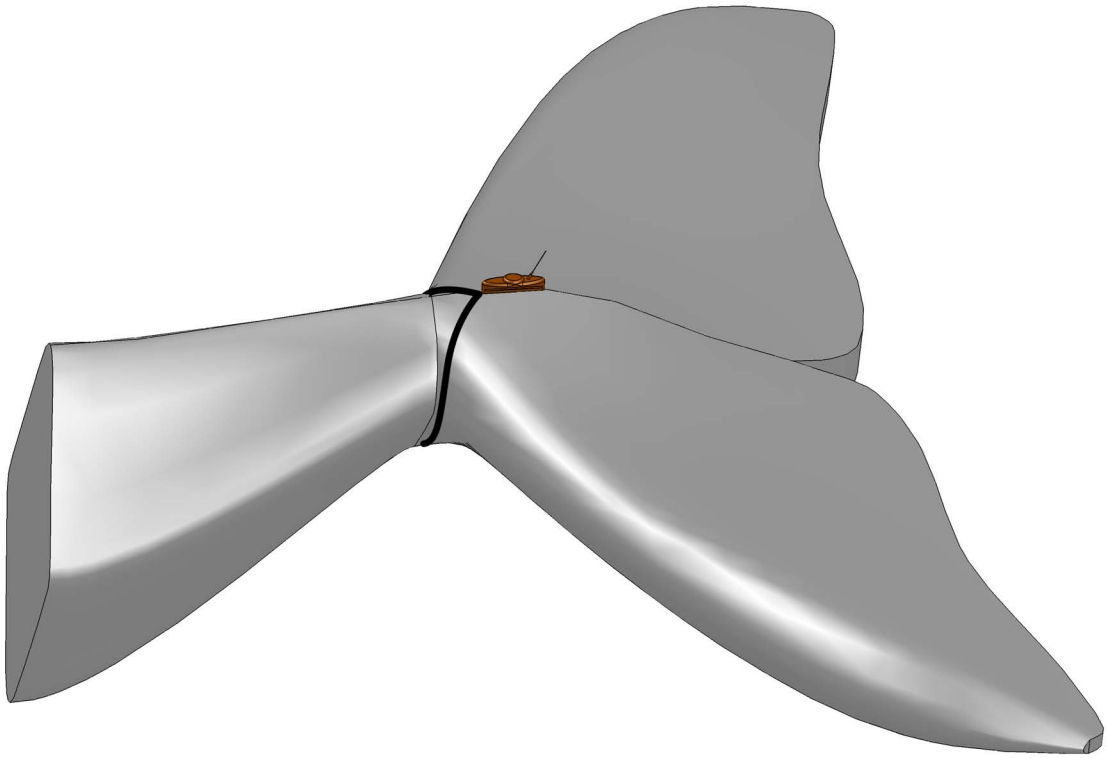

Figure 1. To scale drawing of the peduncle "charm" tag on a humpback fluke. Tag package attaches directly to a loose padded harness that encircles the whale's peduncle.

Figure 2. Successful lasso attempt on a model right whale tail during on-the-water testing of the net gun deployment system.

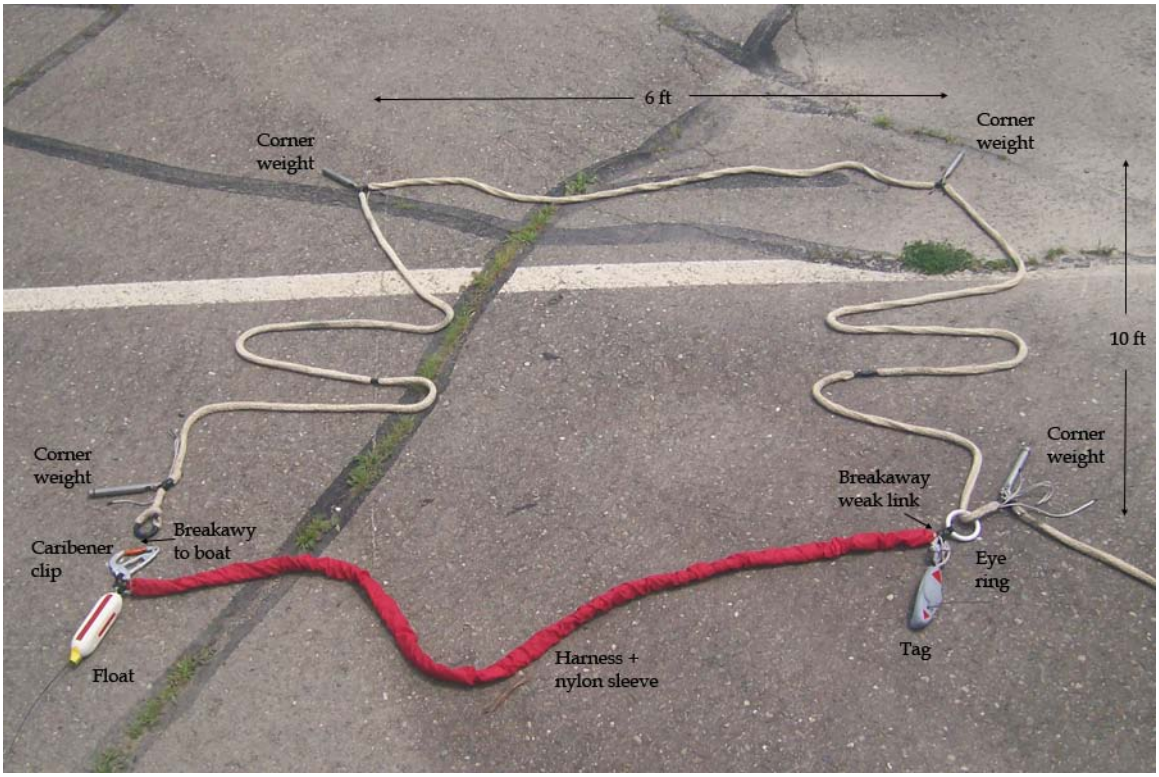

Figure 3. Lasso ready for deployment. Tag is connected to the eye ring side of the loop while the carabiner clip and spare flotation is on the opposite end of the padded harness section. Once the carabiner clips onto the eye ring, a breakaway to the boat releases the remainder of the lasso leaving only the padded harness on the whale.

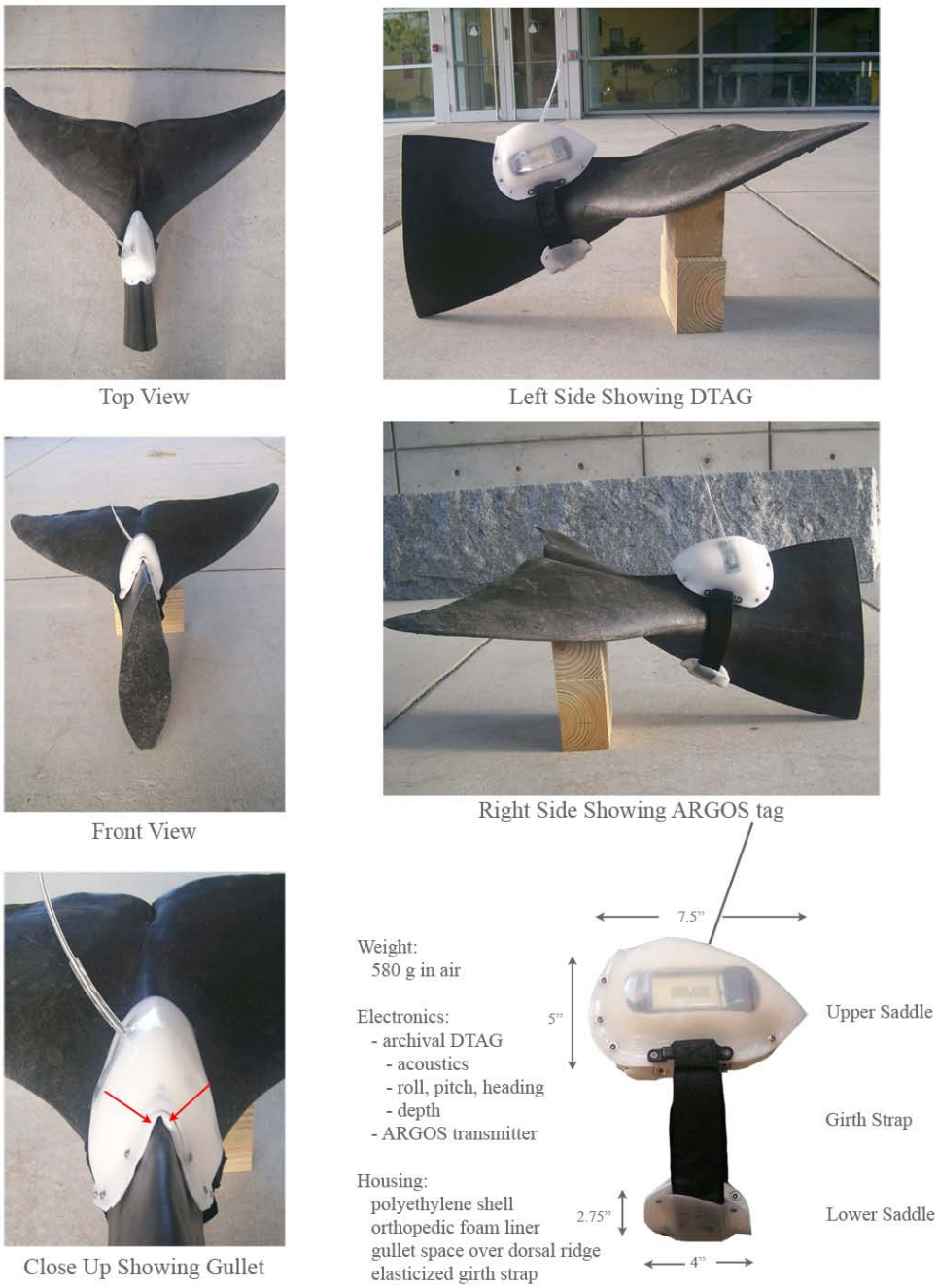

Figure 4. Prototype peduncle saddle pack tag on pilot whale model.

Figure 5. Net gun deployment system mounted on the bow of the tag boat. The sides of the lasso pack into the four compartments of the green bucket while the excess line from the retractor tube coils in the red tray below. The line retraction system lies at the base. Emergency rope cutter at the bow can be used to sever the lasso line if it fails to break free from the whale.

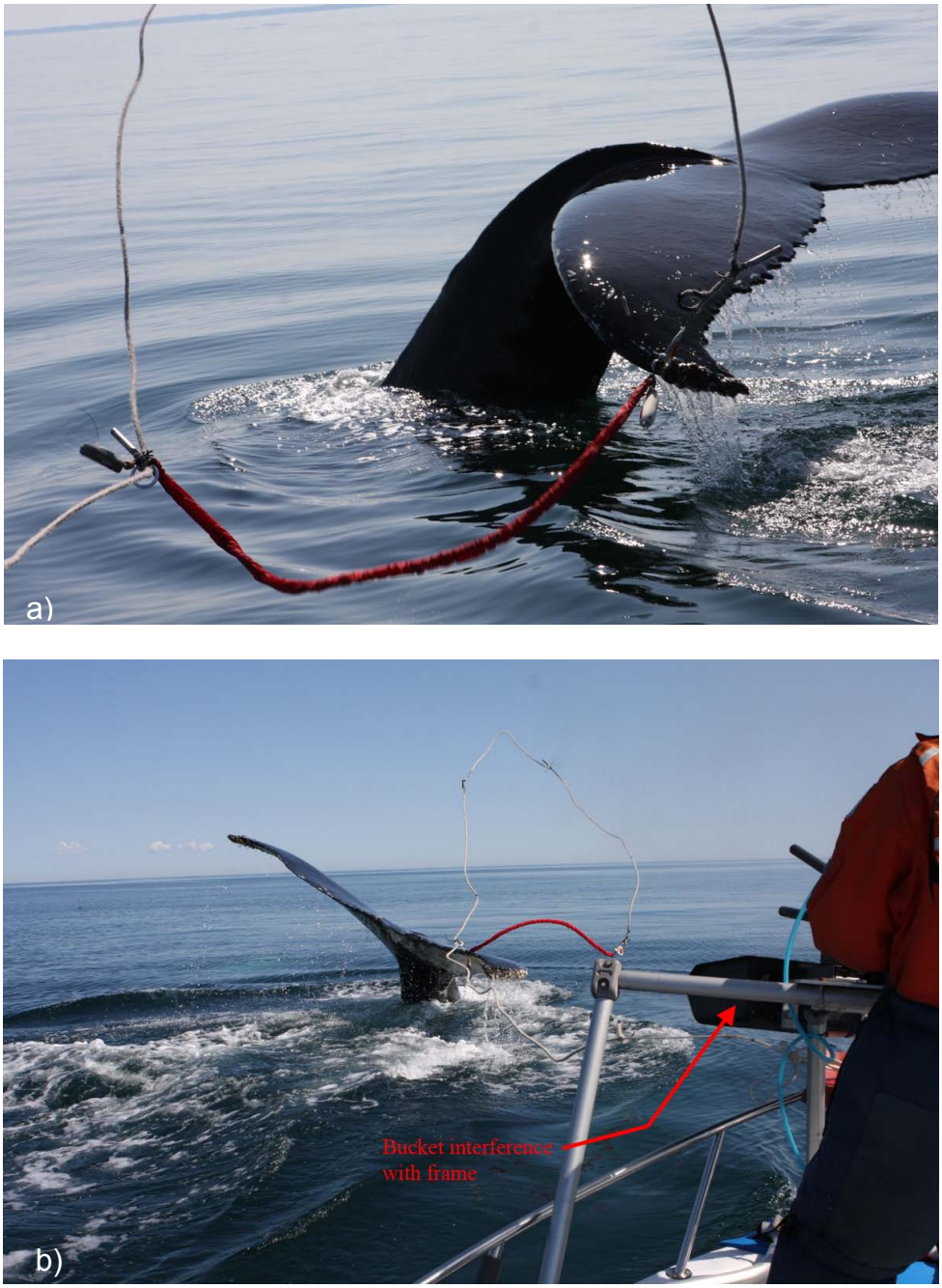

Figure 6. Common causes of missed lasso attempts: a) small lasso size. The 6ft x 10ft lasso just misses the near edge of the fluke blade. b) bucket interference with gun mount frame. The bucket hit the frame and could not turn any further. As a result, even with the gun hard over, the lasso passes just ahead of the flukes. With a slightly larger loop and greater range of motion of the gun, the lassoing success potential would be greatly increased.

Figure 7. Mini saddle pack tag on false killer whale at Hawaii Institute of Marine Biology. Dorsal and ventral saddles protect the peduncle ridges. Tag electronics are housed in the dorsal saddle pack along with flotation for tag recovery.

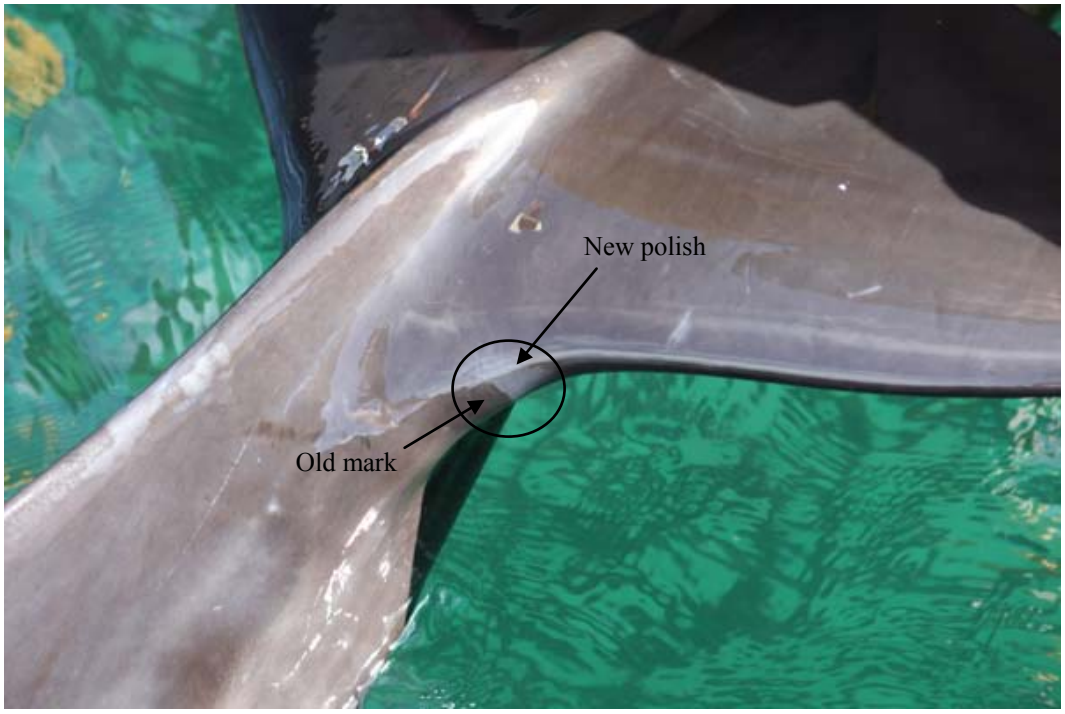

Figure 8. Fluke juncture after 15 min free swim and 10 minutes of high speed recalls. There is only a slight polishing of the skin surface. Dark mark is chafe from non-padded, elastic girth from the day before. White area is polishing following swim with the foam padded girth.