LIFE DELFI

Dolphin Experience: Lowering Fishing Interactions

LIFE18 NAT/IT/000942

Action A3: Framework for fishery interaction

1. INTRODUCTION

Every year, thousands of cetaceans are victim of the interactions with fisheries and many other are not included in the statistics due to the absence of standardized diagnostic frameworks and the difficulties to evaluate decomposed carcasses as well as the unrecorded cetacean strandings on inaccessible locations. This document gives the opportunity to partially fill these gaps proposing a framework created to support the examiner of a cetacean carcass in the collection of signs and lesions attributable to the interaction with fishery.

The framework presents a multi-tier structure (considering the expertise of the examiner, human resources and logistic), according to the "Best practice on cetacean *post mortem* investigation and tissue sampling" joint ACCOBAMS and ASCOBANS document (IJsseldijk, L.L., Brownlow, A.C., Mazzariol, S. 2019) annexed to the ACCOBAMS Resolution 7.14.

The aforementioned joint document should be considered as an update of the existing *post mortem* protocols with the currently available techniques and methodologies agreed between all member countries of ACCOBAMS and ASCOBANS. This updated protocol aimed to provide a reference document across European networks; to highlight harmonization of data from existing networks; to provide a start-up guide for researchers attempting to instigate new stranding monitoring and surveillance programs.

2. GLOSSARY

In the present document we have included all those terms that should be related to interaction with fishing activities, while for the forensic and anatomo-pathological definition refer to the glossary of "Best practice on cetacean post mortem investigation and tissue sampling" joint ACCOBAMS and ASCOBANS document (IJsseldijk, L.L., Brownlow, A.C., Mazzariol, S., 2019).

2.1 Definitions related to interaction with fishing activities

Fishery interaction: any behavior which drives a marine animal to have a contact with a fishing gear or operation.

Active fishing gear: gears that are moved in order to catch fish by trapping or encirclement (e. g. trawlers).

Passive fishing gear: gears that are left in place for a period before retrieval (e. g. set nets, longlines).

Chronic entanglement: when the pathological sign of the entanglement are chronic (i.e. entanglement in ghost nets or part of it, or by-catch event where the animal survived ripping the net).

Peracute Underwater Entrapment (PUE) – *acute entanglement*: acute mortality of marine mammal caused by entanglement and forced submersion and can entail complex determinations of ultimate cause of death (Moore *et al.*, 2013) the pathological sign of entanglement are acute.

Entanglement: is defined as the entrapment of an animal in marine debris (related to fishery or not) or fishing gear in activity. The impact of the entanglement in fishing gear is a global issue impacting more than 260 species including marine mammals, sea turtles and seabirds (Derraik, 2002). The immediate effects of entanglement include acute mortality, serious injury, minor injury, or no injury. Long-term effects include deteriorating health, decreased reproductive ability, chronic injuries, impairment and energetic burden, long-term sub-lethal effects or no impact. The deleterious effects of entanglement occur most frequently at the level of the individual (Asmutis, 2004; Wells *et al.*, 1998). For smaller cetaceans, entanglement can cause death by drowning due to the difficulty of such animals to break free from net (McCulloch and Goldstein, 2011). While a special emphasis of the effects of marine debris and fishing gear interactions by the marine mammal management agencies

has been on commercial fishery, not the same pressuring interest is addressed to the impact of recreational fishery. Within the anthropogenic threats on marine wildlife entanglement is considered of high priority for the welfare and conservation of these species. The entrapment of cetaceans or part of them in fishing-related debris (ghost nets) is defined **passive entanglement** (Macfadyen *et al.*, 2009). The entanglement due to direct interaction of cetaceans with operating fishing gears is considered an **active entanglement** (i. e. bycatch or PUE). The competition for the same resource or opportunistic feeding are considered the principal driving cause of small cetacean by-catch in fishing gear (FAO, 2018).

2.2 Glossary related to categories of entanglement based on post mortem examination

During the post mortem examination is difficult to determine the origin of materials removed from entangled cetaceans and to assess whether the origin of the entanglement signs represents a by-catch event, where the animal succeeds in ripping the net, or a passive entanglement event in fishing related debris. Therefore, from a pathological point of view, these cases fall within the same fishery interaction category (i.e. chronic entanglement). It's fundamental to stress the importance of making this determination because incorrect assumptions about the source and origin of entanglements could funnel time, resources and political will in the wrong direction.

Larynx entanglement or laryngeal strangulation: the condition in which a larynx (goose-beak) get wrapped and/or twisted in an ingested fishing. This occurrence is particularly observed in dolphins depredating fishing gears (gill-net) which, in the time to swallow, the net, with or without the prey, instead to reach the forestomach gets the larynx trapped. The fishing gear can be of different types and size mesh and can encircle the larynx at different depth and level from the top to the base. The gear lodged at the larynx level can cause displacement, dislocation, compression, obstruction or chronic lesions resulting in serious and fatal consequences related to feeding, breathing (asphyxia) or health deterioration. Fishing net hanging from the mouth, sometimes enrolling flippers or other appendages, is frequently the first indication during the external examination. According to Gomerčić *et al.* (2009), the most frequent pathological changes affecting the larynx are edema, mucosal injury, and hypergranulation. Their severity reflects the time interval from the strangulation to death. The main issue concerning odontocetes is represented by the position of the larynx making it vulnerable to foreign bodies, for example, fishing-net parts, during deglutition. Indeed, as described by Gomerčić *et al.* (2009): "the larynx is elongated into a tubular extension, the laryngeal spout, that transverses the digestive tract into the nasal cavity, where

it remains in the erect position during deglutition". With this structural adaptation, the inspired air directly flows from the blowhole and nasal cavity to the larynx and trachea, while the ingested food passes through wide food channels lateral to the laryngeal cartilages by way of the paired piriform sinuses (Reidenberg and Laitman 1987; McLeod *et al.*, 2007), differently from the terrestrials mammals.

Ingestion: with ingestion is defined the active consumption/feeding of marine debris causing physical blockage at various level of the digestive system, leading to injuries, pain and death. This circumstance involved in particular the species with not-selective feeding behavior (raptorial feeders and suction feeders) which may confuse and consequently ingest marine debris in the same foraging ground or in the vicinity of actual food items (Werner *et al.*, 2016). In order to study the impact of marine debris ingestion on marine mammals during *post mortem* examinations, it is recommended to adopt the "Evidence Based Diagnostic Assessment framework for cetaceans necropsies on marine debris ingestion and common data collection" (Annex 5 IWC/SC/68B/REP03 and ASCOBANS/MOP9/Inf.6.2.3a). The framework represents an effective tool to assess and categorize the presence of fishery-related debris in the marine mammals digestive system.

Intentional injury: the situation where a fisherman intentionally hurt the cetacean (i.e. shoot, amputate fin in still alive animals). Globally, pelagic and coastal fisheries consider cetaceans as undesirable competitors, or responsible for gear damage or catch damages and reduction. In the Mediterranean context, due to the frequent daily direct contact with the fishery industry stakeholders, dolphins were the target to eradicate perceived competitors of the fishing industry (Bearzi *et al.*, 2010; 2008) or their meat was consumed regularly as a traditional food (Curci & Brescia, 2015). Today, the implementation of legislations, protection measures and public awareness have reduced the impact of this threat, despite the persistence of irrespective practices of national and international regulations such as the dolphin meat black market (Curci & Brescia), the use of dolphins as bait (Mintzer *et al.*, 2018), and the direct injury by fishers who blame dolphins for poor fishing yields (McLaughlin, 2017; Squires, 2017). Any injury inflicted deliberately to a dolphin could happen due to different reasons and using different weapons. The injury could present many different characteristics based on the weapon and the position of the aggressor. The injury can occur *pre mortem* or *post mortem*, on board or directly in the sea or while the dolphin is entangled/by-caught in the net; in any case, it is frequent to observe the injury inflicted on the laterodorsal side of the animal which is consistent with the fishermen's position just

above (Puig-Lozano *et al.*, 2020) or perform a mutilation or amputation of the appendages (flippers, fluke, dorsal fin) if the animal is entangled in the net (Moore *et al.*, 2013). Based on this, the injury can be unique or multifocal, superficial or penetrating, gunshot, contusion or sharp tool wounds.

2.3 Glossary related to post-mortem evidences of fishery interaction

Evidences of direct evidences of fishery interaction (specific for each category)

Presence of fishing gears: fishing gears or part of them still presented on the body or part of it (rostrum/mandible, head, pectoral flippers, dorsal fin, peduncle, fluke), rope around the tail stock that was added to enable removal from a net (Cox *et al.*, 1998; Moore *et al.*, 2013).

Marks/linear signs: acute: fresh fine or deep skin linear lesions with alteration of skin, colour, furrows and impressions encircling or present at the level of the whole body, rostrum/ mandible, head, pectoral flippers, dorsal fin, peduncle, fluke, prescapular; lacerations at the gape of the mouth; chronic (constriction lesions): linear necrotic and fibrotic lesions; (de Quirós *et al.*, 2018; Moore *et al.*, 2013).

Sharp and penetrating wounds: i. e. amputation of fins, flukes, or tail, penetrating incision into the abdominal cavity (Cox *et al.*, 1998; Moore *et al.*, 2013).

Fractures: in the mandible (fractured beaks), other parts of the cranium, and ribs, broken/lost teeth (Kuiken, 1994; Cox *et al.*, 1998; Jepson et al., 2013; Moore *et al.*, 2013).

Other fishery interaction - associated lesions

Capture myopathy: to be confirmed through histopathological exam (multifocal acute degenerative changes in cardiac and skeletal muscles) and IHC with anti-fibrogen and anti-myoglobin antibodies.

Separation of the rectus abdominis muscles: rupture of the *linea alba* with concomitant separation of the left and right muscles from each other (Epple *et al.*, 2020).

Decompression gas bubbles: presence of gas bubbles dissiminated in the cardio-vascular system and organ (both sub-capsular and in the parenchima) (De Quiros *et al.*, 2012).

Linea alba erniation: entrapment of the peritoneum, often in addition to mesentery (including the omentum, medial umbilical ligaments, median umbilical ligament, and/or falciform ligament) through the internal lamina of the rectus sheath or *linea alba* that showed evidence of an acute response (Epple *et al.*, 2020).

Aspecific findings

Airway and pulmonary changes: macroscopic lesions: stable froth/ blood-tinged watery fluid in the airways; heavy edema and congestion, multifocal emphysema and atelectasis, diffused hyperinsufflated lungs, incomplete collapse of the lungs, pulmonary subserosal petechiae; microscopic lesions: perivascular edema and haemorrhage, (Duignan *et al.*, 2003; Epple *et al.*, 2020; Jepson *et al.*, 2013; Puig-Lozano *et al.*, 2020).

Other pathologies

Absence of other pathologies: absence of other severe pathological processes that could have brought the animal to a compromised health status and, possibly, to death. It's important to differentiate the simple positivity of the animal to a specific pathogen and the positivity associated to the infection (presence of pathogen specific associated lesions). If an animal is positive to a pathogen but have no manifestations of the infection, it cannot be considered as a presence of the disease.

3. MULTI-TIER APPROACH

According to the aforementioned post-mortem investigation protocol (IJsseldijk, L.L., Brownlow, A.C., Mazzariol, S., 2019), the framework has been developed according to a multi-tier approach, considering the expertise, human resources and logistic.

Evidences and data collected in **tier 1 and 2** are useful to assess any interaction between the stranded individual and fishery activities. At these levels, information suggesting an interaction with fishing activities are useful for those stakeholders involved in fishery and environment policy and management.

The cause of death and the possible relation to fisheries can be reported only during **tier 3**, which allows a deeper investigation of the interaction, implying a complete necropsy and a specialized expertise in forensic pathology. This Tier support the interpretation of interaction with fishing activities during *post mortem* examinations, the evaluation of gross and microscopic evidences and all other related exams, regardless of whether this interaction may have caused or contributed to the stranding or death of the animal. Suggestions and procedures included in Tier 3 have to be used during a throughout necropsy carried out by a trained veterinary pathologist, being a supportive tool to evaluate and interpret main findings.

3.1 TIER 1 - External examination and stranding data collection: determination of life history and fishery interaction occurrence.

Tier 1 is addressed to a wide range of operators with basic training in cetacean biology. The external examination data allows to collect information of the life history of the stranded animal/s, including external signs and findings of fishery interaction. The cause of death, included interaction with fisheries, cannot be determined.

Interaction with fishing activities can be hypothesized only with positive evidences and the absence of external findings do not support the absence of interaction. Tier 1 examiner can report the following fishery interaction: entanglement (active/passive fishing gear).

3.2 TIER 2 - Post mortem investigations and tissue sampling: assessment of fishery interaction category

Tier 2 is addressed to responders (veterinarians or trained biologists, depending on country legislation) with basic experience in cetacean *post mortem* investigations and tissue sampling. This Tier allows gross evaluation and description of the general aspect of the carcass and main findings,

but not the cause of death. From this information, the examiners could be able to categorize the type of the fishery interaction. Tissue sampling allows subsequent and targeted investigation.

Tier 2 examiner can report the following fishery interaction: entanglement (active/passive fishing gear) and ingestion.

3.3. **TIER 3 - Post mortem examination with diagnostic aims: determination of cause of death**

Tier 3 is addressed to trained veterinary pathologists able to provide an overall assessment of the *post mortem* findings, carrying out ancillary analyses aimed to assess all the possible cause of death, the presence of any ongoing infection and interpreting all the *post mortem* collected data. Tier 3 can allow to determine the role of the fishery interaction in the death of the animal, assessing mechanism and manner of death and then the cause.

4. TIERED POST-MORTEM INVESTIGATIONS

This section is focused to address personnel working on strandings to collect post-mortem data and findings according their skills and expertise, using the tiered approach described in section 3. The section is also aimed to give a support in interpreting these information in assessing evidence consistent with an interaction with fishing activities, giving some suggestions, in tier 3, when this event could be hypothesized as the main cause of death. As stated elsewhere in the document, information herein summarized should be used as a support tool for diagnosis and not as a shortcut because a complete necropsy should be always performed. Each table, correlated to a specific tier, is organised in categories to which corresponds a list of findings. The presence or absence of a specific finding (yes/no) will confirm or suggest the interaction and in the case of tier 3 also which kind.

4.1 TIER 1

At this level, only entanglement can be hypothesized. The table here below reports the list of external findings related to fishery interaction. If at least one findings is recorded, the fishery interaction is confirmed.

Categories	Findings
Findings that confirm the interaction with fishery	fishing interaction in the animal history
	presence of fishing gears (differentiate passive and active fishing gear)

4.2 **TIER 2**

The table here below summarizes the list of findings related to fishery interaction, including entanglement and ingestion, that can be assessed by a Tier 2 executer. If one or more of the relevant (confirming) findings are reported, the fishery interaction is confirmed. If only the presence of recent feeding remains in the oesophagic/gastric content is observed, the interaction cannot be confirmed.

Categories	Findings	Entanglement	Ingestion

Findings confirming the interaction with fishery	fishing interaction in the animal history	x	
	net marks/linear signs (acute or chronic)	x	
	presence of fishing gears (differentiate passive and active fishing gear)	x	
	presence of fishing gear around larynx (differentiate passive and active fishing gear)	x	
	presence of fishing gear or fragments in the gastro-intestinal tracts		x
Findings suggesting the interaction with fishery	presence of recent feeding	x	

4.3 TIER 3

Evaluation at tier 3 requires appropriate skills and expertise as well as logistic and laboratorial equipment. Besides a complete necropsy, it requires to confirm/state:

- the carcass decomposition condition code (DCC)
- Confirmation of the fishery interaction
- Presence or absence of other ongoing diseases
- Assessment of the mechanism of death

The first table here below summarizes the list of the main categories and related findings associated with fishery interaction that should be assessed during a *post mortem* investigation. Evidences are cathegorized as "certain/patognomonic" (labeled as C/P), "consistent" (named as C) and "suggestive" (S) in relation to the type of fishery interaction (i. e. by-catch with active fishing gear, by-catch with passive fishing gear, chronic entanglement, larynx entanglement, ingestion).

Categories	Findings	B (a)	B (p)	LE	CE	I	II	DCC
Direct fishing gear - associated lesions	fishing interaction in the animal history (specific for each category) (12, 18, 20)	C/P	C/P	C/P	C/P	C/P	C/P	1-5
	presence of fishing gears (active v/s passive) (12, 18, 20)	C/P	C/P		C/P			1-4
	net marks/linear signs (acute) (12, 18, 20)	C/P	C/P					1-3
	net marks/linear signs (chronic, i.e. constriction lesions) (12, 18, 20)				C/P			1-3
	presence of fishing gear around larynx (11)			C/P				1-4
	sharp and penetrating wounds (12,18)	C	C				C/P	1-3
	gunshot/bullet wounds (12,18)						C/P	1-3
	contusions (12,18)	C						1-3
	fractures (12,18)	C						1-4
Other fishery interaction - associated lesions	capture myopathy (to be confirmed with histology and IHC) (20)	C/P	C/P					1-3
	separation of the rectus abdominis muscles (6)	C	C					1-2
	gas bubbles in main vessels (2)	C	C					1-2
	linea alba erniation (6)	C	C					1
Nutritional findings	Presence of fresh oesophagic/gastric content (12,18)	C	C					1-4
	absence of fresh gastric content (12,18)			S	C			1-4
	good NCC (12,18)	C	C					1-3
	poor NCC (12,18)			S	C			1-3
Aspecific findings	bulging eyes/red eyes (2)	C						1-2
	microscopic muscular haemorragies (histology) (20)	S	S					1-3
	pulmunary and vascular changes (epicardial petechiae, edema, froth/ blood-tinged watery fluid in the airways, congesition, bullae in the lung parenchyma, incomplete collapse of the lungs, chyle in the ductus thoracicus and) (2)	S	S					1-3
	multiorgan congestion (2)	S	S					1-3
Other pathologies	Absence of other ongoing diseases (2, 12, 20)	C	C					1-3

TABLE LEGEND

B(a) = By-catch with active fishing gear
B (p) = By-catch with passive fishing gear
CE = Chronic entanglement
LE = Larynx entanglement
I = Ingestion
II = Intentionally injured
DCC = interval of decomposition code of the carcass where the finding can be assumed as true;
NCC = nutritional code of the carcass;
(no.) = references describing findings, sampling and analytical approaches

A single "certainly associated" evidence will deem a confirmed interaction. With minimum 3 S he occurrence of the specific fishery interaction can be suspected. The following table will help to hypothesized the cause of death with a degree of certainty by coupling the previous findings related to fishery interaction with other postmortem findings.

Certain (only in carcasses with code of decomposition 1 and 2)	The fishery interaction is confirmed + absence of other severe pathologies + the mechanism of death is assessed
Probable (only in carcasses with code of decomposition 1 and 2)	The fishery interaction is confirmed or suspected + absence of other pathologies
Suspected/Possible? (if the carcass present a decomposition code higher than 2)	The fishery interaction is confirmed + absence of other pathologies
Fishery interaction as a consequence of underlying pathologies	The fishery interaction is confirmed + neurological, systemic and other severe pathologies that could have predisposed the animal to the fishery interaction

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