

# Example of applying a Health, Safety and Environment management system in cetacean research: Case study from a satellite tagging field accident

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## ABSTRACT

Satellite telemetry is a powerful method to study the movements and habitat use of cetaceans. The deployment of transmitters is usually conducted using remote techniques and involves close approaches to the target animals. The present study reports on an accidental collision between a female humpback whale and an inflatable boat, which occurred on 7 October 2010 off the coast of Brazil. At the time of the accident, the boat was occupied by four crew members: the tagger, the photographer, the driver and an observer. This collision resulted in head trauma and severe brain injury to the photographer. It also resulted in changes of the tagging deployment procedures and the implementation of a Health, Safety and Environment (HSE) management system. The objective of this work is to report on this accident and describe procedures adopted to assess and minimise risks. Changes and updates in deployment protocols are viewed as improvements to minimise accidents during marine mammal tagging operations. Some of these improvements were also discussed and implemented by other organisations. Accidents such as the one reported here can and should be prevented. However, when they occur, they provide an opportunity to assess and correct unanticipated deficiencies in field work procedures.

**KEYWORDS:** HEALTH AND SAFETY; ENVIRONMENTAL MANAGEMENT; MARINE MAMMALS; SATELLITE TAGGING; FIELD ACCIDENT; HUMPBACK WHALE; BRAZIL

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## INTRODUCTION

Telemetry has become a powerful technique to study marine mammals in the past three decades and has broad application in cetacean research and management (Johnson *et al.*, 2009; Lander *et al.*, 2018; Mate *et al.*, 2007; Nowacek *et al.*, 2016; Andrews *et al.*, 2019). Electronic tags can be used to track individuals and describe their migratory routes and migratory destinations (Quakebush *et al.*, 2010; Zerbini *et al.*, 2006; Mate *et al.*, 2015), to understand their physiology, foraging ecology and the environment that they inhabit (Goldbogen *et al.*, 2017; Laidre and Heide-Jørgensen, 2007, Heide-Jørgensen *et al.*, 2014; Madsen *et al.*, 2006; Noren *et al.*, 2012; Schorr *et al.*, 2014), and to assess their behaviour relative to human-related activities (Falcone *et al.*, 2017; Nowacek *et al.*, 2004; Rosenbaum *et al.*, 2014; Zerbini *et al.*, 2015).

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Because of their relatively large size, it is often impractical to capture medium and large size cetaceans for instrumentation. Therefore, electronic tags are usually deployed using remote techniques, which typically involve the use of small boats to closely approach target animals, often within just a few meters at relatively high speed (Heide-Jørgensen *et al.*, 2001; 2006; Mate *et al.*, 2007; Gales *et al.*, 2009). Such proximity may result in contact between the animals and the researchers, representing a risk for both.

Most activities conducted by people involve some risk, but the implementation of a health, safety and environmental (HSE) management system can be seen as a step towards managing this risk (Bedford and Cooke, 2003). Risk assessment can serve as the basis of a HSE management system (Mackay, 2004) and constitutes an appropriate way to prevent accidents, assess the controls in place, implement recovery measures, and mitigate consequences when controls fail (Bedford and Cooke, 2003). Most risk assessment techniques are composed of four different steps: identify, assess, control and recovery.

This paper describes an accident that resulted in a severe head trauma and highlights the importance of implementing a HSE system for marine mammal field work in order to identify the hazards and document their monitoring and control procedures. This study documents a case of a collision between a small boat and a female humpback whale during satellite tagging operations using remotely deployed instruments. This accident is used as an example to demonstrate the value of the implementation of risk assessment techniques to better assess conditions prior to tag deployment, minimise risks, and potentially improve safety during marine mammal field operations.

## THE ACCIDENT

Satellite tagging of humpback whales has been carried out off the coast of Brazil since the early 2000s (Zerbini *et al.*, 2006; 2011; Andriolo and Zerbini, 2011). The tagging team is based on land or on a large vessel that serves as the ‘mother’ boat. When operating from land, if conditions are appropriate, a fibreglass vessel (e.g., a 35–40ft launch with a tall flying bridge) and two smaller rigid hull inflatable boats (RHIBs, 22ft, outboard engines) are deployed for conducting tagging, biopsy sampling and photo-documentation. One small RHIB operates as the ‘tagging’ boat and carries four crew members (a tagger, a coxswain, a photographer and a biopsy sampler). The second RHIB carries 2-4 crew members and is used as a safety boat or serves as a platform for collecting behavioural information and additional samples (e.g., biopsies, photo-identification data) whenever applicable. If necessary, the second RHIB can also be used as a tagging platform. The larger fibreglass boat is used as platform for searching for whales and tracking groups that could potentially be approached for tagging. If operations are conducted from a large vessel (as opposed to land), small boats operate in a fashion similar to the one described above, and the ‘mother’ boat plays the role of the fibreglass launch.

Two types of tags have been deployed during this project: type A (anchored tags, e.g. LIMPET tags) or, more commonly, Type C (consolidated) tags as defined by Andrews *et al.* (2019). Deployment of these tags are done using remote methods, including poles (Heide-Jørgensen *et al.*, 2006), crossbows (Andrews *et al.*, 2008) or pneumatic rifles (Heide-Jørgensen *et al.*, 2001; Gales *et al.*, 2009). These types of tags require the tagging boat to closely approach an animal targeted for instrumentation, often within range of 3–10m, which represents a potential risk to both whales and researchers if contact between the tagging boat and the animal occurs.

On 7 October 2010, an accident occurred during attempts to deploy a Type C tag on a humpback whale mother-calf group using a pole at approximately 12.7 n.miles southeast off the entrance of the Camamu Bay estuary (13°48′09″S; 38°55′32″W), Bahia State, Brazil. At the time of the accident, the sea (Beaufort 2) and visibility conditions were appropriate. Two attempts to deploy the tag on the adult whale (calves are not tagged) had occurred, starting at 11:35am but were unsuccessful as the approaches were insufficient to place the tagger within deployment range and no contact of the tagging pole with the target animal took place. The tagger indicated that a third approach would be needed but requested the boat to stop so adjustments to the pole could be made and he could better position himself in the boat’s tagging bow platform. The engine was set to idle and the bow of the boat moved to the opposite direction relative to the target whales. As the RHIB is turning away from the whale, at 11:41am, the larger animal collided with the tagging boat and two impacts were felt by the crew due to the contact of the boat with the whale’s dorsum and tail. The first contact, a lighter one, pushed

the boat towards the port side and the second, a stronger one, occurred at the moment the boat was righting itself up. As a result of the collision, the coxswain sustained injuries on his left arm, shoulder and back due to blunt force impact to the boat's cockpit. The photographer was first thrown forward upon the first impact and hit his forehead on the back of the tagger, then he was thrown backwards upon the second impact hit the back of his head on the boat cockpit. The photographer became unconscious due to a severe head/brain injury as a consequence of the blunt force impact with the boat cockpit. He required immediate medical evacuation, remained in a coma for 10 days, and had to be away from regular work for two years after the accident. The tagger was thrown overboard upon the first impact but neither him nor the fourth crew, located at the rear of the RIHB, member was injured. All crew members were wearing their life-jackets and the tagger was also harnessed to the boat. The harness became undone, as it was designed to do, upon the impact of the boat and the whale.

It is unclear why the impact occurred because the boat had changed trajectory away from the whale. Examination of video footage taken from the tagging attempt at a distance and interviews with the crew suggested that immediately prior to the incident, the calf changed its swimming direction and dove underneath the boat. The mother followed the calf and initiated a dive such close proximity to the tagging boat that resulted in the contact of the dorsum and the fluke. The fate of the whales involved in the accident is unknown, however, the observers in the flying bridge of the fibreglass vessel observed the whales come to the surface within minutes of contact with the boat, as that vessel approached the tagging RIHB to provide assistance. No clear injuries were seen on the mother and no abnormal behaviour was documented. Longer-term visual tracking of these whales was not possible the crew on all vessels focused on providing first aid to the two injured crewmembers.

## **RISK ASSESSMENT FOR TAGGING OPERATIONS AND PROTOCOL CHANGES**

The combination of information from incidents such as the one described above, along with an evaluation of methods for remote deployment of telemetry instruments to free ranging cetaceans can provide a means to identify potential hazards so that procedures can be modified to control and mitigate the risks involved (Slovic, 2000) and operational safety can be improved.

Risk assessment techniques provide an early identification of the hazards and effects and assesses the potential consequences, estimating their likelihood. A risk assessment matrix was used to identify potential hazards, their likelihood of occurring and their consequences. The likelihood is related to the events frequency based on historical data (Slovic, 2000). The risk assessment matrix uses the hazard identification method, assessing the risk level and the controls in place to manage these.

This incident stimulated the development of a HSE (Health, Safety and Environmental) management system based on a risk assessment (Table 1) taking into consideration operational safety, assets, environment and reputation of the research structure that conducts the project and company which sponsor it. The accident also provided enough information to implement procedures to manage, avoid and remedy operational hazards. The risk assessment conducted for tagging operations in the present study considered various hazards (Table 1). On that assessment developed and discussed, health hazards such as sunstroke, physical injury to personnel as well as equipment damage/loss and the health of the animals.

As a result from the study conducted, five main changes have been made and are now mandatory for occupants of the tagging boat:

- (1) use of helmets and padded life-jackets by all crew members to provide protection for head and torso;
- (2) more rigorous training in tagging operations and previous experience on other cetacean sampling activities (e.g., biopsy sampling) for crew members of a tagging boat;
- (3) no observers are allowed onboard;
- (4) a change of arrangement of the people on the boat, so that the photographer, who is often looking through the viewfinder of a camera and, as such, may lose situation awareness, is more protected (Fig. 1); and

- (5) a more structured evaluation of the animals' behaviour must be completed before the tag deployment (Hunt *et al.*, 2008).

If there are any concerns about safety then the operations are cancelled. As methods improve, other actions to minimise risk have been developed. For example, biopsy samples can now be collected by tag carriers or devices at the tip of the poles and high-definition action cameras can be used to document tag deployment so that the number of crew members in a tagging boat can be reduced.

Table 1

Risks identification developed for the Whales Satellite monitoring project (PMBS). The risk Rank numbers shows the risk assessment result, as a project HSSE Medium Risk. The numbers represent the amount of registers related to each occurred impact, to base the risk assessment.

Severity	Consequences				Increasing likelihood				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of in the industry	Heard of in the industry	Has happened in the Organisation or more than once per year in the Industry	Has happened at the Location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact	0	0	0	0	0
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact	1	1	0	0	0
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact	3	1	0	0	0
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact	0	7	0	1	0
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact	0	0	0	0	0
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact	0	0	0	0	0

Key:

Risk rank		
Very low	5	36%
Low	8	57%
Medium	1	7%
High	0	0%
Total	14	100%

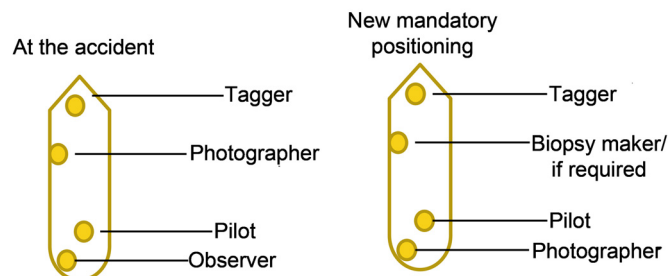


Fig. 1. Positions of the crew onboard of the tagging boat during the accident and after the new procedure was developed.

## FINAL REMARKS

The use of methods where contact between researchers and the research subjects can lead to risk of injuries the implementation of prevention and recovery procedures is necessary to guarantee a safe working environment (Hunt *et al.*, 2008). The changes and updates in the deployment procedures presented here are designed to minimise accidents during field work operations. Efforts are made to remotely deploy electronic tracking devices

and the approach described above could be extended to other similar research. Such approach includes formal processes to manage all identified risks for safety, health and environment. After the accident reported here, 5 safety procedures were changed or updated (numbers (1) to (5) above). These changes were designed to minimise hazards within a management system (Jacobzone *et al.*, 2007) using the development of a risk assessment. A management system that includes appropriate prevention and recovery procedures is an important tool to ensure risk management is consistent with risk assessment. Such tools have become standard in several human activities (Schwing and Albers, 1980; Slovic, 2000; Wijnhoven *et al.*, 2009). The use of such a system is essential to guarantee the monitoring, prevention, avoidance and management of all hazardous events. (Bhuiyan and Baghel, 2005). Some of the changes and improvements proposed above have also been discussed and implemented by other organisations performing tag deployment operations (e.g., NOAA's Alaska Fisheries Science Center).

When accidents occur, such as the one reported here, the circumstances associated with the events need to be documented in detail to serve as a basis for future risk assessment. This will also provide an opportunity to assess and correct unanticipated shortcomings in field work operations. It is important to manage risky marine mammal field operations with management systems that can identify and manage hazards. Because of this, the development of HSE management systems must be based on a risk assessment that includes all the related procedures so that all hazards can be identified and mitigated (Hillary, 2000).

Besides the changes on the operational tagging procedures, there were updates and operational changes which were based on an evaluation of the potential causes of accidents. Several programs and procedures were developed within the management system including a wildlife protection programme, waste management procedure, protection equipment checklist, operational risk assessment, safety plan, emergency plan, evacuation plan, vessels equipment checklist, and documentation checklists for vessels and crew.

When referring to a management system and the planning approach, a HSE policy statement can be seen as a first step of its implementation (Mackay, 2004; Bhuiyan and Baghel, 2005). This is then followed by a continuous cycle of improvement, termed the PDCA (Plan, Do, Check and Act). This cycle is the basis of a management System, whether Health, Safety or Environment Management (Jacobzone *et al.*, 2007; Mackay, 2004). Development, implementation and management of a PDCA system should not only be updated upon a significant event, it requires continuous monitoring (Romaniello *et al.*, 2011). Considering the accident reported here, the development of an internal policy, including a commitment to protect health and safety corresponds to the 'Plan' step with the procedures to monitor, prevent and remediate the identified hazards as the 'Do' step. The identified changes and improvements on prevention and remediation procedures can be seen as the 'Check' step, and when the procedures were created or reassessed can be stated as 'Act' step. These actions, along with a risk assessment represent appropriate tools to monitor and control the identified HSE hazards and effects (Mackay, 2004; Romaniello *et al.*, 2011). It is important to note that risk assessments that fall into yellow or red categories (Table 1) do not imply cancellation of operations, but they require procedures to be put in place to minimise those risks and to ensure a quick and efficient response in case of an accident (Slovic, 2000).

The implementation of HSE management systems in marine mammal research is an important step to prevent and manage potential hazards identified during field operations. These strategies, which include avoidance, prevention, rescue and evacuation procedures (Romaniello *et al.*, 2011) make research operations safer for scientists and animals. The lessons learnt using these management systems have helped to improve safety in research conducted by other organisations involved in remote tagging of marine mammals and have become standard best practices in operations for this type of research (Andrews *et al.*, 2019).

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