

LIFE DELFI

Dolphin Experience: Lowering Fishing Interactions

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Action A3

Framework for fishery interaction

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Beneficiario coordinatore

Beneficiari associati

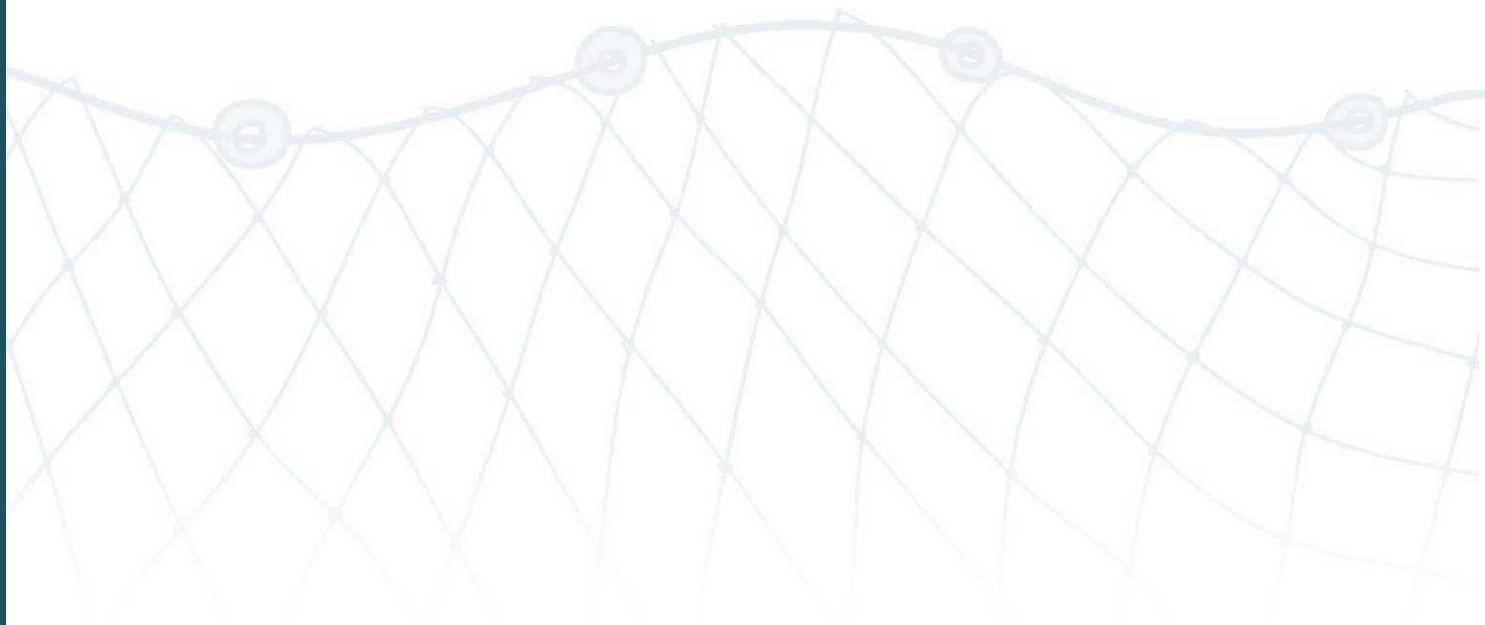


1. INTRODUCTION

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

The framework presents a multi-tiered structure (considering examiner expertise , human resources and logistics), 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 ACCOBAMS Resolution 7.14.

The aforementioned joint document should be considered as an update of the existing post-mortem protocols with currently available techniques and methodologies agreed upon by all ACCOBAMS and ASCOBANS member countries. This updated protocol is intended to provide a reference document for all European networks; to highlight the harmonization of data from existing networks; to provide initial guidance for researchers seeking to investigate 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 please refer to the glossary of “Best practice on cetacean post-mortem investigation and tissue sampling” joint document ACCOBAMS and ASCOBANS (IJseldijk, L.L., Brownlow, A.C., Mazzariol, S., 2019).

2.1 Definitions related to interaction with fishing activities

Fishery interaction: any behaviour that leads a marine animal to have contact with a fishing gear or operation.

Active fishing gear: gear that is moved to catch fish by trapping or encirclement (e. g., trawlers).

Passive fishing gear: gear that is left in place for a period before being retrieved (e. g. set nets, gillnets, longlines).

Ghost net: fishing nets or part of them that have been abandoned or lost. Sometimes these nets may aggregate together.

Entanglement: is defined as the entrapment of an animal in marine debris (fishery related or otherwise) or fishing gear in activity. The impact of entanglement in fishing gear is a global issue impacting more than 260 species including marine mammals, sea turtles and seabirds (Derraik, 2002). Immediate effects of entanglement include acute mortality, serious injury, minor injury, or no injury. Long-term effects include health deterioration, decreased reproductive capacity, chronic injury, impairment and energy 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 result in death by drowning due to the difficulty of these animals have in breaking free from the net (McCulloch and Goldstein, 2011). While a special emphasis of the effects of marine debris and interaction with fishing gear by marine mammal management agencies has been on commercial fisheries, not the same pressing interest is directed at the impact of recreational fisheries. Among anthropogenic threats to marine wildlife,

entanglement is considered a 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). Entanglement due to direct interaction of cetaceans with operating fishing gear is considered active entanglement (i. e. bycatch or PUE). Competition for the same resource or opportunistic feeding is considered the primary cause of small cetacean by-catch in fishing gear (FAO, 2018).

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.

Chronic entanglement: persistence of fishing gear in a region of the body over a long period causing chronic pathological signs (i.e. entanglement in ghost nets or part of it; secondary by-catch event in which the animal survived by ripping the net).

2.3 Definitions related to categories of entanglement based on post-mortem examination

During 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, in which the animal manages to rip the net, or a passive entanglement event in fishing-related debris. Therefore, from a pathological point of view, these cases fall into the same category of fishery interaction (i.e. chronic entanglement). It's critical 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 catch. This occurrence is particularly observed in dolphins depredating fishing gear (gillnets) that, upon swallowing, the net, with or without the prey, instead of reaching the forestomach becomes entrapped in the larynx. The fishing gear can be of different types and mesh sizes and can encircle the larynx at different depths and levels from top to the base. Trapped gear at the level of the larynx can cause displacement, dislocation, compression, obstruction or chronic lesions with serious and fatal consequences for feeding, breathing (asphyxia) or health deterioration. When visible and preserved, the fishing net hanging

from the mouth, sometimes enrolling flippers or other appendages, is often the first indication during external examination. Otherwise, the net may be present only at the level of the larynx and caudal to it toward the oesophagus. 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 strangulation to death. The main issue concerning odontocetes is represented by the position of the larynx which makes it vulnerable to foreign bodies, for example parts of fishing nets, during deglutition. In fact, 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 remains in the erect position during deglutition”. With this structural adaptation, inspired air flows directly from the blowhole and nasal cavity to the larynx and trachea, while ingested food passes through large alimentary canals lateral to the laryngeal cartilages via paired pyriform sinuses (Reidenberg and Laitman 1987; McLeod *et al.*, 2007), differently from the terrestrials mammals.

Ingestion: the active consumption/feeding of marine debris that cause physical blockage at various levels of the digestive system, leading to injury, pain and death. This circumstance has particularly involved species with non-selective feeding behaviour (raptorial feeders and suction feeders) that may confuse and consequently ingest marine debris in the same foraging grounds or in close proximity to 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 for assessing and categorising the presence of fishery-related debris in the digestive system of marine mammals.

Intentional injury: the situation where a fisherman intentionally hurt the cetacean (i.e. shooting, amputating the fin in animals still alive, while disentangling the animal from the net). Globally, pelagic and coastal fisheries consider cetaceans as undesirable competitors, or responsible for gear damage or damage and reduction catch. In the Mediterranean context, due to frequent daily direct contact with the fishing industry stakeholders, dolphins were the target to eradicate perceived competitors of the fishing industry (Bearzi *et al.*, 2010; 2008) or their meat was regularly consumed as a traditional food (Curci and Brescia, 2015). Today, the implementation of legislation, protection measures and public awareness have reduced the impact of this threat, despite the persistence of practice irrespective of national and international regulations such as the black market in dolphin meat (Curci and Brescia, 2015), the use of dolphins as bait (Mintzer *et al.*, 2018), and the direct injury by fishermen who blame dolphins for poor fishing yields (McLaughlin, 2017; Squires, 2017). Any injury deliberately inflicted on a dolphin could occur due to many different reasons and using many different weapons. The injury could present many different characteristics depending on the weapon and the position of the aggressor. Injury may occur pre or post-mortem, on board or directly

at sea or while the dolphin is entangled/by-caught in the net; in any case, it is common to observe injury inflicted on the laterodorsal side of the animal that is consistent with the fishermen's position just above (Puig-Lozano *et al.*, 2020) or perform mutilation or amputation of appendages (flippers, fluke, dorsal fin) if the animal is entangled in the net (Moore *et al.*, 2013). Depending on this, the injury can be single or multifocal, superficial or penetrating, from a firearm, a contusion or a sharp tool.

2.4 Glossary related to post-mortem evidences of fishery interaction

Evidences of direct signs of fishery interaction (specific to each category)

Presence of fishing gears: fishing gears or part of them still on the body (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).

Penetrating wounds: lesions caused by sharp tools (Cox *et al.*, 1998; Moore *et al.*, 2013).

Mutilation: acute: partial or complete missing of fin or flippers; the lesion appears without chronic inflammatory reaction; **chronic:** partial or complete missing of the dorsal fin or pectoral flippers due to trauma or chronic entanglement; microscopically, the lesion shows chronic inflammatory reaction and granulation tissue as well as diffuse fibrosis and signs of tissue remodelling; in this case, the animal survives but can present signs of the past interaction with fishing gears.

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. This condition can be also be found in other stress-related conditions as in live strandings).

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 disseminated 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). Pulmonary perivascular edema is frequently associated with PUE cases (Epple *et al.*, 2020).

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 (IJseldijk, 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 logistics.

Evidences and data collected in Tier 1 and 2 are useful in assessing any interaction between the stranded individual and fishing activities. At these levels, information suggesting an interaction with fishing activities is useful to stakeholders involved in fisheries and environmental policy and management.

The cause of death and the possible relationship to fishing can only be reported during tier 3, which allows for 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, evaluation of gross and microscopic evidence 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 should be used throughout necropsy performed by a trained veterinary pathologist, as they are a supporting tool for evaluating and interpreting key findings.

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

Tier 1 is intended for a wide range of operators with basic training in cetacean biology. External examination data allows for the collection of information on the life history of the stranded animal(s), including external signs and findings of interaction with fishing. The cause of death, including interaction with fisheries, cannot be determined.

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

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

Tier 2 is aimed at responders (veterinarians or trained biologists, depending on country legislation) with basic experience in cetacean post-mortem investigations and tissue sampling. This Tier allows for gross evaluation and description of the general aspect of the carcass and major findings, but not

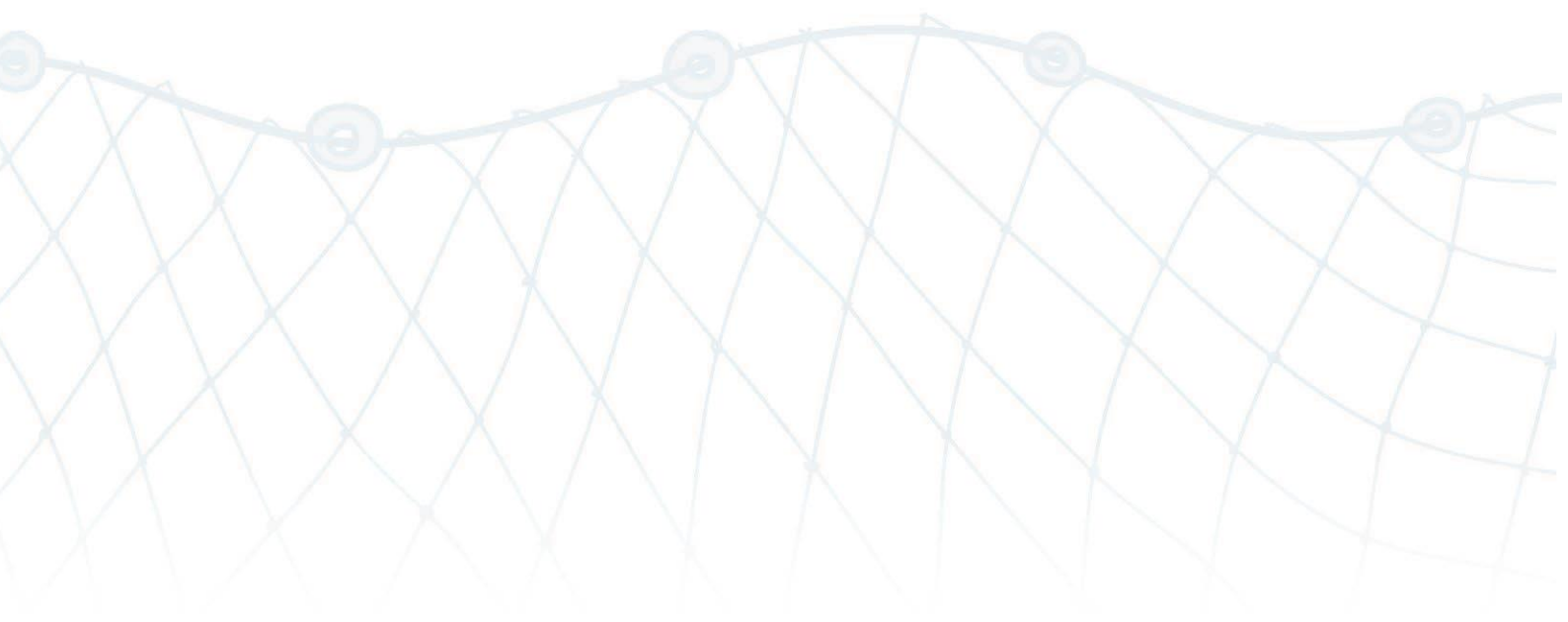
the cause of death. From this information, examiners may be able to categorize the type of the fishery interaction. Tissue sampling allows for subsequent, targeted investigation.

The Tier 2 examiner can report the following fishery interactions: entanglement (active/passive fishing gear) and ingestion (active/passive fishing gear or part of it at different levels of the GIT).

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

Tier 3 is for trained veterinary pathologists who can provide a comprehensive assessment of post-mortem findings by performing ancillary analyses designed to evaluate all possible cause of death, the presence of any ongoing infection and interpreting all data collected post-mortem. Tier 3 may allow determination of the role of fishery interaction in the death of the animal, assessing mechanism and manner of death and thus the cause.

The Tier 3 examiner can identify the specific fishing gear and fishing interaction.



4. TIERED POST-MORTEM INVESTIGATIONS

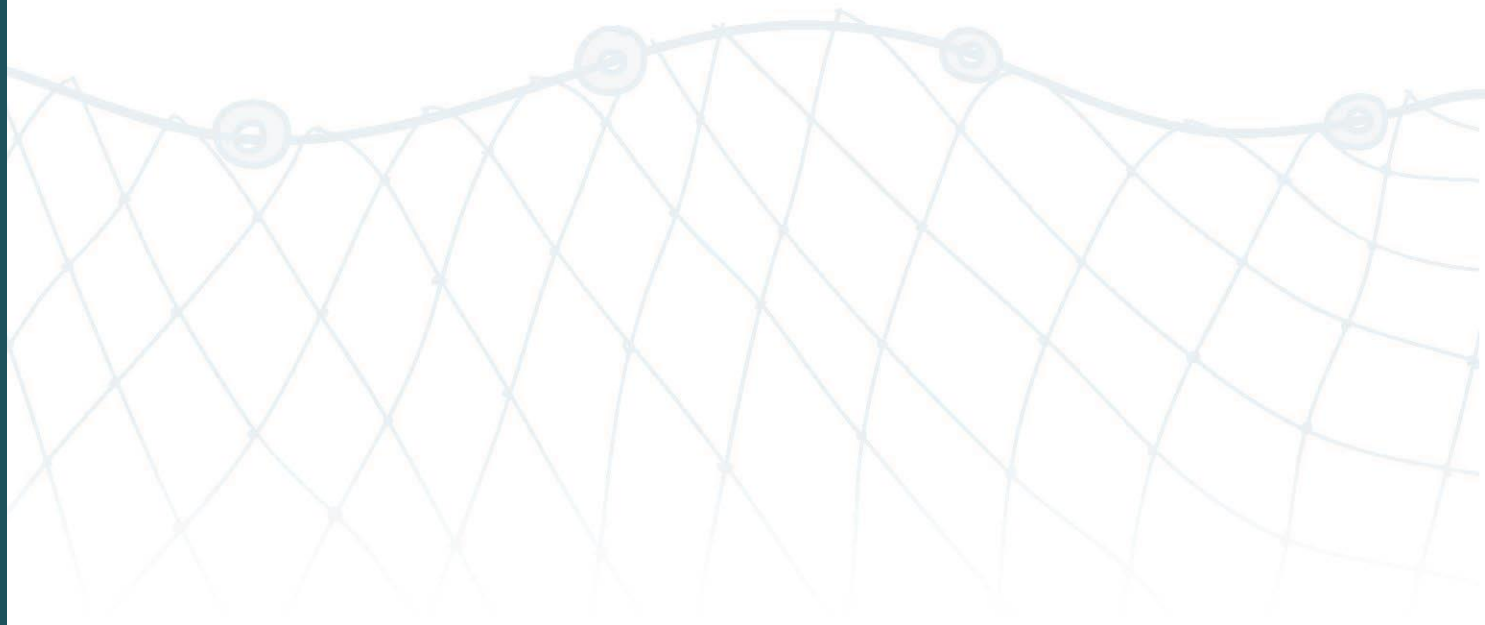
This section is intended for personnel working on strandings to collect post-mortem data and findings according to their skills and expertise, using the tiered approach described in Section 3. The section is also aimed to provide support in interpreting the above information in assessing evidence consistent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



TIER 1

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

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



TIER 2

The table below summarizes the list of fishery interaction findings , 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 the 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 the fishery	presence of recent feeding	X	

TIER 3

Evaluation at Tier 3 requires appropriate skills and expertise as well as logistical and laboratory equipment. In addition to a complete necropsy, the following must be confirmed/stated:

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

The first table below summarizes the list of the main categories and associated findings related to fishery interaction that should be assessed during a post-mortem investigation. Evidence is categorised as “certain/pathognomonic” (labeled as C/P), “consistent” (labeled as C) and “suggestive” (S) with respect to the type of interaction with the fishery (i. e. by-catch with active fishing gear, by-catch with passive fishing gear, chronic entanglement, laryngeal entanglement, ingestion).



CATEGORIES	FINDINGS	B(A)	B(P)	LE	CE	I	II	DCC
Direct evidences of fishing interaction	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
	penetrating wounds (12,18)	C	C				C/P	1-3
	mutilation with <u>acute</u> inflammatory reaction	C	C				C/P	1-3
	mutilation with <u>chronic</u> inflammatory reaction	S	S		S			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 haemorrhagies (histology) (20)	S	S					1-3
	pulmonary and vascular changes (epicardial petechiae, edema, froth/ blood-tinged watery fluid in the airways, congestion, 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

While a single C/P evidence will deem a specific fishing interaction confirmed, the experience and skills of the examiner will consider the type and number of C/P and S/P evidences in diagnosing the fishing interaction. As a suggestion, a minimum of 3 between C/P and S/P can deem the occurrence of a specific fishing interaction probable or suspected. The following table will help to hypothesise the cause of death with some degree of certainty by coupling previous fishery interaction findings with other post mortem findings.

For statistical purposes, the first 2 scores (Certain and Probable) should be considered among human-induced mortality, while the uncertainty of the 3rd score (Suspected) does not allow to be included. For the 4th score, it should only be included when interaction with fishing is considered the ultimate cause of death.

Certain/Pathognomonic (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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