Report of the Technical Expert Workshop: Developing National Criteria for Assessing Post-Interaction Mortality of Sea Turtles in Trawl, Net, and Pot/Trap Fisheries

Shepherdstown, West Virginia, USA
18-22 August 2015

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U.S. Department of Commerce
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Executive Summary

Under Section 7 of the Endangered Species Act of 1973 (ESA) the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) is required to assess whether Federal actions are likely to jeopardize the continued existence of listed species, and/or result in the destruction or adverse modification of critical habitat. Where appropriate, Section 7 biological opinions provide an exemption for the otherwise prohibited "take" of listed species while specifying (1) the amount of take exempted, (2) the Reasonable and Prudent Measures necessary to minimize impacts from the Federal action, and (3) the Terms and Conditions with which the federal action agency must comply. Fisheries regulated or permitted by NMFS that may affect sea turtles require a Section 7 consultation to determine the anticipated level of lethal and non-lethal incidental take. Incidentally captured sea turtles that are alive when encountered may succumb to their injuries at some point after being released alive. To assess the full effects of fishing activity on listed sea turtles, NMFS must use the best available information to estimate what proportion of turtles incidentally captured and released alive will subsequently die. This mortality is referred to as “post-interaction mortality.”

National criteria were developed in 2004 for assessing sea turtle post-interaction mortality after release from longline gear. Post-interaction mortality rates were estimated based on characteristics of the interaction (e.g., hook location, degree of entanglement, hook and line removal). Using a similar approach, NMFS Greater Atlantic Regional Fisheries Office (GARFO) developed regional guidelines for assessing post-interaction mortality in northeast non-longline fisheries. However, there are no comparable national criteria in other regions for assessing post-interaction mortality in non-longline fisheries that incidentally entrap and entangle sea turtles.

To promote national consistency when assessing post-interaction mortality of sea turtles captured in trawl, net, and pot/trap gear, the NMFS Office of Protected Resources (OPR) convened an expert workshop in Shepherdstown, West Virginia August 18-21, 2015, to gather individual input to inform development of national criteria. The Workshop brought together a diverse group of experts including veterinarians, sea turtle biologists, observer program experts, and resource managers to consider available, relevant information and to elicit expert opinion to best inform the future development of post-interaction mortality criteria. The group also included individuals familiar with the NMFS injury determination process for marine mammals, which also considers mortality resulting from fisheries interactions that are documented by observers.

The Workshop consisted of two sessions: an invited expert participant session (Day 1-3) and a closed federal session (Day 3-4). Day 1 included a series of background presentations on existing sea turtle and marine mammal injury or mortality determinations; an overview of sea turtle physiology and physiological effects of bycatch in the fisheries of interest; an assessment of decompression sickness in sea turtles; sources of injuries from bycatch in trawl, net, and

pot/trap gear; relating observations to the risk of post-interaction mortality; and an overview of NMFS observer programs by region. Day 2 included a series of facilitated discussions centered on three topics: (1) veterinary medicine/physiology aspects of bycatch, (2) empirical data on post-interaction mortality, and (3) use of observer program information to inform assessments of post-interaction mortality. Day 2 also introduced a framework for assessing post-interaction mortality – the Workshop Feedback Instrument. Day 3 focused on completion of the Feedback Instrument by participants, followed by the beginning of the federal session. The primary objectives of the federal session were to reflect on the presentations and discussions, take an initial look at results from the structured Feedback Instrument administered as part of the Workshop, discuss a timeline for moving toward national criteria, and discuss administrative approaches to implement national criteria, once developed.

Workshop Feedback Instrument

Part 1 of the Feedback Instrument was designed to elicit individual expert opinion on (1) percentage mortality estimates within three relative risk of mortality categories: low, medium, and high, and (2) assignment of a relative risk of mortality category for each of 43 observations that described turtle behaviour and types of injuries. Participants were given the option to increase or decrease the number of risk categories, provide point estimates or ranges, assign different percentages to hard-shelled species vs. leatherbacks, and assign a category of "deceased" if they felt that a condition was incompatible with survival (i.e., death is imminent). Participants also had the option to rate an observation as "not informative" for the purposes of estimating mortality. They also were invited to amend descriptions of any observations within the instrument as they saw fit.

Part 2 of the Feedback Instrument included a series of questions to address additional information related to post-interaction mortality. Questions focused on relevant non-gear parameters, strategies to enhance information collection by observers, sub-lethal effects of fishery interactions, future research into post-interaction mortality, and other suggestions for assessing post-interaction mortality.

The individual Feedback Instruments were tabulated and presented initially for discussion during the federal session on Day 3-4. Additional compilation and synthesis were completed following the conclusion of the workshop.

Key Results

1. Strong support was expressed among many attendees for the post-interaction mortality estimates applied in the existing GARFO guidelines, but additional refinement is needed for mortality assigned to the low risk category (GARFO category I).

2. General concurrence was expressed regarding many of the Feedback Instrument post-interaction mortality assessment criteria (centered around behavioral observations and

traumatic injuries), but with recommendations for some modifications and additional factors to be considered during evaluation of interactions.

3. Non-gear parameters (e.g., turtle size, temperature) significantly influence the probability of mortality following fisheries interaction but vary in their applicability to assessment of mortality following individual capture events.

4. Recommendations were offered for enhancing observer data collection that would better inform assessment of post-interaction mortality, standardize data among regions, and promote consistency in assessment of post-interaction mortality.

5. Sub-lethal effects are difficult to quantify, but loss of reproductive potential may be the most applicable.

6. More direct study is needed on the physiological and pathological effects of capture and mortality in bycaught turtles.

Next Steps in Developing National Post-Interaction Mortality Criteria

A session involving Federal agency participants discussed next steps to develop and implement national criteria for assessing sea turtle post-interaction mortality. These steps include development of draft national post-interaction mortality criteria and the criteria application process by the NMFS OPR, internal and external review processes, and administrative processes to incorporate the criteria and application process into the NMFS Policy Directive system. The complete process is expected to take several months.

1. Workshop Overview

1.1. Background

In 2004, NMFS developed national criteria for assessing sea turtle post-interaction mortality after release from longline gear. These criteria consider the nature of the interaction (e.g., hook location, degree of entanglement, hook and line removal) to determine post-interaction mortality rates. No national criteria exist for assessing post-interaction mortality from trawl, gillnet, or pot/trap fisheries, which affect turtles primarily through forced submergence or entanglement. In 2009, the NMFS GARFO developed regional guidelines for assessing sea turtle post-interaction mortality in northeast non-longline fisheries. The question of sea turtle post-interaction mortality in shrimp trawl fisheries arose as an area of critical concern during NMFS' consideration of turtle excluder device (TED) requirements for skimmer trawls in the southeastern U.S. During those deliberations, NMFS OPR was charged with developing national criteria for consistently assessing post-interaction mortality in all domestic trawl, net, and pot/trap fisheries. For the purposes of this effort, "net fisheries" includes all fisheries (e.g., gillnet, pound, purse, seine) that use any type of entangling, gill, or entrapment/encirclement net to harvest target species.

As a first step in developing such criteria, NMFS OPR convened an expert Workshop at the U.S. Fish and Wildlife Service (USFWS) National Conservation Training Center August 18-21, 2015, to gather expert input that will inform development of post-interaction mortality criteria. The Workshop brought together a diverse set of experts to consider all available information, including: (1) previous GARFO efforts to assess post-interaction mortality in non-longline fisheries, (2) the current NMFS post-interaction mortality guidelines for sea turtles captured in longline fisheries, and (3) the current criteria and process for distinguishing serious from non-serious injury of marine mammals.

The Workshop was organized into two parts. The agenda is provided in Appendix A. The initial part brought together both federal (NMFS/USFWS) and non-federal participants to focus on the following objectives:

- Examine available information on the effects of interaction between sea turtles and commercial fisheries and examine other studies relevant to post-interaction mortality;
- Examine currently employed criteria and processes for assessing non-longline post-interaction mortality of sea turtles (i.e., the GARFO process); and
- Gather individual input to inform development of criteria by which to assess post-interaction mortality in trawl, net, and pot/trap fisheries (i.e., Feedback Instrument).

The second portion of the Workshop included federal-only participants and focused on an initial review of the information presented during Part I of the Workshop, an initial review of the feedback instrument, and framing initial recommendations and next steps in the process to develop post-interaction mortality criteria for the referenced gear types.

1.2. Participants

The Workshop was attended by 28 participants with a diversity of affiliations and expertise including veterinarians, sea turtle biologists and physiologists, observer program staff, resource managers, and individuals with expertise in marine mammal biology. NOAA staff included representatives from headquarters (OPR and Office of General Counsel), regional offices, and science centers (excluding a representative from the West Coast regional office (unable to attend) and Alaska Regional Office and Science Center). See Appendix B for a listing of all Workshop participants. The Workshop was convened by the NMFS OPR and was led by Barbara Schroeder and Brian Stacy; Jennifer Keene served as rapporteur. Scott McCreary with CONCUR, Inc. and Bennett Brooks with the Consensus Building Institute facilitated the workshop.

1.3. Workshop Organization and Materials

To prepare for the Workshop, NMFS convened a Steering Committee to inform Workshop structure and agenda, identify candidate participants, and develop materials for use before and during the workshop.

The Steering Committee, which included both NMFS and non-NMFS members, was instrumental in guiding Workshop preparation. Barbara Schroeder and Brian Stacy spearheaded planning for the Workshop. Other Steering Committee members were: Michael Barnette, NMFS Southeast Regional Office; Craig Harms, North Carolina State University College of Veterinary Medicine; Kristy Long, NMFS OPR; Lesley Stokes, NMFS Southeast Fisheries Science Center (SEFSC); Yonat Swimmer, NMFS Pacific Islands Fisheries Science Center (PIFSC); and Carrie Upite, NMFS GARFO.

Based on the Steering Committee work, the following materials were developed or provided to inform deliberations, with much of the material distributed prior to the Workshop.

- Workshop agendas (plenary and federal session)
- Draft observations (behavioral and traumatic injuries)
- Draft participant Feedback Instrument
- Detailed literature review

2. Workshop Presentations

The Workshop began with brief welcomes from OPR Director Donna Wieting, USFWS Sea Turtle Specialist Earl Possardt and NOAA National Sea Turtle Coordinator Barbara Schroeder. Welcoming remarks were followed by a review of the Workshop purpose, agenda and meeting ground rules, as well as participant self-introductions.

2.1. Workshop Overview and Context

2.1.1. Workshop Overview

B. Schroeder provided an overview of the Workshop impetus, objectives and structure, as well as a synopsis of how input generated during the Workshop will be used by the Agency to inform development of national criteria. Key presentation points included the following: (1) national criteria are needed to help NMFS better estimate the proportion of sea turtles released alive following interaction with trawl, net, or pot/trap gear that will subsequently die; and (2) earlier efforts (national criteria for assessing sea turtle post-interaction mortality for longline gear, criteria developed by GARFO for assessing sea turtle post-interaction mortality in Northeast fisheries) provide important and useful information.

Key discussion points among participants included the following:

- Participants inquired as to how the criteria will be implemented and it was explained that the process for implementation will be the next phase of this effort and will be primarily considered in the federal portion of the Workshop.

2.1.2. Legal Impetus

J. Forman with NOAA's Office of General Counsel provided a brief overview of the legal impetus for the need for post-interaction mortality guidelines, noting that an assessment of post-interaction mortality is necessary for the federal government to confirm (consistent with its responsibilities under the ESA) that fisheries interactions authorized by NOAA Fisheries will not either jeopardize a species nor adversely affect designated critical habitat. An overview of ESA Section 7 Incidental Take Statements was also provided.

2.2. NMFS' Marine Mammal Injury Determination Processes

2.2.1. Marine Mammal Injury Determination Process

K. Long (NMFS OPR) and K. Forney (NMFS Southwest Fisheries Science Center) summarized the process used to distinguish serious from non-serious injuries for marine mammals. The presentation reviewed: (1) the 1997 and 2007 workshops used to develop serious injury criteria for large whales, small cetaceans and pinnipeds; and, (2) the ongoing annual process used to make determinations, including cross-region review of each determination. The presenters noted that injuries can be classified as either serious, non-serious or case-specific (e.g., depends on situation-specific factors such as animal age, duration of struggle, etc.). They also noted that the workshop process resulted in both a policy and a procedural

directive applied consistently to all marine mammal injury determinations. Among the key lessons shared included the following:

- Related to injury criteria:
    - Rely on observable, objective metrics as possible.
    - Complementary categories simplify scoring.
    - A tiered system can be useful to prorate "incomplete" observations with those that have known outcomes.
- Related to implementation:
    - One individual reviews cases from each region and makes an initial determination; that initial determination is reviewed by at least two other individuals. Any cases not specifically addressed by the criteria are reviewed by an ad hoc group as appropriate. The determination subsequently undergoes additional review by the appropriate NMFS Science Center, Regional Office, and marine mammal regional Scientific Review Group.
    - Close coordination with NMFS regional observer programs is essential to ensure collection of most relevant information.
    - Cross-Science Center reviews enhance consistency and provide opportunities to address variability in applying the criteria.
    - Need ability to update and clarify criteria.
    - Use of consistent terminology is critical for evaluating implementation of criteria and process.

<u>Key discussion points among participants included the following:</u>

- For marine mammals, there is an ad hoc working group of experts available to evaluate cases that do not fall into the established categories. The marine mammal injury determination criteria have similarities to the sea turtle longline criteria when the gear and injury are visible. The effects of interactions in the fisheries relevant to this Workshop are often less visible (e.g., these gears do not use hooks, trawl gear rarely results in entanglement, etc.).
- All human-caused injuries and mortality (not just fisheries) are considered and evaluated for marine mammals. All injuries reported are evaluated, and any injuries that are determined as "serious injuries" are compared against the Potential Biological Removal (PBR) level that is calculated for each marine mammal stock in the stock assessment reports.
- Veterinary input was essential during development of the marine mammal injury criteria. When evaluating individual injuries and applying the criteria, a veterinarian is not required.
- It is important to bridge the gap between terminology used by observers and the medical terminology used by veterinarians.

2.2.2. GARFO Post-Interaction Mortality Criteria and Process

C. Upite (NMFS GARFO) provided an overview of the process used by GARFO to assess sea turtle post-interaction mortality in non-longline fisheries in the northeast region. The presentation summarized the impetus for the process, as well as the injury guidance developed and the ongoing process used within the region to make injury determinations. Key presentation points included the following:

- The GARFO process relies on three categories of injuries - Category 1 or low probability of mortality (20%); Category 2 or intermediate probability of mortality (50%); and Category 3 or high probability of mortality (80%). Each category has an associated set of physical or behavioral observations associated with it.
- Injury criteria and mortality estimates were based on input from an expert working group that included veterinarians, biologists, physiologists, and resource managers.
- Determinations are made by a four-person serious injury working group that includes NEFSC, OPR and GARFO staff (at least one member of the group is a veterinarian); determinations are made on an annual basis using observer data logs and photos. The region maintains a 5-year running average for determinations to account for annual variability. The working group has functioned as a collegial group and has helped build and maintain institutional memory.
- Results to date include the following: 231 total determinations from 2006-2013, with 153 cases in trawl gear and remainder from gillnet (48), dredge (12) and seine (1) gear; 2 cases were excluded because of confidentiality issues; loggerheads account for 173 of the total observed interactions during that period; the majority of the injuries were classified as Category 1.
- Injury determinations have been used both by management for ESA Section 7 consultations and by the Science Center in fishery bycatch estimates.
- Key lessons learned include: (1) data collection checklists can standardize reporting and help minimize variation among observer reports; (2) videos and timely debriefs with observers provide valuable information when the review team meets annually to make determinations; (3) consistent approaches to assessing injuries are necessary; (4) a consistent review team that includes diverse disciplines (including veterinary medicine) is valuable; and (5) consider wide range of injuries, behaviors and scenarios in development of initial guidance.

<u>Key discussion points among participants:</u>

- Participants discussed how environmental conditions affect vital processes and could factor into injury determinations. Water temperature data are collected as are other parameters; however, applying these parameters to individual case assessments is difficult.
- The percentages developed for the GARFO injury categories were based on available data and expert opinion, not on known fate of turtles following fisheries interactions.
- As with the current Workshop, the GARFO workshop was not consensus seeking.
- Using tow time as a mortality risk parameter is problematic because it is not known when

during the tow the turtle entered the net. Injury evaluations for this guidance are based on the observations of the turtle in hand.

- Suggestion: for this Workshop, as categories are developed, consider separating out fishery/gear types or applying similar categories with similar tow times/depths/etc.

2.3. Impacts to Sea Turtles from Net, Trawl, and Pot/Trap Interactions

The third set of background presentations centered on summarizing the effects on sea turtles of incidental capture in trawl, net, and pot/trap fisheries and understanding the ramifications for post-interaction mortality.

2.3.1. Sea Turtle Physiology and Physiological Effects of Capture on Sea Turtles

C. Harms and A. Southwood-Williard summarized the available information on physiological effects of net capture on sea turtles. Sea turtles interact with fishing gear in four main ways, which are not mutually exclusive. These interactions are entrapment (restricted space, but free to swim and surface within that space), entanglement, forced submergence, and evasion and escape attempts.

Drowning[1] and exertion/exertional myopathy are the two main mechanisms of physiologic effect on sea turtles from gear interactions. Mechanisms may overlap to varying degrees in individual occurrences.

The array of physiological responses to gear interaction have been assessed primarily via blood gas, acid-base and lactate changes, electrolyte shifts, tissue enzyme elevations, and endocrine responses.

Voluntary dives (lab and field; Lutcavage & Lutz 1991, 1997) generally have a longer duration for larger/older turtles and in cooler water temperatures. They also vary by species, but these dives routinely range from 4 to 56 minutes and can last up to 300 minutes. Blood pH is nearly constant during these dives, pCO_2 increases slightly, and pO_2 decreases. These studies show that turtles remain within aerobic limits throughout voluntary dives.

Forced submergence (lab; Lutz & Bentley 1985, Stabenau & Vietti 2003) caused multiple negative physiological changes primarily reduced heart rate, anaerobic metabolism, oxygen debt; decreased pH (acidosis), pO_2; and increased pCO_2, lactate, K, Na, norepinephrine, and plasma osmolality. Blood gases and lactate recovered within 24 hours after a single submersion of 90 minutes. Repeated submersions of 7.5 minutes (simulating interaction

[1] Drowning, as broadly defined by the WHO (Van Beeck et al. 2005): "'Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid.' Drowning outcomes should be classified as: death, morbidity, and no morbidity… the terms wet, dry, active, passive, silent, and secondary drowning should no longer be used." The term "impairment" distinguishes drowning from voluntary dives in sea turtles.

with a TED in a trawl) showed a nearly complete recovery 3 hours after final submergence if the turtle was given a 3 hour rest interval between submersions. This recovery was not seen in turtles given 10 or 42 minute rest intervals.

Summary of Results from Directed Studies by Gear Type

Interaction with Pound Nets (not entangled; Harms et al. 2003)

Turtles entrapped in the pound of the net (able to swim and surface freely) exhibited minimal changes in blood gases and lactate, though lactate increased and bicarbonate decreased after holding on deck for 30 minutes following removal from the pound enclosure.

Interaction with Trawls (Lutz & Dunbar-Cooper 1986, Henwood & Stuntz 1987, Stabenau et al. 1991, Harms et al. 2003, Stabenau & Vietti 2003, Sasso & Epperly 2006)

Mortality rate increased rapidly when tow times exceeded 50 minutes. There was a higher mortality rate from these interactions in winter than in summer. It took approximately 20 hours for lactate to return to baseline after a trawl encounter; however, tow time was not given. Turtles developed marked acidosis and lactic acidemia after 30 minutes tow time without a TED. There was substantial recovery of acidosis, via respiratory compensation and bicarbonate depletion, after 30 minutes on deck, but lactate levels remained high. Repeated (3x) escapement from TEDs under experimental conditions (2.7 to 7.2 min duration) following 10, 42 or 180 minute resting intervals substantiated lab-based forced submergence experiments (see above), resulting in a nearly complete recovery with a 3 hour resting interval but not with 10 or 42 minute intervals. Of particular concern is observed increased potassium with decreased pH.

Interaction with Gillnets/Entangling Nets (also applicable to entanglement in other gear types, Hoopes et al. 2000, Snoddy et al. 2009, Snoddy and Williard 2010, Christiansen 2015, Phillips et al. 2015)

When turtles were removed immediately after entanglement, there were moderate elevations in lactate, catecholamines and potassium, which required 1 to 10 hours to return to baseline; elevations resolved more rapidly in in-water net pens than in tanks. Blood gas and lactate derangements were intermediate between those observed in turtles caught by pound nets and 30 minute trawl tows, with no change in lactate status after 30 minutes on deck. When turtles were left in a net 20 to 240 minutes (or until considered in danger of drowning), lactate elevations were profound (up to 50 mmol/L). Confirmed and suspected post-release mortalities (determined via satellite telemetry) were associated with high lactate and potassium, and/or non-physiologic extreme elevations in sodium and chloride values (due to possible aspiration), even though all turtles were released alive. Physical grades were assigned based on activity level, reflexes, and presence or absence of injuries in Snoddy et al. 2009. Poorer grades were generally associated with alterations in blood biochemistry parameters.

Exertional myopathy (diagnosed by acid-base status, lactate, muscle enzyme and potassium elevations, and histopathology) can result in delayed mortality even with veterinary intervention.

Summary

- Physiologic impacts of gear interaction on sea turtles appear minimal for entrapment without entanglement or forced submergence (e.g., capture in the head or pound of pound nets), intermediate for entanglements with immediate removal (research application) and short duration (<30 min) trawl interactions, and severe for longer duration entanglements (0.3 to 4 h, typically gill net, but applicable to any entanglement) even if some surfacing to breathe is possible.
- Based on experimental studies, physiologic recovery from repeated short duration forced submergence in trawls equipped with functioning TEDs is possible with 3 hour intervals between interactions.
- Post-interaction mortality may result from severe blood gas, pH, lactate and electrolyte (particularly potassium) alterations, and/or exertional myopathy, even with live release.
- Blood lactate elevates after 30 minutes on deck if it starts low (e.g., capture in the head or pound of pound nets), maintains if it starts high (e.g., 30 minutes in a trawl, immediate removal from entanglement net), can take up to 20 hours to resolve, and resolves more rapidly in an in-water net pen than in a confined tank.

Implications for better understanding effects of gear interactions

- Translating physiologic effects on blood gases, acid-base status, lactate, electrolytes, catecholamines, and muscle enzymes into post-release mortality estimates is difficult because of scarce studies on post-release mortality and the impracticality of conducting more than behavioral and reflex assessment of turtles captured in fisheries. Nevertheless, understanding those physiological changes with respect to outwardly observable signs (e.g., Snoddy et al. 2009) and clinical experience with affected animals in rehabilitation can be used to make rational qualitative assessments.
- The duration of gear interactions in which physiologic effects are studied rarely approaches actual soak times (e.g., up to a maximum of 4 hours in gill net by Snoddy et al. 2009, vs. 10 to 12 hour overnight soak times or more in many commercial gill net fisheries). Studies that approach or reach actual soak and tow times where forced submergence is a factor demonstrate far more profound effects, including mortality, as compared with short duration interactions in research applications or entrapment without forced submergence.

<u>Key discussion points among participants:</u>

- Much of subsequent discussion related to the use of Point of Care (POC) analyzers in health and physiological studies.

2.3.2. Assessing Mortality and Decompression Sickness in Turtles Incidentally Captured in Net and Trawl Fisheries in the Mediterranean Sea

D. Garcia-Parraga provided an in-depth look at recent work on decompression sickness (DCS), which has been recently recognized as a new pathological condition in sea turtles incidentally captured by trawl and gillnet fisheries of the Valencian Community region, Spain. In order to investigate this disease, fishermen were asked to bring bycaught turtles back to shore for evaluation. To facilitate participation, incentives were provided to recognize fishermen for their efforts and the local communities were engaged in rehabilitation and release.

The main goal of this presentation was to share knowledge and experience with DCS in sea turtles, including crucial diagnostic and therapeutic information, factors relevant to survival and mortality, and recognition of clinical signs and postmortem findings. Bycaught turtles (n=103) received during four years of study were systematically evaluated for gas embolism (GE), which was attributed to DCS based on history of capture, successful treatment with hyperbaric treatment, and gas analysis. A relatively high prevalence of GE of around 50% was documented in examined turtles based on several diagnostic imaging techniques.

To date, gas embolism has not been reported in sea turtles from any other region of the world, which may be due to following factors:

- Fishing gear and techniques used in the Valencian Community area (e.g., no TEDs, prolonged trawling times, fishing depth, etc.) are somehow unique
- Specific, unique conditions related to the local environment or local sea turtle population
- Lack of adequate resources to diagnose gas embolism in sea turtles in other regions or lack of timely access to bycaught sea turtles in other regions
- Lack of awareness of the condition to prompt investigation in other regions

The following conclusions were derived from preliminary data:

- Based on animal clinical condition and severity of embolism, average post-interaction mortality (without application of any hyperbaric treatment) is estimated at around 100% in GE cases vs. over 40% in non-GE (NGE) cases for gillnets, and over 50% in GE cases vs. less than 5% in NGE cases for trawlers.
- Considering the effects of GE, the percentage of affected individuals from each fishery type, and mortality resulting from both GE and NGE causes (previous bullet), estimated total post-interaction mortality by fishery in the study region would be over 60% for gillnets, and over 30% for trawlers.
- DCS is often associated with other pathological conditions co-occurring with forced submersion (hypoxia, acidosis, water aspiration, etc.), therefore specific contribution of DCS to mortality is extremely difficult to assess.

- Mortality is likely underestimated: we estimated that over 20% of animals caught alive in trawlers and reported in apparent good condition when brought aboard have a moderate to severe degree of GE and evidence suggests that they die during the first 48 to 72 hours if left untreated.
- There have been no opportunities to evaluate animals immediately after being retrieved from the gear, only several hours later. Thus, the consequences of immediate release on affected sea turtles during the preliminary stages of GE are unknown. In other species; however, rapid bubble formation occurs during the first minutes in "fast tissues" such as blood or the central nervous system. Associated conditions, such as hypoxia or acidosis, could preclude or at least significantly limit the physical ability of turtles to perform serial normal deep dives that are necessary to remove excess absorbed nitrogen and prevent formation of GE. Thus, bycaught sea turtles may be physically incapable of reversing GE once the process has progressed beyond a certain degree.

Physical exam is typically not very informative, especially in the early stages of disease when animals are asymptomatic. Clinical findings commonly appear with time after being brought to the surface in the gear. These findings include:

- General condition of affected individuals includes a broad spectrum of consciousness:
  - Normal
  - Highly active
  - Comatose
  - Dead
- Breathing difficulties (stretched neck, opened mouth)
- Signs of pain (opened mouth, retracted flippers)
- Neurological signs:
  - Loss of sensitivity
  - Limb paresis
  - Full paralysis
- Positive buoyancy / erratic swimming
- Gas obtained by venipuncture or observed within anterior chamber of the eye

The primary external observation with DCS is likely progressive deterioration of neurological status and development of clinical signs with time after the turtles is brought to the surface, progressing from a normal or even highly active animal (in the initial gas off phase) to a comatose state or death during the first hours, depending on the severity of embolism and associated complicating factors resulting from forced submersion (hypoxia, acidosis, hyperkalemia, etc.).

Diagnostic imaging techniques are the most reliable method for diagnosis of GE in both live and dead individuals. These methods use relatively common and affordable veterinary equipment, including simple radiography or basic ultrasonography. The anatomical regions

that most consistently exhibit GE are the kidneys, heart and liver, which show different degrees of intravascular gas accumulation depending on severity. Renal/cardiac ultrasound is probably the simplest and most cost effective technique for rapid diagnosis. Radiography (dorsoventral view) is the simplest semi-quantitative technique to estimate severity of embolism. A lateral view increases sensitivity, but has limited capability for gas quantification.

Careful dissection of deceased individuals could permit pathologists to directly visualize the presence of gas in certain key anatomical regions, including the right atrium, sinus venosus, mesenteric veins and post-caval vein. However, it is rather difficult to visualize any gas in less severe cases during necropsy. Some necropsy findings in dead stranded sea turtles, though highly compatible with GE, could not be confirmed to be a consequence of DCS due to putrefaction. Other gross lesions commonly present in confirmed DCS cases are congested or hemorrhagic areas in the kidneys, liver and/or intestinal mucosa. The main histological findings are intravascular gas bubbles associated with general congestion and perivascular hemorrhage in a variety of tissues and changes consistent with disseminated intravascular coagulation.

Disease outcome greatly depends on the total amount and distribution of intravascular gas, timing and administration of hyperbaric oxygen therapy (HBOT), severity of clinical signs and evidence of pulmonary water aspiration. We (Dr. Garcia and colleagues) have modified recompression-decompression tables used by human divers for treatment of sea turtles with DCS with a tendency towards longer treatment regimens for turtles. As previously mentioned, DCS is generally lethal in moderate and severe cases that do not receive HBOT, and could result in other consequences in patients with mild cases. Kidney lesions have been detected by magnetic resonance and computed tomography imaging in surviving individuals several days after gas reabsorption and normalization of hematological and blood chemistry parameters. These lesions could reflect a persistent loss of renal functional capacity. In addition, long-term (3 weeks post-interaction) neurologic, hepatic and cardiac damage (confirmed by histopathology) has been observed with delayed HBOT treatment for mild embolism. Therefore, potential sub-lethal, insidious effects in survivors should be also considered. Large scale effects on fitness could affect populations beyond the effect of individual mortality.

There is limited understanding of some of the pathophysiological processes that lead to DCS; however, we have gained some insight in initial in vitro studies. Based on preliminary findings, it is hypothesized that underwater entrapment causes sudden and prolonged stress, which in combination with vigorous physical activity leads to reversal of the intracardiac right to left physiological shunt via opening of pulmonary arterial sphincters and concurrent tachycardia. These events would result in an immediate, dramatic increase in pulmonary perfusion and abnormally heightened increase in nitrogen absorption.

Further research is needed to better understand the actual effects of DCS on post-interaction mortality in sea turtles in the following areas:

- Evaluation of initial first stages of GE upon capture and reversibility of the condition if animals are immediately placed back into the water
- Study of occurrence in global fisheries
- Characterization of associated risk factors, such as gear soak time, depth, water temperature, sea turtle species and susceptibility of different age/size groups, etc. This information would allow us to design mathematical models to predict risk and severity of DCS based on known risk factors for decompression and physiological parameters in sea turtles.
- Study of direct mortality as well as sub-lethal effects and long-term survivorship of affected individuals

<u>Key discussion among participants included:</u>

- It was suggested that if an animal is alive and active when released - and dives once in the water - that there may be a chance for natural recompression. However, the opinion was offered that, depending on the severity of embolism and gas distribution, turtles could be positively buoyant or neurologically impaired. In addition, pain, hypoxia, and physiological derangements (hyperkalemia) may interfere with diving. Thus, it is unlikely turtles would be capable of a diving profile that achieves recompression.
- The general pathophysiology of gas embolism was discussed, including potential reversal of cardiopulmonary shunting during capture.
- There is a need to determine a range of depths where DCS is most likely. In Spain, DCS is not usually seen in turtles captured by trawls at depths shallower than 30m. Decompression has been documented in turtles captured in gillnets at shallower depths (10m) likely because submergence times are longer (several hours).
- Participants queried whether bringing the turtle up rapidly in the gear would re-inflate organs and cause damage. In response, it was commented that maximum distention of the lungs in breath-hold divers (such as sea turtles) is defined by lung volume at the beginning of the dive, thus barotrauma is highly improbable unless there is differential collapse/hyperinflation of the lungs. In addition, one participant opined that retrieval of trawl nets and gillnets is likely slower than a natural dive ascent.
- Temperature could be an important factor in the incidence of DCS. As temperature decreases, the solubility of gases increases, potentially leading to a higher risk of DCS in winter. If the turtle's body temperature warms while on deck, it may off gas more quickly and also increase oxygen consumption by different tissues which could lead to a poorer prognosis.
- It was also noted that turtle behavior in colder water (less active, potential more time spent on bottom) may increase the probability of interaction with some fishing gears (especially trawls).
- Pressure (depth), time, and temperature all affect the amount of nitrogen absorption. Other factors affecting nitrogen absorption include the increase in heart rate and

reversal of vascular shunts due to capture/forced submergence stress/struggle.
- Definitive diagnosis of DCS has been demonstrated by resolution of signs after recompression in a hyperbaric chamber.

2.3.3. Assessment of Post-Interaction Mortality: Integrating Field Observations and Common Mechanisms of Injury

B. Stacy presented on two topics: physical injuries that can occur in trawl, net, and pot/trap fisheries, and an overview of integrating the types of effects and injuries into assessment of post-interaction mortality.

Potential sources of physical injuries resulting from incidental capture in trawl, net, and pot/trap fisheries

Types of physical trauma that may be observed in turtles caught by non-longline fisheries are presented in Table A. Although there is the potential for significant injuries caused by interaction with fishing gear (including entanglement, contact with vessels/machinery, boarding, removal from gear, release) many turtles captured in trawl and net fisheries do not have observable injuries or have only minor, relatively superficial wounds. In general, wounds are acute and the thick skin of hard-shelled sea turtles is relatively resilient to injuries and does not readily show evidence of certain gear interactions. The fragile skin of leatherbacks is more readily injured and cutaneous trauma is more common in this species following interaction with fishing gear.

Table A. Sources of physical trauma in trawl, net, and pot/trap gear and characteristics of injuries.

	Entanglement	Vessel/machinery	Removal from gear	Other catch
Sources of injury	• Net/lines wrapped around head, neck, appendages	• Vessel components (e.g., propeller) • Fishing gear • Machinery used to haul gear, handle catch	• Dropping catch onto deck • Cutting animals from gear • Boarding animals	• Stingrays, sharks
Wound characteristics	• Soft tissue trauma • Vascular injury: edema, necrosis/ gangrene • Compression of airway • Skeletal fractures • Dislocations	• Skeletal fractures • Dislocations • Soft tissue trauma	• Skeletal fractures • Dislocations • Soft tissue trauma	• Punctures (embedded stingray barbs), bite wounds*

*Entrapment under catch also can result in forced submergence, as covered in previous talks.

Significant trauma is more often observed in turtles entangled in pot/trap fishing gear. The principal factors that determine the severity of injuries caused by this type of gear include the degree of compression or tightness, chronicity, and the extent of soft tissue trauma. These characteristics are also influenced by the type of gear (monofilament vs. multifilament, diameter), the amount present, and whether animals are anchored or heavily weighted down. The location of the entanglement is obviously critical and affects the degree of impairment of mobility and involvement of vital structures, such as the airway or major blood vessels. With regard to assessment of survival and outcome of entanglement injuries, it is important to consider that there can be a time lag until the extent of tissue damage is fully evident. Injuries with visible signs of circulatory impairment, such as edema or discoloration, can worsen following initial observations.

The potential for internal injuries should always be considered when evaluating the full extent of trauma in sea turtles. The seemingly tough external features of sea turtles and potential initial flight response can easily mask injury involving more sensitive soft tissues and organs. There is often significant bias among individuals with regard to the question of probability of survival in sea turtles. Encounters with animals that have survived significant injuries without medical care can result in a false sense of confidence in their resilience. The same potentially life-threatening complications associated with trauma in other taxa are a concern in turtles, and these conditions are regularly encountered in stranded sea turtles. Actual survival rates associated with various injuries are largely unknown and observed examples of survival following severe injury may represent the rare exception.

The implications of traumatic injuries on sea turtles include both lethal and sub-lethal effects. Lethal effects include damage to vital organs, blood loss, and secondary infection. Near-term sub-lethal effects may ultimately prove lethal, or result in reduced reproductive fitness, from decreased ability to forage (which may affect growth), increased susceptibility to predation, interference with normal migratory behavior, reduced resistance to other insults, reduced nutritional reserves for egg production, or inability to mate. Some of these effects may be relatively temporary but may entail significant risks of mortality, such as susceptibility of recovering turtles to predation, while others are permanent, chronic, and life long, such as loss of flipper function.

Relating observations to effects with risk of delayed/post-interaction mortality

Post-interaction mortality occurs as the result of inability to recover from physiological derangements, such as hypoxia and acidosis; death from aspiration, traumatic injuries, or gas embolism; and death as a consequence of reduced fitness. Countervailing factors include wound healing and homeostatic mechanisms that allow recovery from some insults. There are numerous individual (e.g., species, life stage) and environmental parameters (e.g., temperature, predation risk) that undoubtedly contribute to outcome; however, these factors are difficult to quantify.

Fisheries observers collect a variety of information relevant to assessment of the condition of sea turtles upon capture. This information consists of written descriptions of circumstances of capture, turtle behavior, and any evident traumatic injuries, as well as photographs and video. There are two general categories of observations: those related to behavior and activity, and basic physical assessment for presence of any apparent traumatic injuries.

The types of behavioral observations resulting from capture in trawl, net, and pot/trap fisheries in sea turtles are nonspecific and can reflect the effects of submergence, exertion, decompression, cryptic internal injuries, or a combination thereof. There are three principal periods of observation during which behavior may be recorded: upon initial removal from gear, while on board, and upon release. Behaviors generally fall within a gradient of relative degree of effect from active, energetic turtles that exhibit apparently normal behavior, to those that appear sluggish or weak, to more severely compromised turtles observed to have specific abnormal signs or that are unresponsive. The pathophysiological processes attributed to these observations and implications on mortality are largely inferred from available field observations, research studies, and clinical experience with turtles that have undergone treatment.

Injuries also range from those that appear outwardly minor to debilitating or clearly life-threatening trauma. Assessment of the significance in terms of mortality requires careful consideration of immediate effects, probability of delayed complications, and the likelihood of additional injury not evident by basic external examination and observation.

2.4. Observer Programs

The fourth and final set of background presentations centered on providing an overview of observer programs by region, especially those for non-hook-and-line fisheries, with each region providing a brief summary of the observed fisheries characteristics, observer training, observer coverage rates, types of data collected and related protocols, and data logs with an emphasis on sea turtles and marine mammals.

2.4.1. Pacific Islands

D. Luers with the NMFS Pacific Islands Regional Office (PIRO) provided an overview of NMFS' Pacific Islands regional observer program relevant to sea turtle and marine mammal interactions with pelagic longline fisheries. He noted that given the current operation of the shallow-set Hawaii longline fishery (i.e., implementation of a fishery closure once incidental take limits (live or dead) in the Section 7 Biological Opinion are reached for loggerheads or leatherbacks), the observer focuses on sea turtle species identification rather than collecting data on behavior or physical injuries. With marine mammals, D. Luers underscored the close coordination, data collection and processing protocol changes undertaken to ensure observer program practices are able to support management needs tied to the recently implemented False Killer Whale Take Reduction Plan. He also noted efforts within the region to improve both the training and debriefing of observers to better

inform marine mammal injury determinations. Key changes included: (1) redefining observer responsibilities during an interaction; (2) emphasizing importance of photos, videos, sketches, etc.; and (3) including Protected Resources Division/PIRO/PIFSC staff in observer training classes to help trainees understand the importance of accurately documenting interactions.

2.4.2. Southeast

L. Stokes with the NMFS SEFSC provided an overview of the southeast regional observer program relevant to sea turtle interactions with shrimp trawl and drift, strike and sink gillnets. Information on the shrimp trawl and coastal gillnet fisheries were provided on behalf of Liz Scott-Denton (NMFS) and John Carlson (NMFS), both of whom were unable to attend. Key presentation points included: (1) SEFSC efforts to standardize training for observers; (2) requirements for observers to monitor post-release swimming and diving behavior, though the amount of time is limited to what the vessel captains will permit (typically limited to 30-60 seconds); (3) photos of sea turtles are required; video is not currently required but is sometimes used; and (4) efforts to retain injured/dead turtles is encouraged but rarely occurs (limited space, captain concerns with catch contamination and/or public perception). L. Stokes also noted that the data collection form was originally developed for observing the longline fishery but was modified to collect observer data in trawl and gillnet fisheries as well.

2.4.3. Northeast

N. Rossi with the NMFS Northeast Fisheries Science Center summarized the northeast regional observer program's work in dredge, trawl, gillnet, and pot/trap fisheries, noting the wide use of observer data to support stock assessments, economic analyses, bycatch analyses, annual catch limit monitoring and quota monitoring. Key presentation points related to monitoring sea turtle bycatch interactions included: (1) the hands-on nature of the region's three-week long observer training program; (2) photos and videos of interactions are required by the region (though not always possible given the specifics of each event, e.g., lighting, sea state, etc.); (3) redesigning the sea turtle biological sampling log in 2013 based on and in support of GARFO's sea turtle injury working group; and (4) reviewing key data collection challenges.

2.4.4. West Coast

Y. Swimmer with the NMFS PIFSC presented an overview of the observer program on behalf of Lyle Enriquez and Charles Villafana (NMFS West Coast Region), both of whom were unable to attend. The west coast observer program covers the deep set longline (100% observer coverage), large mesh drift gillnet (20-30% observer coverage) and set gillnet fisheries (not currently observed). Key presentation points included: (1) new observers are required to complete a two-week training course; returning observers complete an annual refresher course; and (2) observers are required to take photos of interactions; videos are not currently taken. Y. Swimmer also suggested that the observer data collection forms for

gillnet gear could benefit from greater standardization across regions and being revised to reflect sea turtle position in the net.

2.4.5. Northeast/Southeast Case Studies

The final presentation – a joint effort by C. Upite and L. Stokes – highlighted a series of observed interactions from both the northeast and southeast observer programs. Using materials from each case (presented to the group and made available as posters throughout the Workshop), the presenters reviewed written descriptions, photos, and videos (when available) of representative fishery interactions. Presenters also summarized the number, type and/or condition of observed bycaught sea turtles in each region. In the northeast, loggerheads were the species most frequently observed as bycatch between 2005 and 2014, with most interactions occurring in trawl gear and 71% of observed turtles released alive. In the southeast, sea turtles are characterized as either alive, dead/comatose/unresponsive or unknown. Almost half are characterized as alive, but with insufficient detail to classify them as active or lethargic. Another 22% were described as alive/active and 7% were described as alive/lethargic or sluggish.

<u>Key discussion among participants included:</u>

- The need to standardize the methods and timeline when documenting bycaught turtles. It was noted that if the timing of observations/interactions is unknown, it can complicate the determination of mortality risk.
- It is difficult to determine activity level from a still photograph, but photos are important for assessment of injuries (including entanglements) and species identification. Guidance is needed to improve the utility of photos and to obtain video whenever possible.
- If an injury occurs on deck or at release, it is considered part of the fishery interaction and is evaluated for mortality risk.
- There was concern among the participants regarding resuscitation protocols for unresponsive turtles. It was explained that observers in the southeast are trained only to observe and collect data without interfering with actions of the captain and crew; the captain and crew decide how to handle or treat unresponsive animals. The observers can offer protocols or assistance if asked. If the observer participates in resuscitation, it should be noted on the form, so that these events can be properly incorporated into estimates of bycatch mortality.
- Post-interaction mortality risk should be evaluated by a team. If the data present in a photo and on the form differ, multiple participants evaluate all data and photos to assess data accuracy. It was noted that there have been very few cases where a video (when available) provides evidence to overturn written observations; more often the video corroborates the observer data.
- Timing of data collection and video should be standardized. While it is helpful to review video and compare observations to written observer data, caution is warranted given that video only represents a portion of time on board.

- There was general recognition that the data fields and coding should be standardized across observer programs; however, it is not necessary to develop a single data form layout, as there are some valid regional data needs/differences.

3. Facilitated Discussions

On Day Two of the Workshop, participants had the opportunity to view videos of turtle behavior immediately following capture in sea turtle research projects as well as turtle behavior in shrimp trawls during TED testing. Many participants noted that videos of apparently normal turtle behavior would provide a tremendous benefit in training observers. Following the videos, participants were introduced to the Feedback Instrument for the Workshop. The instrument asked each individual to determine a mortality estimate for three risk categories (Low, Medium, and High), explain their rationale, and finally to apply the categories to three types of observations/injuries that are documented during fisheries interactions: (1) behavioral observations, (2) traumatic injury – general, and (3) traumatic injury – entanglement type (see Appendix C).

Three facilitated discussions were then held to allow participants to ask clarifying questions on each of the following topics: veterinary medicine/physiology, empirical data on post-interaction mortality, and use of observer data to assess post-interaction mortality. These discussions were intended primarily to inform each participant's individual completion of the Feedback Instrument. Below is a summary of key themes raised during each of the three facilitated discussions.

<u>Facilitated Discussion #1: Veterinary Medicine/Physiology</u>

- *Species differences* – Participants were asked to comment on the relevance of species differences in assessing post-interaction mortality. The influence of size and species was discussed in relation to physiological, energetic, and behavioral parameters. Multiple participants noted a desire to consider leatherbacks and hard-shelled turtles separately due to physiological and behavioral differences that have been observed. Participants were also reminded that it was not necessary to parse out small differences between species if the end-result will leave them in the same risk category.

- *Environmental parameters* – Much of the discussion focused on the risk of decompression sickness. This condition has not been documented in U.S. fisheries, but it was acknowledged that it is likely happening world-wide in fisheries with similar operational characteristics to those in the Valencia region of Spain. Gas embolism is a function of time and depth – turtles caught in shallower depths (<10 m) are less likely to be affected, unless capture time/submergence time is lengthy. It was suggested that maximum submergence time and depth be considered in the injury assessments. The current data on DCS are limited to one published study and one in-preparation; participants discussed whether this dataset could be used to model relative risk of DCS. Temperature was also mentioned as a possible factor that could affect post-interaction mortality. Key discussion points regarding temperature included the following: turtles may be less active at colder temperatures (which may affect their susceptibility to capture), may rely on limited energetic resources, and cooler water impacts/decrease in healing time. It was generally

agreed that not enough is known about the effects of temperature to determine its effect on relative mortality risk.

- *Observations for evaluating impairment* – Most of the discussion on this topic focused on the behavior of the animal at release and the limited ability of the observer to monitor the turtle for longer than a few seconds immediately following release. Most participants felt that it is abnormal for a hard-shelled turtle to remain at the surface without actively swimming away from the boat. Several participants voiced concern regarding the Feedback Instrument's designation of observing a turtle for 2 minutes post-release, noting that boat operations and environmental conditions do not always allow for observation beyond a few seconds.

- *Assigning percent mortality* – The basis for the mortality percentages applied in the GARFO guidelines was discussed. These percentages reflect the known effects of various injury types and the uncertainty of effects that cannot be observed in the short observation time typically following a fisheries interaction. Specific observations from a study of turtles caught in a shallow set gillnet fishery were considered. For animals that were satellite-tagged after capture, and released seemingly healthy, there was a 7-30% mortality rate. The question was posed as to whether 20% for the lowest risk category was conservative enough based on available data. Some participants voiced reservation about assigning a percent mortality without considering the fishery-specific characteristics because various cryptic injuries could be directly related to the time/depth in the gear. Participants were reminded that the point of this exercise is not to determine the probability that a fishery causes death; rather, it is to determine the likelihood a turtle will die if it presents with certain observable characteristics. Additionally, when the injury assessment is made from observer data, some characteristics of the tow/set (e.g., tow time/soak time, set location) are documented. One participant expressed concern that without knowing each turtle's specific interaction with the gear (time in dive, depth, time of interaction); it is inappropriate to use tow/set characteristics as a surrogate for assessment.

<u>Facilitated Discussion #2: Empirical data on post-interaction mortality</u>

- Participants acknowledged that the data on post-interaction mortality is limited to a small number of studies. Most turtles are not brought in for rehabilitation, so the opportunity for data collection is limited to information collected on board the vessel. The question of returning fresh dead turtles to shore for diagnostic imaging (to look for the presence of gas embolism) was raised and discussed. It was confirmed that frozen carcasses can yield information on DCS, but there are some caveats. This topic was further discussed in other sections of the Workshop and is summarized elsewhere.

<u>Facilitated Discussion #3: Use of observer program information to assess post-interaction mortality</u>

- The NMFS Northeast Regional Fisheries Observer Program data collection forms were discussed and it was noted that the format was revised for efficiency and consistency by using check boxes that cue documentation of specific observations relevant to the GARFO assessment. It was voiced that the NMFS southeast regional observer program likely would be reluctant to adopt the same format as the northeast observer program's form, as not all data fields are applicable in different regions. Where relevant to post-interaction mortality assessments, necessary data fields will be added. It was also noted that objective (check box) detail on the data log is beneficial for the observer (increases efficiency) and decreases debriefing time.
- Many participants felt that a timescale should be included on the data collection form to document time of boarding, time of behavioral/injury observations, and time when photos and videos are taken.
- A frequently expressed opinion was that injury photos and videos are essential for documentation. Concern was voiced that these cannot replace written documentation because photos/video may not turn out well, cameras may malfunction, or digital media may be lost. Video is more useful for behavioral assessment than photos; photos of traumatic injuries are more useful than video. Management of video storage, file size, and editing (redacting or language censoring) would have to be considered.
- Participants noted that behavioral descriptions should be coded on the datasheets and included as checkboxes, not just general descriptions, which can be subjective. Additional notes can be made as needed. The coding should be standardized across regions to reduce variability and facilitate analysis.

4. Feedback Instrument

4.1. Overview and Information Compilation Process

Each participant was asked to complete the two-part Feedback Instrument independently (see Appendix C). Part 1 asked participants to assign a percentage mortality estimate to each of three relative risk categories: low, medium, and high. Participants were given the option to increase or decrease the number of risk categories, provide point estimates or ranges, and assign different percentages to hard-shelled species vs. leatherbacks. These categories were used to rate the probability of mortality associated with 43 observations that described turtle behaviour and types of injuries. These observations or criteria were organized into three tables that were developed by the Workshop Steering Committee and modified based on individual input during the Workshop. In addition to the categories of low, medium, and high probability of mortality, participants also had the option of assigning "deceased" if they felt that a condition was incompatible with survival; i.e., death is imminent. Participants also could rate an observation as "not informative" for the purposes of estimating mortality or could amend the descriptions of observations in any manner they chose.

Part 2 of the Feedback Instrument included a series of open-ended questions that provided an opportunity for participants to discuss additional information related to post-interaction mortality. Questions focused on relevant non-gear parameters, improving information collection by observers, sub-lethal effects of fishery interactions, future research into post-interaction mortality, and any other suggestions a participant may have for assessing post-interaction mortality.

Detailed summaries of the responses are provided in Appendix D (Part 1) and Appendix E (Part 2).

4.2. Summary of Key Results

Below is a summary of key results gleaned from a detailed analysis of the individual responses to the Feedback Instrument including any associated comments.

Key Result #1: Strong support for the mortality estimates applied in the GARFO guidelines, but additional refinement is needed for mortality assigned to the low risk category (GARFO category I).

The existing GARFO guidelines figured prominently in discussions and feedback provided by participants. Consideration of these guidelines was an important and not unexpected aspect of the Workshop given that they were the product of a previously convened, similar working group that included sea turtle experts (veterinarians and researchers); the types of injuries considered are not unique to commercial fisheries in the northeast U.S. (as commented upon by attendees at the current Workshop); and the GARFO approach was implemented in 2012 and has been successfully implemented by NOAA for ESA purposes.

With regard to mortality assigned to the relative risk categories, many individual participants supported the percentages currently used by GARFO, which are 20%, 50%, and 80% (low,

medium, high, respectively) (Figure A). A minority of respondents used alternative scales. These alternative scales applied mortality values perceived by the respondent to fall logically within low, medium, or high risk ranges, whereas most other respondents either weighed support for or against the existing GARFO values and/or incorporated available data to derive mortality estimates. In some instances, differences in mortality assigned using these two approaches were offset by the assigned relative risk category. For example, some observations were rated as medium by some respondents, low by others, but the actual assigned percent mortality was similar.

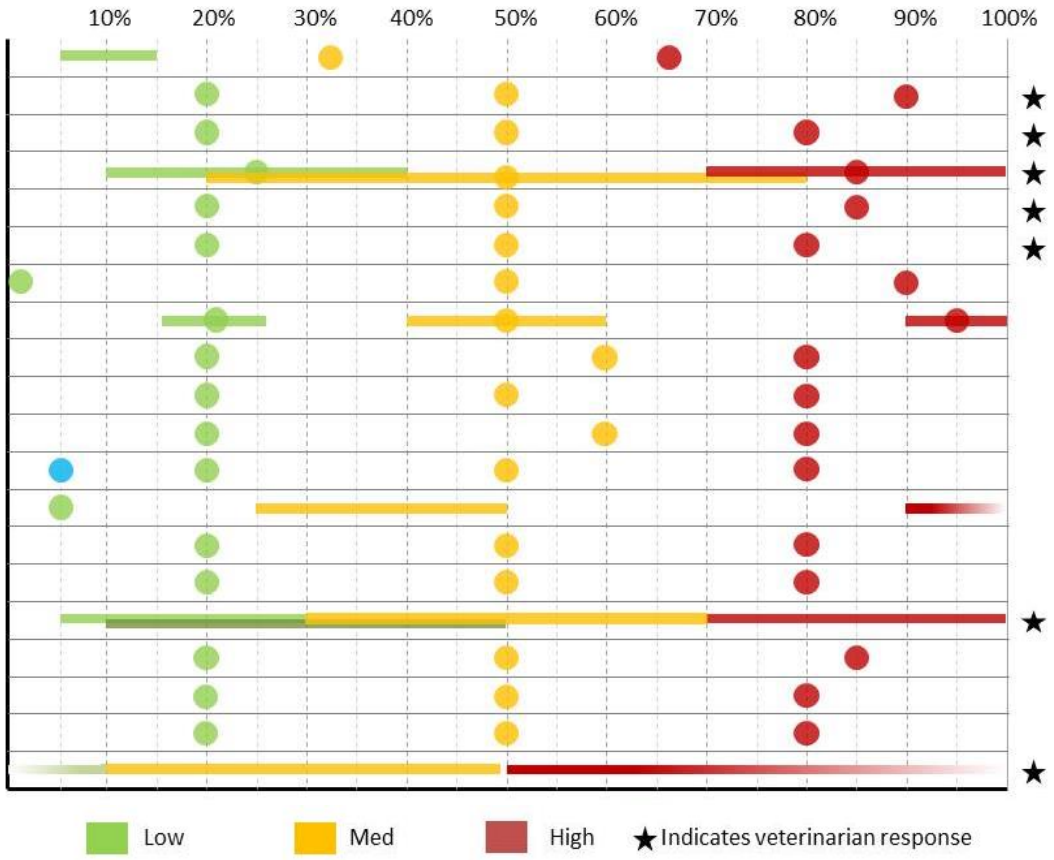

Figure A. Mortality estimates provided by expert participants for low, medium, and high risk categories. One respondent added a "very low" category indicated by the blue circle. Point estimates are shown as circles, ranges as bars. Bars that fade indicate ranges expressed as "greater than" or "less than." The black stars indicate veterinarian responses.

Many attendees made comments related to the low risk category, specifically regarding risk of decompression sickness. Based on information reported in the literature and presented at the meeting, concerns about DCS were most often cited for those turtles that appear active and uninjured, or as grounds for additional concern in those animals exhibiting various behaviors or injuries. Given the current understanding of decompression sickness in turtles and assumptions regarding basic comparative pathophysiology across taxa, it is likely that risk of DCS is not

uniform under all conditions of capture in all fisheries. Non-gear parameters, including duration of submergence and depth, should be considered. Methods such as modeling of capture parameters leading to DCS could potentially be developed to better quantify risk based on currently available information. This concern was less of an issue for medium and high mortality risk observations, which present as more obvious anomalous behaviors or injuries about which there is insufficient information to suggest that risk of complications or mortality would vary across different fisheries.

Key Result #2: General concurrence with many of the Feedback Instrument criteria but with recommendations of some modifications and additional considerations during data evaluation

The criteria used in the Feedback Instrument were initially constructed based upon and adapted from the GARFO guidelines and then modified based on input from the Steering Committee and Workshop participants. Most of the criteria elicited clear responses from participants or points of clarification were presented. Evaluation of individual criteria without the context of other findings or information regarding timing of observations relative to when the turtle was brought aboard and when the turtle was released made some participants hesitant to assign risk of mortality. Some respondents also cited lack of other information (e.g., thorough clinical assessment) as a qualification for given responses. These concerns are partially reflected in the suggestion for documentation of additional information by observers (e.g., observation timeline).

Risk of mortality assigned to criteria related to behavior and other findings in Table 1 (Tables 1-3 are included in Appendix C) was most consistent for those animals that exhibited active, vigorous movement or those that are most severely debilitated (e.g., unresponsive, inability to right self in water, or abnormal neurological signs). For active animals, aforementioned concerns related to decompression sickness were considered by many participants who opined that mortality in this group is higher in some fisheries. Those behaviors that were intermediate between the extremes of active and obviously impaired elicited more variable responses when all participants were considered, although most veterinarians tended to regard behaviors described as weak, sluggish, or slow as having greater risk of mortality, citing potential underlying hypoxia, metabolic derangement, trauma, and/or aspiration. Several areas of needed clarification or modification also were identified. Some respondents were concerned that some observers might equate gulping behavior described with decompression sickness to normal respiratory motions. Similarly, there was concern that water expelled from the esophagus may be mistakenly noted as aspiration and that erratic swimming behavior is overly vague and may be confused with initial flight response upon release. Closing of the eyes for prolonged periods also was considered to have very different implications by participants. Some considered this observation to be within the limits of normal behavior and others regarded it as a sign of profound morbidity. The criterion about which the most diverse responses were given was related to the duration that sea turtles stay at the surface and their behavior upon release. Most participants suggested an observational interval of much less than

2 minutes to define “abnormal” behavior, but comments generally indicated a need for additional refinement of this criterion.

Most of the criteria related to traumatic injuries presented in Table 2 were assigned very similar risk of mortality by participants. Minor points of clarification were suggested related to impaired movement of flippers and gear on animals at release. One area of needed additional assessment is traumatic amputation of a flipper or flippers, which was considered somewhat differently by participants. Most respondents primarily described long-term implications of traumatic flipper amputation rather than the immediate threat of blood loss. In addition, the broad category of risky boarding and handling practices was not considered useful, as it was viewed as either overly vague by many participants or redundant with other criteria.

Table 3, which included observations related to entanglement, had many areas of consistency among participants, but the various approaches to nuanced assignment of mortality risk significantly contributed to variability in assigned mortality estimates. Comments by participants, especially veterinarians, advocated for additional refinement in assessing mortality assigned to these injuries with greater risk applied to those resulting in greatest impairment of mobility.

Key Result #3: Non-gear parameters significantly influence the probability of mortality following fisheries interaction but vary in their applicability to assessment of individual capture events

All of the non-gear parameters included in the feedback instrument were viewed as being generally important to risk of mortality, but few were identified as having specific determinative value in the assessment of mortality of individual animals. For example, the intrinsic factors of species and size were regarded as important, but most respondents that commented on application to prognosis did not feel these factors would alter their assessment or that there was sufficient information available to warrant doing so.

Participants commented that differences in behavior across species are relevant to assessment of normal and abnormal behavior/activity. The ability to score leatherbacks differently was incorporated into the feedback instrument based on requests by participants, but the assigned risk category most often was not significantly different from hard-shelled species for most types of injuries. Water temperature was considered to be a generally important environmental parameter with various potential implications on pathophysiology of effects or injury resulting from interaction, but was often regarded less relevant to individual case determinations. Similar comments were made related to conditions of fishing operations, specifically maximum depth and duration of submergence; however, responses by many participants expressed the importance of these parameters as related to decompression sickness. Uncertainty with how to use this information was based on inability to determine the timing or depth of individual captures. Multiple participants suggested exploring quantitative or semi-quantitative approaches to apply depth and duration of submergence in mortality prediction.

Most respondents agreed that behavior and visible injuries, which are the current principle means of assessment, are important and, as commented by one participant, are most often the only information available with which to assess the actual condition of turtles. There was considerable variability in responses as to which period following capture is most informative with regard to evaluation of behavior, which is consistent with the commonly expressed sentiment that the complete context of all observations is critical to assessment.

Key Result #4: Recommendations for improvements in observer programs would better inform assessment of post-interaction mortality

The three predominant suggestions to improve information available for assessments were: (1) provide additional temporal information for behavioral and other observations; (2) use standardized videography and photography to thoroughly document turtle behavior and other observations; and (3) improve consistency in data collection and training across observer programs, including use of videos of normal and abnormal behaviors for instructional purposes. Specific suggestions related to these three core topics were included among individual comments, including ideas of how to maximize practicality and efficiency of data collection by observers.

Key Result #5: Sub-lethal effects are difficult to quantify, but loss of reproductive potential may be the most applicable

Most participants expressed strong opinions that sub-lethal effects are an important consequence of fisheries interactions, but many also acknowledged that they are difficult to quantify and incorporate into the current exercise of mortality estimation. A frequent comment was that sub-lethal injuries can be generally accounted for in the justification of mortality estimates to some degree. Over half of the respondents referred to reproductive losses resulting from some flipper injuries as a significant sub-lethal effect equivalent to death from the reproductive population perspective.

Key Result #6: More direct study is needed on effects of capture and mortality in bycaught turtles

The primary focus of research topics identified as priorities by most participants related to actual study of bycaught turtles. Many commented on the importance of tagging studies to infer mortality in various fisheries, some noting the caveats associated with these data and necessity of rigorous study design. Several participants also commented on the value of recovery of bycaught turtles for clinical and postmortem examination/study, especially as related to decompression sickness.

5. Federal Session

Following the plenary portion of the meeting, a federal-only session was convened for preliminary review of the initial results of the Feedback Instrument, to consider initial implications for national criteria, and to map a timeline and next steps toward development of the post-interaction mortality criteria. Below is a brief synthesis of the federal-only discussion themes and next steps.

- **Review and Continued Synthesis of Results:** Participants discussed an initial scan of the quantitative results of the Feedback Instrument. Given the number of responses and the critical need to digest the extensive comments and notes that were included in the feedback instrument, the group agreed that additional synthesis was needed before any general patterns and findings could be reliably discerned. Participants did note some individual differences in the way the terms "low", "medium" and "high" were interpreted by those completing the Feedback Instrument. Participants also noted the value of both point estimates (practical for policy guidance) and ranges (more closely reflect the reality of varying contexts) when considering the likelihood of mortality associated with different injuries and behaviors.

- **Strengthening Observer Program Data:** Participants discussed several ways to strengthen observer data. Specific suggestions included standardizing data fields across regions, making increased use of videos and photographs with time stamps, incorporating critical parameters into observer forms, streamlining the data collection process and removing non-essential elements, and incorporating video of normal and abnormal turtle behavior into observer training programs. Another key point of discussion was the need to strengthen the process for debriefing observers, with a particular emphasis on data timeliness. There was a call for conveying information on turtle bycatch events in or close to real time. Finally, each region strongly endorsed the concept of working with their respective observer program to incorporate (as practicable) many of the changes noted above.

- **Consideration of the GARFO Structure:** Participants discussed and confirmed their general support for the GARFO structure for applying mortality criteria. Key aspects included the following: 4-person team comprising varied expertise and perspectives; opportunity for near real-time (within one month) conversations with observers; and annual review of cases.

- **Review Group Composition:** Participants in the federal session broadly supported the establishment of a Review Group for determination of sea turtle injuries. There was support for building the Review Group on a regional basis with some discretion left to the region on composition. GARFO's current Review Group mix of Region, Science Center, OPR and veterinarians was generally seen as an effective composition. There was support for cross-region participation on Review Groups and comments that this cross-region participation can come from the Region or Center, wherever the primary

expertise exists. There was strong support for including at least one veterinarian with sea turtle expertise on the Review Group.

- **Periodicity of Review:** Members discussed the periodicity of post-interaction mortality case review and suggested that the initial case review take place within a month of occurrence and that all cases be reviewed annually, but with an opportunity for expedited review, as needed for management purposes.

- **Case Write-Up and Determination Records:** Participants discussed options for case write-ups, noting that while GARFO maintains a spreadsheet with a determination of each case, it does not create a full case report for each interaction. The view was expressed that brief case write-ups (e.g., one paragraph detailing the determination and the associated rationale) is useful for management purposes. Additional suggestions were to establish a template to create consistency across regions and to create a database with a function that allows output reports to be generated with only minimal effort. OPR staff noted it is considering preparing an annual, national report for marine mammal determinations to reduce the reporting workload within each region.

Next Steps

Based on the discussion, OPR staff outlined and discussed with participants the following next steps.

- Related to Feedback Instrument Surveys:
    - OPR will distill input from the Feedback Instruments to inform the draft Workshop Report and to draft post-interaction mortality criteria and will seek selective clarification from participants, if needed.
- Related to Workshop Report:
    - OPR will complete draft Workshop report and provide to participants for focused review with a target distribution date of November 1, 2015.
- Related to Development of Technical Memorandum/Post-interaction Mortality Criteria:
    - OPR will finalize the Workshop Report as an OPR Technical Memorandum with a target completion date of December 31, 2015.
    - OPR will develop draft post-interaction mortality criteria and criteria application process; will seek technical expertise, as needed; and will make use of small work groups, as needed, with a target completion date of December 31, 2015.
    - OPR will initiate NMFS internal review process (through the Protected Resources Board) with a target completion date of January 2016.
    - OPR will address internal comments and initiate an external peer review with a target date of February 2016.
    - OPR will address peer review comments and complete the final draft of Post-interaction Mortality Criteria and Criteria Application Process.
    - OPR will initiate the NMFS Policy Directive process with a target date of March 2016.

- Related to the Observer Program:
    - Convene a working group to develop recommendations for enhanced observer training.
    - Disseminate video best practices from NMFS PIRO program to all regional observer programs.

Appendix A – Meeting Agendas (Non-federal and Federal Sessions)

AGENDA

DEVELOPING NATIONAL CRITERIA FOR ASSESSING POST-INTERACTION MORTALITY OF SEA TURTLES IN TRAWL, NET, AND POT/TRAP FISHERIES

Convened by NMFS – Office of Protected Resources
Facilitated by CONCUR, Inc.
18 – 21 August 2015
National Conservation Training Center, Shepherdstown, WV
Instructional East ROOM 114

DAY 1: AUGUST 18, 2015 (TUESDAY)

WORKSHOP START-UP AND GENERAL OVERVIEW

8:30 Welcome and Purpose of Workshop - Donna Wieting

8:40 Agenda Review, Ground Rules, Logistics and Introduction of Participants - CONCUR

9:00 Introductory/Background Presentation on Developing Criteria for Assessing Post-Interaction Mortality of Sea Turtle in Non-Longline Fisheries - Barbara Schroeder

9:30 Legal Background and ESA Context for Assessing Post-Interaction Mortality and Developing Guidelines - Jason Forman

BACKGROUND PRESENTATIONS – EXISTING MARINE MAMMAL/TURTLE PROCESSES
(Each presentation includes 10-15 minutes for clarifying questions)

9:40 Overview of Marine Mammal Injury Determination Guidelines and Process - Karin Forney and Kristy Long

10:25 BREAK

10:40 Assessing Post-Interaction Mortality in Non-Longline Fisheries in the Northeast U.S.: An Overview of GARFO's Workshop, Process, Guidelines and Implementation - Carrie Upite

DAY 1: AUGUST 18, 2015 (TUESDAY) – CONTINUED

BACKGROUND PRESENTATIONS – EFFECTS OF INCIDENTAL CAPTURE IN NET, TRAWL, AND POT/TRAP FISHERIES AND IMPLICATIONS ON POST-INTERACTION MORTALITY
(Each presentation includes 10-15 minutes for clarifying questions)

11:25 Overview of Sea Turtle Physiology and Physiological Effects of Incidental Capture in Net, Trawl, and Pot/Trap Fisheries – Craig Harms and/or Amanda Southwood-Williard

12:00 LUNCH

1:00 Assessing Mortality and Decompression Sickness in Turtles Incidentally Captured in Net and Trawl Fisheries in the Mediterranean– Daniel Garcia

1:30 Assessment of Post-Interaction Mortality: Integrating Field Observations and Common Mechanisms of Injury – Brian Stacy

2:00 Opportunity for Participant Initial Reflections

BACKGROUND PRESENTATIONS – *SEA TURTLE TRAWL, NET, AND POT/TRAP BYCATCH OBSERVER PROGRAMS BY REGION*
(Each presentation includes 5 minutes for clarifying questions)

2:15 Pacific Islands Region Observer Program – Dan Luers

2:35 Southeast Region Observer Program – Lesley Stokes

2:55 BREAK

3:10 Northeast (Greater Atlantic) Region Observer Program – Nichole Rossi

3:30 West Coast Observer Program – Yonat Swimmer

3:50 Presentation of Illustrative Observed Interactions – Lesley Stokes, Carrie Upite

4:50 Opportunity for Participant Reflections

5:20 Preview of Day Two

5:30 ADJOURN

DAY 2: AUGUST 19, 2015 (WEDNESDAY)

FACILITATED DISCUSSION

8:30 Additional Reflections from Day One and Overview of Day Two

8:45 A Framework for Assessing Post-Interaction Mortality (Brian Stacy)

a. Introduce the proposed framework and seek clarifying questions

9:15 Facilitated Discussion #1: Veterinary Medicine/Physiology

a. What lethal and/or sublethal effects may occur from trawl, net, and pot/trap capture (including both single and multiple interactions/escapement from TED-equipped trawls) that can result in mortality following release?
b. Are there inherent differences among sea turtle species relevant to the probability of mortality interactions (e.g., forced submergence and/or traumatic injury) with these gear types?
c. Are there inherent differences among sea turtle life stages relevant to the probability of mortality interactions (e.g., forced submergence and/or traumatic injury) with these gear types?
d. Are there critical environmental parameters relevant to the probability of mortality interactions (e.g., forced submergence and/or traumatic injury) with these gear types?
e. What observations are most useful for evaluating the degree of impairment using information that can be practically obtained? Are there observations that are too variable (among individual turtles) or too subjective to be considered in assessment?
f. Other key observations?

11:00 BREAK

11:15 Facilitated Discussion #2: Empirical Data on Post-Interaction Mortality

a. What does the information gleaned from satellite telemetry studies of sea turtles captured in these gears tell us about post-interaction mortality?
b. What does the information on captive survival in rehabilitation following bycatch in these gears tell us about post-interaction mortality in the wild?
c. What information is most useful for evaluating the degree of impairment using information that can be practically obtained? Is there information that is too variable (among individual turtles) or too subjective to be considered in assessment?
d. Other key observations?

12:30 LUNCH

DAY 2: AUGUST 19, 2015 (WEDNESDAY) - CONTINUED

1:30 Facilitated Discussion #3: Use of Observer Program Information to Assess Post-Interaction Mortality

a. Are current observer programs collecting appropriate and sufficient data needed to assess post-interaction mortality?
b. If necessary, are there practical ways in which the current programs could be modified to provide enhanced or new information to improve assessment of post-interaction mortality?
    1. What descriptors/terminology can be incorporated into observer observations/trainings that will maximize the objectivity of assessment?
    2. What other methods (video, etc.) and specific guidance can be practically incorporated into observations to inform assessments?
c. Are there impediments to collecting this information? If so, how can they be overcome?
d. What are the steps/timelines needed to implement improvements?

3:30 BREAK

3:45 Revisit Framework for Assessing Post-Interaction Mortality and Introduce Feedback Instrument

a. Short break (as needed) for Agency to consider possible edits to Feedback Instrument
b. Provide revised, final Feedback Instrument to all participants for consideration prior to Day Three

4:45 Preview of Day Three

5:00 ADJOURN

DAY 3: AUGUST 20, 2015 (THURSDAY)

FACILITATED DISCUSSION

8:30 Overview of Day Three

8:45 Additional Reflection and Synthesis

a. Opportunity for additional participant comments on ideas generated during Day Two moderated discussion

9:30 Feedback Instrument

a. Revisit purpose and structure of Feedback Instrument, take additional clarifying questions
b. Workshop participants individually fill out Feedback Instrument based on Workshop discussions and individual expertise

12:00 Next Steps

12:20 Final Comments and Observations

12:30 ADJOURN

- Workshop ends for non-Federal Agency participants only.
- Schedule for Federal Agency-only discussion below; all Federal Agency participants are expected to stay through 12 PM on Friday, August 21.

FEDERAL AGENCY-ONLY DISCUSSION

DAY 3: AUGUST 20, 2015 (THURSDAY)

2:30 – 5:30 PM: See Agenda

DAY 4: AUGUST 21, 2015 (FRIDAY)

8:30 – 12:00 PM: See Agenda

AGENDA – FEDERAL SESSION

20-21 August 2015

DEVELOPING NATIONAL CRITERIA FOR ASSESSING POST-INTERACTION MORTALITY OF SEA TURTLES IN TRAWL, NET, AND POT/TRAP FISHERIES

Instructional East ROOM 114

THURSDAY - 20 August 2015

2:30 – 5:30 PM

INTRODUCTION (60 minutes)

- Overview of Fed session objectives and agenda flow
- Restate intent/timing for workshop output to culminate in policy directive
- Take stock of workshop feedback
    - Summarize/characterize workshop discussions/feedback – key themes and messages, important points (divergence/convergence)
    - Summarize initial review of feedback instrument (flag notable patterns, divergence/convergence)
    - Assess divergence/convergence from existing GARFO Criteria

DISCUSSION: CRITERIA (PROBABILITY OF MORTALITY) (120 minutes)

- Consideration of Strawman Criteria based on Meeting Presentations/Input and GARFO Existing Criteria (includes focused discussion on specific criteria, as needed, based on Workshop/Feedback Instrument results)

FRIDAY - 21 August 2015

8:30 – 12:30 AM

IMPLICATIONS FOR OBSERVER PROGRAMS - ARE MODIFICATIONS NEEDED TO IMPROVE INCOMING INFORMATION TO SUPPORT APPLICATION OF CRITERIA? (60 minutes)

- Data forms
- Training
- Debriefing
- Video

CRITERIA APPLICATION PROCESS (propose use of GARFO process as strawman) (90 minutes)

- Presentation of GARFO Process Details; logic of GARFO as potential strawman
- Establishment of regional or national review team(s)
  - Composition of team (internal vs mixed w/external)
  - Frequency of evaluations (i.e., quarterly, annually)
- Details of review process (e.g., individual case review of observer data and debriefing, review team discussions, final determinations)
- Format of Write-up/ Summary

REVIEW OF CRITERIA AND CRITERIA APPLICATION PROCESS (30 minutes)

- Regions/Centers/USFWS
- External Peers
- Public Review

NEXT STEPS (30 minutes)

- Additional Focused Studies to Potentially Refine Criteria in the Future
- Workshop Summary
- Policy Directive and Leadership Review Step
- Timeline

Appendix B – Workshop Participants

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Appendix C – Feedback Instrument

(The format has been modified to reduce the number of pages.)

PART I: Feedback Instrument for Assessing Post-Interaction Mortality of Sea Turtles in Trawl, Net, and Pot/Trap Fisheries

PARTICIPANT NAME:

Probability of Mortality:
Please provide a probability of mortality (percentage) associated with each category (Low, Medium, High). Provide rationale in comment section below table.

PROBABILITY OF MORTALITY SCORE					
LOW		MEDIUM		HIGH	
Hardshell	Leatherback	Hardshell	Leatherback	Hardshell	Leatherback

Comments:

Table 1. BEHAVIORAL OBSERVATIONS[1]		Probability of Mortality Score (L, M, H)	
		Hardshell	Leatherback
1	Vigorously crawls around when brought on board[2] Comments:		
2	Moves little or remains stationary when brought on board[2], but actively responds and/or crawls if moved, handled, or tagged[3] Comments:		
3	Movements generally appear or become slow, sluggish, or weak at any time while on board[2] Comments:		
4	Responds slowly or sluggishly to being moved, handled, or tagged Comments:		
5	Water or froth discharges from mouth or nares Comments:		
6	Difficulty breathing, including extension of neck and gulping behavior Comments:		
7	Eyes are continuously closed for seconds or more at a time Comments:		
8	Does not appear conscious/ responsive (does not move) when moved, handled, or tagged at any time while on board[4] Comments:		
9	Exhibits abnormal neurological signs, such as circling, head tilt, tremors, or uncoordinated movement Comments:		
10	Movements generally appear slow, sluggish or weak immediately before release (just prior to placing back in water) Comments:		
11	Immediately dives or swims deliberately away from vessel when released Comments:		
12	Remains at surface and/or does not swim deliberately away from vessel for up to 1 minutes (note: provide opinion on duration) Comments:		
13	Remains at surface and/or does not swim deliberately away from vessel for greater than 2 minutes (note: provide opinion on duration) Comments:		
14	Swims erratically Comments:		
15	Lists, rolls, or unable to right self when placed in the water Comments:		
16	Does not appear conscious/ responsive (does not move) upon release; and/or sinks (exhibits no swimming motions) Comments:		

[1]The 'but for' principle will be applied for any pre-existing conditions or adverse environmental conditions determined to be unrelated to the current gear interaction but likely to affect risk of mortality, i.e. risk will be increased accordingly for such cases.

[2]This behavior refers to general level of activity when turtles are first brought on board. It is not considered abnormal behavior if turtles calm down after crawling into a corner and or after being placed onto tires or other devices as part of safe handling measures.

[3]Active response includes vigorously crawling, lifting the head, or flapping or withdrawing flippers in response to being moved, handled, or tagged.

[4]Whether or not responds to reflex stimulation including: bilateral eyelid reflex, bilateral front and rear flipper pinch, corneal reflex, or cloacal clasp.

Table 2. TRAUMATIC INJURIES – GENERAL[1]		Probability of Mortality Score (L, M, H)	
		Hardshell	Leatherback
17	No apparent injuries Comments:		
18	Superficial abrasions , chips, or scuffs to carapace or plastron Comments:		
19	Minor or superficial injuries to skin[2] Comments:		
20	Fractures of shell margin involving <50% width of marginal or pygal[3] Comments:		
21	Fractures of shell margin involving >50% width of marginal or pygal[3] Comments:		
22	Any shell fracture involving bones other than marginal/pygal bones[3], but not involving the dorsal midline Comments:		
23	Any shell fracture that crosses the dorsal midline Comments:		
24	Fractures or wounds penetrating the body cavity OR exposing visceral organs Comments:		
25	Skull or mandibular fracture Comments:		
26	Injuries to neck affecting spinal cord, major blood vessels, or airway Comments:		
27	Injuries to flipper(s), which may impair movement or function (note: please comment on concerns related to front, rear, or multiples) Comments:		
28	Amputation of half or more (at carpus/tarsus) of one or more flippers (note: please comment on concerns related to front, rear, or multiples) Comments:		
29	Any open fracture of major long bones Comments:		
30	Evidence of bleeding from cloaca, nares, eyes, or oral cavity, unrelated to superficial wounds[2] Comments:		
31	Injuries to cornea, sclera, and/or globe of one eye Comments:		
32	Injuries to cornea, sclera, and/or globe of both eyes Comments:		
33	Gear remaining on animal at release Comments:		
34	Trauma inflicted during boarding, while on deck, or at release, including turtle hoisted onto or off of deck by lines tied to flippers, turtle lifted by flipper(s) distal to the elbow, and/or turtle dropped onto deck, or buried under heavy catch Comments:		

[1]Relative risk may be cumulative for multiple injuries.
[2]Including abrasions involving nasal planum, eyelid or cloacal skin
[3]These designation uses commonly applied anatomical references and refers to fractures involving peripheral bones (underlying marginal scutes) and pygal bones (underlying postcentral scutes).

Table 3. TRAUMATIC INJURIES – ENTANGLEMENT/LIGATURE-TYPE[1]		Hardshell			Leatherback		
		Probability of Mortality Score (L, M, H)			Probability of Mortality Score (L, M, H)		
		single flipper	multiple flippers[2]	neck	single flipper	multiple flippers[2]	neck
35	No visible compression or damage to the skin after removal of gear Comments:						
36	Ligature impression visible, but skin not damaged Comments:						
37	Skin abraded or ulcerated, but does not expose muscle Comments:						
38	Skin ulcerated with exposure/injury of muscle Comments:						
39	Skin ulcerated with exposure/injury of bone Comments:						
40	Swelling distal to entanglement Comments:						
41	Discoloration[3] distal to entanglement Comments:						
42	Necrosis[4] distal to entanglement Comments:						
43	Voluntary movement of entangled appendage is abnormal (for flippers, movement is slow, absent, or stiff compared to unaffected limbs) Comments:						

[1]Relative risk will be considered separately for single flipper involvement, multiple flipper involvement, and entanglements involving the neck.
[2]Provide comment on concerns related to front, rear, or multiples.
[3]Discoloration refers to the flipper having a diffuse red or purple hue or appearing whiter than the unaffected limbs.
[4]Necrosis appears as loss of the scaly layer of the skin or deeper tissues exposing muscle or bone, including odor or gas formation present

PART II: PARTICIPANT FEEDBACK INSTRUMENT for Assessing Post-Interaction Mortality of Sea Turtles in Trawl, Net, and Pot/Trap Fisheries

PARTICIPANT NAME:

_____

1. **Which of the following non-gear parameters, if obtainable from observer data, do you believe would make a meaningful difference in the probability of mortality? Provide narrative thoughts on how the parameter is (or is not) relevant and how important you believe it is relative to influencing the probability of mortality.**

    a. Size of turtle
    b. Species
    c. Behavior
        - Initial behavior on board
        - Behavior just prior to release
        - Behavior in-water after release
    d. Nature or extent of visible injuries (for example: extensive tissue damage, minor abrasions etc.)
    e. Length of time retained on board
    f. Maximum submergence time
    g. Maximum depth of capture
    h. Water temperature
    i. Other (describe):

2. **Relative to information currently collected by observers, do you have any recommendations for improvements that would help to better inform assessments of post-interaction mortality of sea turtles in trawl, net, and pot/trap gear?**

3. **Are there any sub-lethal effects (for example: reduced fitness, delayed maturation due to depressed growth rates, decreased reproduction, etc.) that should be factored in to an assessment of post-interaction mortality? If so, how would you incorporate sub-lethal effects into post-interaction mortality criteria?**

4. **Are there focused studies or analyses that could help refine post-interaction mortality criteria in the future? Please identify the most critically important and potentially informative, feasible studies/analyses that you would recommend.**

5. **Please provide any additional comments or recommendations you have relative to assessing post-interaction mortality in trawl, net, and pot/trap fisheries.**

Appendix D – Results of Feedback Instrument Part 1A

General summary and participant approaches

Twenty participants provided point estimates and/or ranges for all relative risk categories. Fourteen gave point estimates, 3 provided ranges, 2 provided both ranges and point estimates for all categories, and 2 provided a combination of either point estimates or ranges for individual categories. Two participants provided very limited completion of the feedback instrument and did not score most of the items in the tables and/or did not provide mortality percentages. Specific comments from these individuals are included in the summary below when relevant, but their scores are not summarized due to limited comparability with those of the other participants.

Two general approaches were taken by participants. Most (n=17) participants applied their expert opinion, discussions during the meeting, data from published studies, or a combination thereof to develop point estimates or ranges for the various observations. These individuals considered various factors that could result in mortality or mortality demonstrated in studies of animals with similar findings to produce a mortality estimate. For example, turtles that initially were considered to be active and uninjured had a mortality of approximately 20% according to Snoddy and Williard 2010, thus 20% mortality was assigned to the lowest risk category. Three participants used an alternative approach and assigned estimates that they felt intuitively were consistent with a general characterization of "low," "medium," or "high," and then applied these categories based on expertise and available information. For instance, in their opinion "low" meant less than 5 or 10%, whereas high meant greater than 80 or 90%. The differences in these approaches resulted in significant differences in the mortality estimates between the two approaches. Those provided by the latter three participants were among the lowest percentages assigned. In addition, these differences also resulted in variability in the relative risk of mortality assigned to different observations in some instances. For example, an observation that most other participants rated as low risk may have been rated a moderate risk by those who defined a lower estimated mortality to the low risk category. To address this difference in the treatment of the Feedback Instrument, responses were compared by both the actual mortality percentages assigned as well as the relative risk categories low, medium, or high.

All, but one participant applied three mortality categories in addition to the designation of "deceased." One participant felt that a "very low" risk category of 5% mortality was warranted and felt this may be more appropriate for certain situations; however, this participant did not subsequently use a "very low" category in their estimates.

Basis for estimates

Twelve participants provided an explanation of the source of the estimates provided. The current estimates used in the GARFO guidelines were either specifically or indirectly mentioned in responses of seven participants. Those that indirectly referenced the GARFO guidelines included in their comments the exact GARFO percentages and weighed information as to whether they felt mortality was consistent with these numbers, higher or

lower. Five participants discussed data from published studies or information shared at the meeting in combination with personal opinion/experience as the basis for the percentages they assigned. The three primary data sources referenced were Snoddy et al. 2010, Garcia et al. 2014, and Monterio et al. (in preparation, shared by Y. Swimmer). The remaining eight individuals referenced professional opinion as the basis for their estimate or did not provide additional specific rationale.

Fishery parameters and decompression sickness

Nine respondents referenced the importance of fishery characteristics or fishing conditions (most often specifically noting depth and/or risk of decompression sickness) as a factor that was important in their estimate or that should be considered in estimates. Two additional participants referenced decompression sickness or barotrauma in their comments. Three participants recognized the relevance of this information, but felt that it was considered within the provided estimates or that there was insufficient data to specifically incorporate it beyond concerns and types of injury already taken into account.

Comparison with mortality estimates assigned in the GARFO guidelines

Mortality estimates assigned by participants are provided in Figure 1. Of the fourteen participants that provided point estimates, half were in full agreement with the point estimates defined in the GARFO guidelines and five gave estimates that were similar, but increased mortality by 5-10% for single categories (2 in the medium risk, 3 in the high risk). Thus, the opinions of 12 of 14 respondents that provided point estimates were consistent with or higher than mortality estimates in the GARFO guidelines. Two of the four participants that provided ranges also provided point estimates, which were higher than the GARFO estimates for the low and high risk categories, and the same for the medium risk category. Of the two respondents that provided ranges but no point estimates, one included the GARFO estimates within the provided ranges. Ranges around 20%, 50%, and 80% for the three categories were from 5% to 30%. Therefore, among the twenty respondents, fifteen (including 10 of 11 participants with expertise in veterinary medicine, physiology, or sea turtle biology) gave responses that were in agreement with or inclusive of mortality estimates currently applied in the GARFO guidelines. The five divergent responses include those of the three individuals that developed assigned percentages based on what they felt was intuitive ranking of mortality risk (as previously described), one individual that applied a fourth category, and one individual that consistently assigned relatively lower mortality estimates for all categories. For three of these individuals, the point estimates or ranges for the medium and high categories were the same as or higher than the GARFO estimates, whereas the lowest risk category (2-5%) was lower. Of the two remaining respondents, one gave a range and estimates that were lower in all categories, and the other provided ranges that overlapped with those of some other participants, but were generally scaled quite differently from the other responses.

Table 1: Behavioral Observations Summary of Participant Responses

Some responses were repeated for multiple behavioral observations by individual participants. For example, one respondent frequently commented that the stated observation would need to be considered in light of other findings, clinical information, and circumstances. Another participant stated that their responses apply to shallow water fisheries and applied a higher mortality for those caught by deeper fisheries.

1-Vigorously crawls around when brought on board (n=20 responses)

There was general agreement that this observation is within the range of normal behavior exhibited by captured sea turtles and most participants categorized these animals within the low risk category. Nine participants commented that delayed effects, most specifically referenced decompression, are still a concern in these turtles. One of these respondents did not feel active behavior was a useful criterion because of delayed effects and problems masked by fight-or-flight response. The two respondents that assigned this observation a higher risk of mortality used a scale that was different from most of the other participants, and both mentioned concerns related to decompression.

2-Moves little or remains stationary when brought on board, but actively responds and/or crawls if moved, handled, or tagged (n=20 responses)

Responses were similar to those of the previous behavioral observations with many of the same respondents repeating comments related to normal behavior and concerns related to decompression sickness in some animals. The decreased activity; however, prompted comments by six participants that they would expect completely normal turtles to be more active, prompting two individuals to assign a moderate risk score. Four of seven veterinarians voiced concerns along these lines. One assigned a higher score of 50% mortality and two commented that actual mortality may be higher than that given for their lower risk estimate (20%). One veterinarian noted that leatherbacks can exhibit periods of reduced activity and thus applied a low risk to this criterion.

3-Movements generally appear slow, sluggish, or weak at any time while on board [suggested addition: "*but becomes active prior to release*"] (n=20 responses)

Comments related to this described behavior generally followed a trend of increased concern for mortality risk. Only three participants rated this observation as low risk, but many commented that there is a lot of uncertainty. Four participants felt this behavior is still within normal limits, especially if turtles are kept on board for a longer period. Multiple participants expressed that a temporal component would be helpful to interpreting this observation; however, some felt an animal becoming more slow/weak would warrant a poorer prognosis (and higher mortality rating), whereas others felt this is expected as animals calm down. Five veterinarians considered these animals at moderate risk, one categorized them as high risk (but considered as moderate in some circumstances), and one felt it was too subjective and within the realm of normal response to capture.

4-Responds slowly or sluggishly to being moved, handled, or tagged (n=20 responses)

Continuing with the previously mentioned trend across observations #1 through 4, more respondents gave this behavior a high risk designation (10/20 respondents), including four of seven veterinarians. Two participants with primary expertise in physiology considered this behavior as still within normal response to capture and applied a low mortality risk, as they did for #1 through 3.

5-Water or froth discharges from mouth or nares (n=16 responses)

In general, mortality estimates reflected a high degree of concern with this observation (four of seven veterinarians classified this observation as high mortality risk). However, clarifying language or specification of concurrent abnormalities (e.g., difficult breathing, sluggishness) was noted as important to the determination. Expert participants with significant experience capturing sea turtles felt that water expelled from the esophagus could be confused with aspirated fluid and was a common finding. Two veterinarians assigned moderate risk for this reason and expressed in their comments that actual aspiration would have a higher risk.

6-Difficulty breathing, including (*prolonged*) extension of neck and gulping behavior (n=19 responses)

There was consistent concern among participants regarding this observation. All veterinarians considered this behavior as having high risk of mortality. Most respondents referenced D. Garcia's presentation and most of the veterinarians included various concerns related to respiratory distress. Two participants commented that fishery observers may confuse this behavior with normal respiratory movements, and one participant suggested additional clarification.

7-Eyes are continuously closed for seconds or more at a time (n=16 responses)

There was considerable divergence of opinion related to this observation. Some respondents felt that it was a grave indication, whereas others assigned low risk. All six veterinarians that responded for hard-shelled turtles rated this observation as a moderate (n=3) or high risk (n=3). One veterinarian stated that it is normal behavior for leatherbacks and one physiologist felt it was unrelated to mortality regardless of species. The comment was made that eye injuries also cause animals to close their eyes and should be distinguished from more worrisome behavioral changes. The suggestion was made to change "seconds" to "minutes."

8-Does not appear conscious/responsive (does not move) when moved, handled, or tagged at any time while on board (n=20 responses)

Most participants considered these animals dead. The phrase "any time while on board" was a source of some confusion. Most participants seemed to interpret this to mean that the turtle exhibited this behavior the entire time while board. Situations in which a turtle recuperates to some degree prior to release was not uniformly considered by participants.

Due to the relatively high frequency of this observation and importance to determinations, veterinary participants were contacted after completion of the Feedback Instrument to get their opinions about risk of mortality related to this criterion, which was modified for clarity. Veterinarians were asked to consider the following: "Exhibits an episode at any time where does not appear conscious/responsive (does not move voluntarily) when moved, handled, or tagged, but subsequently becomes conscious/responsive prior to release." Five of 7 considered this observation to have a high risk of mortality and two assigned medium risk. Two veterinary respondents made additional comments that mortality risk would depend on the degree of recovery prior to release.

9-Exhibits abnormal neurological signs, such as circling, head tilt, tremors, or uncoordinated movement (n=18 responses)

All but one respondent (including all of the veterinarians) considered this behavior as a high risk of mortality (n=12) or considered these turtles as inevitable mortalities (n=4). One participant considered hard-shelled turtles to have a high risk and leatherbacks to be inevitable mortalities.

10-Movements generally appear slow, sluggish or weak immediately before release (just prior to placing back in water) (n=20 responses)

The majority of participants placed this observation in their high risk category, including five of seven veterinarians. Multiple respondents commented that turtles may exhibit a higher activity level when introduced into the water, which caused some to consider this a moderate mortality risk. Others felt that this behavior indicates an uncertain degree of clinical impairment that likely will compromise survival. In addition, several participants mentioned the importance of temporality, e.g., citing a negative trend in alertness or decline prior to release as of concern.

11-Immediately dives or swims deliberately away from vessel when released (n=20 responses)

Most respondents placed this behavior within the low risk category and characterized it as within the spectrum of normal behavior. Two of the veterinarians expressed reservations that immediate escape does not necessarily mean that animals are healthy, one felt that the observation did not have meaning on its own. Three respondents included consideration of fishing depth in their responses, two of which gave an estimate of 50% mortality for turtles caught in deep water fisheries.

12-Remains at surface and/or does not swim deliberately away from vessel for up to 2 minutes (n=19 responses)

The responses to this observation were quite varied. Among the veterinarians, three rated it as low risk, two as moderate, and two as high. Many participants suggested changes to the duration of observation, but these specifications did not clearly explain the differences in responses. The most frequent suggestion was to decrease the period to 30 seconds or 1

minute. One veterinarian suggested increasing it to 5 minutes, acknowledging that this probably was not realistic under normal fishing conditions. Others felt that it is unlikely that observers would be able to keep turtles within sight for 2 minutes. Many of the respondents (n= 9) felt strongly that immediately diving is the normal response in hard-shelled turtles and any deviation from this behavior is abnormal. Multiple participants commented that this was their observation in turtles caught during in-water studies and/or in fisheries. Some of those with experience with leatherbacks stated that this species may normally stay near the surface for longer periods than hard-shelled turtles. Two respondents commented that it should be clarified that the turtle then dives after a given period of observation.

13-Remains at surface and/or does not swim deliberately away from vessel for greater than 2 minutes (n=18 responses)

There was more agreement among participants as compared to #12. Sixteen of eighteen respondents placed this behavior in their high mortality category, with one considering these turtles dead. The same changes to the duration of observation given in #12 were recommended as were comments related to leatherbacks. Four participants placed leatherbacks in lower risk categories (1 in low risk and 3 in moderate risk).

14-Swims erratically (n=19 responses)

Most (13 of 19) participants considered erratic swimming within the high risk category, although five participants felt that "erratic" swimming could be confused with initial flight behavior and others commented that additional description is needed. To account for this distinction, two respondents added a temporal component to the description and rated mortality higher if the behavior persisted for a longer period. One participant gave hard-shelled turtles a lower score relative to leatherbacks based on the concern that hard-shelled turtles will sometimes exhibit behavior upon release that may be misinterpreted as erratic. Two respondents (and two participants that did not fully complete the instrument) expressed concern that this criterion is too vague or would be difficult for observers to identify.

15-Lists, rolls, or unable to right self when placed in the water (n=20 responses)

All respondents considered turtles exhibiting this behavior to be in the high risk mortality category (n=12) or imminently fatal (n=8).

16-Does not appear conscious/responsive (does not move) upon release; and/or sinks (exhibits no swimming motions) (n=20 responses)

All but one respondent considered turtles exhibiting this observation to be associated with inevitable mortality. One placed it in their high mortality category, which included 100% in its high range.

Table 2: Traumatic Injuries (General) - Summary of Participant Responses

17-No apparent injuries (n=20 responses)

Seventeen out of 20 respondents placed this observation in the lowest risk category. Six respondents mentioned the importance of other concerns in animals within this category, most specifically referencing the importance of either fishing characteristics (i.e., tow time, depth) or decompression sickness. Three participants that gave this observation a moderate mortality score included similar comments in their justification.

18-Superficial abrasions, chips, or scuffs to carapace or plastron (n=20 responses)

Scores and comments were very similar to those provided under #17. One participant gave a higher score for leatherbacks stating concerns regarding greater susceptibility to injury.

19-Minor or superficial injuries to skin (n=19 responses)

Scores and comments were very similar to those provided under #17 and #18. One participant gave a higher score for leatherbacks, but did not provide supporting comments. One participant noted leatherbacks may have a higher mortality risk, but scored them the same as hard-shelled turtles. Others (including three of the veterinarians) noted that while leatherbacks are more prone to skin injuries, they would not use this as the basis for higher estimated mortality.

20-Fractures of shell margin involving <50% width of marginal or pygal (n=17 responses)

This observation was associated with greater concerns among some participants as compared to more superficial injuries. Of the responses from veterinarians, five considered these fractures to be relatively low risk for hard-shelled turtles and two considered them moderate risk (but the related % mortality assigned by one of these respondents was within the bounds of low mortality assigned by the larger group). One veterinarian gave a moderate ranking citing concerns related to internal injuries. Two veterinarians assigned leatherbacks a higher score (one moderate, one high) than hard-shelled species. Two respondents noted that leatherbacks do not have the anatomical equivalent of the marginals, thus this description would need to be modified.

21-Fractures of shell margin involving >50% width of marginal or pygal (n=17 responses)

This more extensive fracture observation was given a higher risk of mortality by some participants than given for #20. Four of the veterinarians assigned a moderate risk score, some citing concerns related to internal injuries, and three assigned low risk. Similar to #20, two veterinarians assigned leatherbacks a higher score (one moderate, one high) than hard-shelled species.

22-Any shell fracture involving bones other than marginal/pygal bones, but not involving the dorsal midline (n=17 responses)

Participants considered these injuries to reflect medium (n=12) or high (n=5) risk of mortality for hard-shelled turtles. Many respondents expressed concerns about injury to internal organs. Of the responses from veterinarians, six of seven placed these injuries in the medium risk category. One veterinarian felt the injuries warranted high risk, but the percentage assigned to that category was inclusive of ranges assigned by other veterinarians (≥50%). Two veterinarians assigned higher relative mortality (one high, one invariably fatal) for leatherbacks and stated that they had never encountered such injuries in a live turtle in their professional experience.

23-Any shell fracture that crosses the dorsal midline (n=19 responses)

All but one participant considered these injuries to have high risk of mortality, including all of the veterinarians. Most respondents who commented cited the likelihood of spinal cord involvement and possible paralysis. One veterinarian considered leatherbacks with such injuries to be mortalities as they have not observed such an injury in any live leatherbacks. One respondent opined that this type of injury would be a moderate risk to turtles caught in shallow water fisheries and a high risk to turtles caught in deeper fisheries.

24-Fractures or wounds penetrating the body cavity OR exposing visceral organs (n=19 responses)

All participants categorized turtles with these injuries as high risk of mortality (n=13) or inevitably mortality (n=6). Six of seven veterinarians rated mortality of hard-shelled turtles as high risk and one considered turtles injured to this degree to be mortalities. One veterinarian considered injuries in hard-shelled turtles as within the high mortality category and leatherbacks to inevitably die.

25-Skull or mandibular fracture (n=19 responses)

Most respondents considered turtles with skull or mandibular fractures to have a high risk of mortality (n=16) or the outcome to be consistently fatal (n=3). Most of the veterinary comments discussed low survivability associated with neurological damage or inability to feed. Some cited high rates of complications in treated turtles.

26-Injuries to neck affecting spinal cord, major blood vessels, or airway (n=18 responses)

All participants considered these injuries either inevitably fatal (n=7) or associated with high risk of mortality. Six of seven veterinarians categorized these injuries as high mortality risk; one regarded these injuries as inevitably fatal.

27-Injuries to flipper(s), which may impair movement or function (note: please comment on concerns related to front, rear, or multiple flippers) [Changes suggested: insert "*visibly*" after "*which*"] (n=17 responses)

Most participants generally assigned single flipper injuries into the medium risk category and multiple injuries into the high mortality category. Several participants mentioned that although turtles with these injuries have been seen in the wild, it is not known what

proportion of animals actually survive. Multiple participants expressed concerns that this category is overly vague and will be difficult to interpret from observer data. It was recommended to add “visibly” instead of “may” to make the criterion more specific and objective. Most respondents generally noted the greater importance of the front flippers for swimming. Two veterinarians gave more nuanced mortality estimates for different combinations of injuries and placed single rear amputations in the low risk category. Some veterinarians also felt that front flipper loss is more significant in leatherbacks, and rated these injuries a higher mortality risk in this species. Multiple respondents noted the significance of front flippers in males and the rear flippers in females and felt loss of reproductive potential should be considered.

28-Amputation of half or more (at carpus/tarsus) of 1 or more flippers (note: please comment on concerns related to front, rear, or multiple flippers) (n=18 responses)

Most of the responses were similar to those provided for #27. One veterinarian pointed out that significant blood loss would occur with such an injury and rated any amputation as having high mortality. Another veterinarian mentioned blood loss, but still assigned medium risk. In consideration of all the responses, it appears that most participants primarily weighed the chronic effects, such as infection, and the long-term implications of flipper loss on survival rather than the immediate risk of mortality.

29-Any open fracture of major long bones (n=17 responses)

Thirteen of 17 respondents (including 6 of 7 veterinarians) placed turtles with open major long bone fractures in the high mortality category, citing complications from blood loss, secondary infection, and loss of the flipper. Notably, these concerns were expressed to a greater degree by some participants than for amputations. Four of the veterinarians specifically mentioned comparison between open fractures and amputations and considered fractures to have a greater relative risk of infection and delayed healing.

30-Evidence of bleeding from cloaca, nares, eyes, or oral cavity, unrelated to superficial wounds [Changes suggested: insert "*active*" after "*of*"] (n=17 responses)

Most participants (14 of 17), including all of the veterinarians, considered this observation to have a high risk of mortality. However, multiple respondents included in their comments that it may be difficult for observers to confidently identify the source of hemorrhage.

31-Injuries to cornea, sclera, and/or globe of one eye (n=16 responses)

Ten respondents gave this observation a medium mortality score, four gave it a low score, and two gave it a high score. Of the veterinary responses, five rated loss of vision in one eye to have a medium risk and two rated it as low risk. Within their responses, veterinarians discussed species differences including individual comments about green turtles (primarily herbivores) perhaps being less affected by vision loss relative to other hard-shelled turtles and leatherbacks perhaps being more affected than hard-shelled turtles (one veterinarian gave hard-shelled turtles a low risk score and leatherbacks medium risk).

Other individual comments were relatively varied for this observation and included concerns related to pain, as well as those noting that unilaterally or completely blind turtles can function to some degree or have been encountered in the wild.

32-Injuries to cornea, sclera, and/or globe of both eyes (n=18 responses)

Most participants (n=15) considered this injury to have a high risk of mortality and three participants considered the injury inevitably fatal. All veterinarians placed this injury in the highest mortality category. Two further commented that they would change their score to inevitable mortality if animals were bilaterally blind; however one veterinarian acknowledged that it would be difficult or impossible to determine this in the field.

33-Gear remaining on animal at release (n=20 responses)

Sixteen respondents considered gear remaining on the turtle at release to potentially have a high risk of mortality. The veterinarians were split between moderate risk (n=3) and high risk (n=4), with one considering leatherbacks with gear on them as high risk and hard-shelled turtles as low risk. However, thirteen respondents felt that this would be highly dependent on the amount and type of gear and whether or not there was impairment of the head/neck and/or swimming. Multiple participants felt this could affect their score and one considered this observation to be insufficient for determination without more detail.

34-Trauma inflicted during boarding, while on deck, or at release, including turtle hoisted onto or off of deck by lines tied to flippers, turtle lifted by flipper(s) distal to the elbow, and/or turtle dropped onto deck, or buried under heavy catch (n=20 responses)

Respondents considered these actions/injuries to have either medium (n=6) or high (n=11) risk of mortality, but most expressed concern that this criterion was overly broad and would have to be assessed case-by-case. Three participants felt that the category was insufficiently specific to provide a mortality risk score. Some participants referenced that the types of injuries that would occur were adequately considered in the other trauma-related criteria; therefore, this general category is not necessary.

Table 3: Traumatic Injuries (Entanglement/Ligature Type) – Summary of Participant Responses

General comments: One veterinary respondent gave a more nuanced assignment of risk that did not lend to specific tabulation with the other responses in some cases. This individual generally assigned a higher score to multiple flipper injuries involving either both front flippers or front and rear flippers on the same side, citing greater risk of impaired mobility.

35-No visible compression or damage to the skin after removal of gear (n=18 responses)

Most respondents assigned this observation a low risk of mortality, including all of the veterinarians. Three participants placed involvement of the neck (n=3) or multiple flippers (n=1) in the moderate risk category. Qualifications to these responses given by individuals

included the importance of context of history and clinical signs in overall assessment (same comment made for all entries), consideration of decompression in turtles captured at depths below 1 atmosphere (same comment made for all entries), and the assumption that the gear was not tightly wrapped and was easily removed. One respondent felt that this observation was not relevant to leatherbacks because it was unlikely that their skin would not be injured. There were no differences in scores assigned to hard-shelled turtles as compared to leatherbacks.

36-Ligature impression visible, but skin not damaged (n=18 responses)

The presence of visible ligature marks elicited assignment of medium mortality risk by eleven respondents (including 6 of 7 veterinarians) for some locations, especially involving the neck (n=10) and involving multiple flippers (n=5). Comments explaining the higher score included concerns related to myopathy, acidosis, and injury to the trachea. Four participants (all veterinarians) scored leatherbacks differently, three giving ligature impressions in all locations a low risk, whereas those involving the neck or multiple flippers were given a medium risk for hard-shelled turtles. One of these respondents explained that the skin of hard-shelled turtles is more resilient, thus any visible injury is more likely to be associated with more significant trauma. The fourth veterinarian assigned ligature marks on one or more flippers in leatherbacks a moderate ranking, citing higher mortality associated with flipper loss for this species. An additional respondent did not provide a score for leatherbacks because they felt this species was unlikely to exhibit this criterion (as stated for #35 as well).

37-Skin abraded or ulcerated, but does not expose muscle (n=15 responses)

Responses were similar to #36 with eleven respondents assigning higher risk of mortality to injuries involving the neck or multiple flippers. Four respondents, including one of the veterinarians associated these injuries with high risk of mortality. Only one respondent scored taxa differently, placing any flipper injuries in leatherbacks in the medium risk category.

38-Skin ulcerated with exposure/injury of muscle (n=15 responses)

In general, more respondents gave an injury with these characteristics higher mortality scores than the preceding categories, especially for injuries involving multiple flippers or the neck. Five of seven veterinarians placed the latter in the high mortality category citing the possible involvement of the trachea, large blood vessels, and spinal cord. Two veterinarians applied a more nuanced assignment of mortality giving injuries involving the rear flippers a lower risk of mortality and a higher risk for combinations of injuries more likely to impair swimming. Notably, two veterinarians had a contrasting opinion for hard-shelled turtles and categorized all injuries in the low mortality category. Three respondents, including two veterinarians, applied high mortality risk for leatherback turtles with injuries involving multiple flippers or the neck.

39-Skin ulcerated with exposure/injury of bone (n=15 responses)

Responses for injury of this severity followed a general trend of increasing concern from #35 through #39, with all but one participant rating single flipper injuries as having at least medium risk of mortality and those involving the neck or multiple flippers as high risk. Four participants, including two veterinarians considered such injuries involving the neck to be inevitably fatal and one considered those with bilateral front flipper injuries as inevitably fatal. Another veterinarian had a similar response and rated single front flipper injuries in the high category and single rear flipper injuries in the medium risk category. Comments of individuals referenced risk of infection, blood loss, loss of vital function, and damage to vital structures. Four respondents (including 3 of 7 veterinarians) gave a higher mortality risk to leatherbacks. These 3 responses from veterinarians included animals with single flipper (1 respondent), multiple flipper (1 respondent), and neck (1 respondent) injuries citing greater potential consequences in this species.

40-Swelling distal to entanglement (n=13 responses)

Eleven participants assigned a higher relative risk for injuries involving the neck (n=9) and/or multiple flippers (n=7). Concerns expressed in comments referred to impairment of circulation, necrosis, infection, and potential loss of affected limbs. All but one veterinarian considered animals with this observation to have at least medium risk of mortality. The veterinarian that applied the lowest category specifically indicated it for rear flipper involvement and placed front flipper involvement in the medium category. All considered involvement of the neck region to be high risk or fatal (two participants noted that this injury type was not applicable to the neck). Four of seven veterinarians considered multiple flipper involvements to be high risk, and one specifically applied this score to bilateral front flipper injuries or unilateral involvement of both flippers. Two respondents applied higher scores for flipper involvement in leatherbacks, with one scoring single flipper involvement as higher and the other considering injury to multiple flippers as more significant.

41-Discoloration distal to entanglement (n=14 responses)

Ten respondents gave this observation a medium risk for single flipper involvement; two participants felt it constituted low risk and two considered it high risk. Concerns cited included impairment of circulation preceding overt necrosis and limb loss. Five of the veterinarians rated multiple flipper involvement as high risk of mortality, with one considering bilateral front limb involvement or involvement of two flippers on the same side as fatalities. All veterinarians generally regarded involvement of the neck as high risk (n=6) or inevitably fatal (n=1). Two participants again commented that this observation is not applicable to the neck. Four participants, including two veterinarians, gave flipper injuries in leatherbacks a higher mortality rating relative to hard-shelled species.

42-Necrosis distal to entanglement (n=14 responses)

Responses for necrosis were similar to those of discoloration, with individual participants making similar comments about loss of the limb and secondary infections. Only one participant placed involvement of an individual flipper in the low risk category – most participants applied a moderate risk for single flipper injuries. Five of the veterinarians placed involvement of multiple flippers in the high risk category (and a sixth veterinarian did so if involvement was bilateral and involved the front flippers or flippers on the same side). Two veterinarians specified that bilateral front flipper involvement is inevitably fatal. Two participants gave different scores to leatherbacks, elevating the risk of mortality associated with flipper injuries.

43-Voluntary movement of entangled appendage is abnormal (for flippers, movement is slow, absent, or stiff compared to unaffected limbs) (n=15 responses)

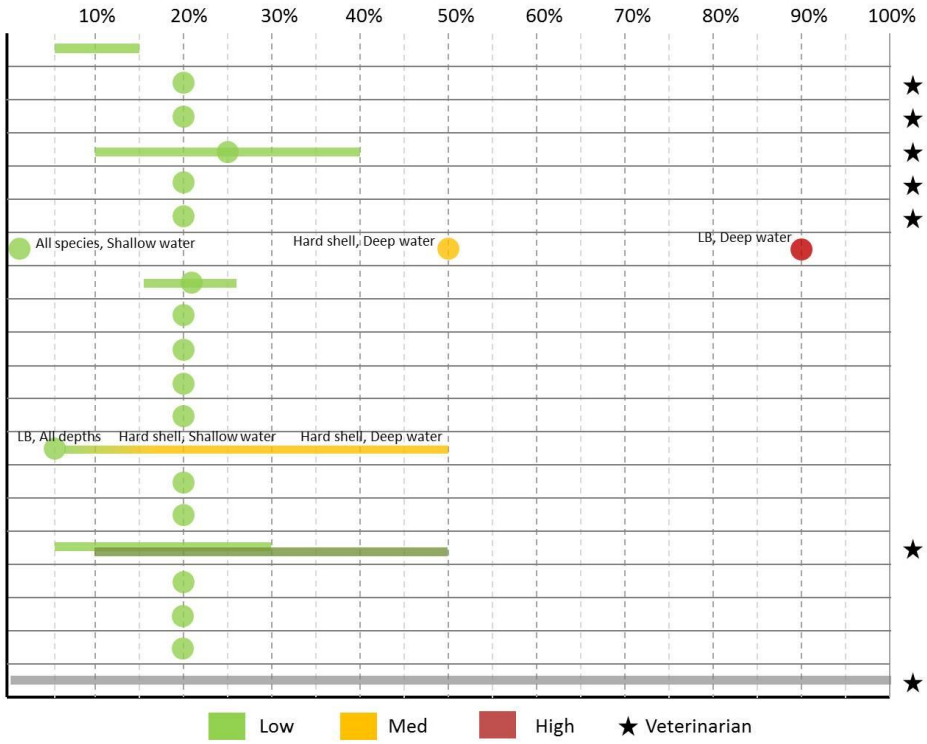
Participant responses were similar to those of other injury categories, most referring to loss of function and assigned at least a moderate risk of mortality. Among the veterinarians, one assigned low mortality to rear limb involvement and another noted the same opinion in their comments, whereas the rest assigned a moderate risk of mortality, especially for front flippers. Similarly, most of the veterinarians assigned high mortality for bilateral front limb involvement, and one considered these injuries as inevitably fatal. Neck injuries were considered at least high risk by all of the veterinarians; two classifying them as fatal. A third veterinarian specifically commented that impaired mandibular function would be considered fatal. Three respondents, including two veterinarians, assigned a higher risk of mortality to leatherbacks with flipper injuries.

Appendix D – Results of Feedback Instrument Part 1B

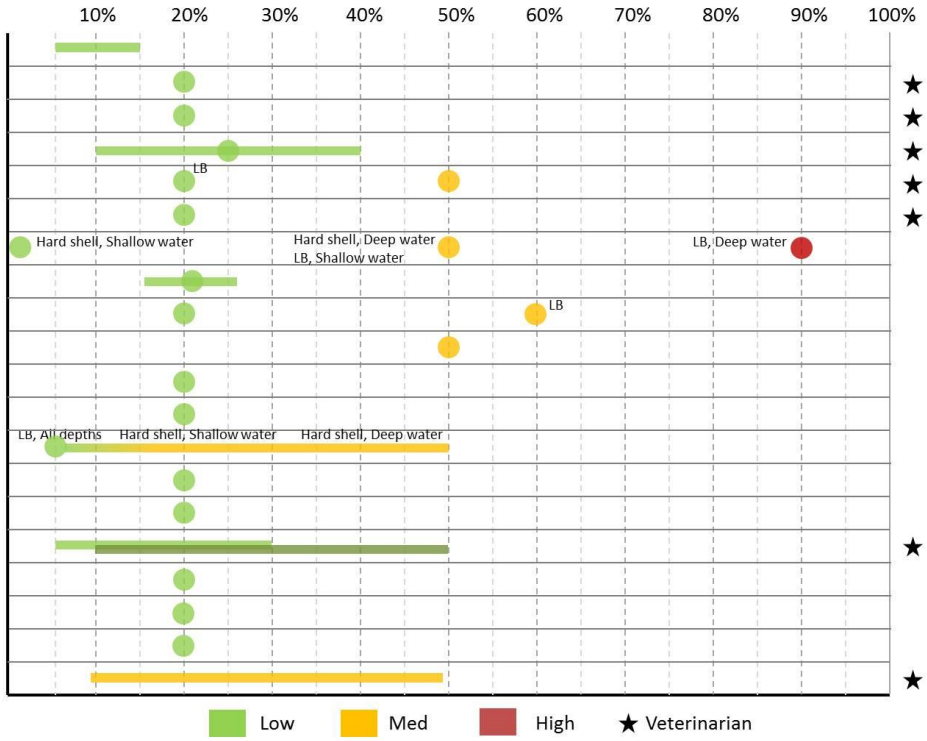
The following figures show categories of relative mortality risk (low, medium, high, deceased) assigned to observations by participants. The 'deceased' category includes turtles expected to die as a result of the interaction. Point estimates are shown as circles, ranges as bars. Bars that fade indicate ranges expressed as "greater than" or "less than." Gray bars indicate that the participant did not find the observation to be informative. The black stars indicate veterinarian responses. For some of the observations in which different responses were given for hard-shelled species as compared to leatherbacks, two separate graphs are shown if necessary to more clearly present responses. Those responses that are different between the taxa for the same finding are shaded in pink.

These graphs are augmented by the written summaries in Appendix D – Part 1A. All nuanced responses could not be captured graphically, especially for responses to injuries in Table 3.

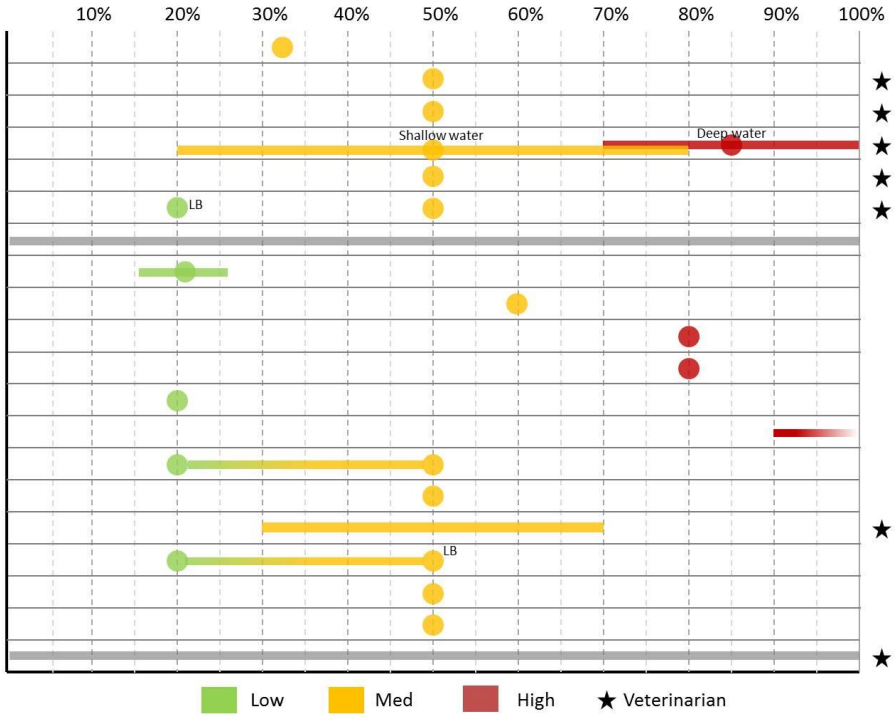
1 - Vigorously crawls around when brought on board



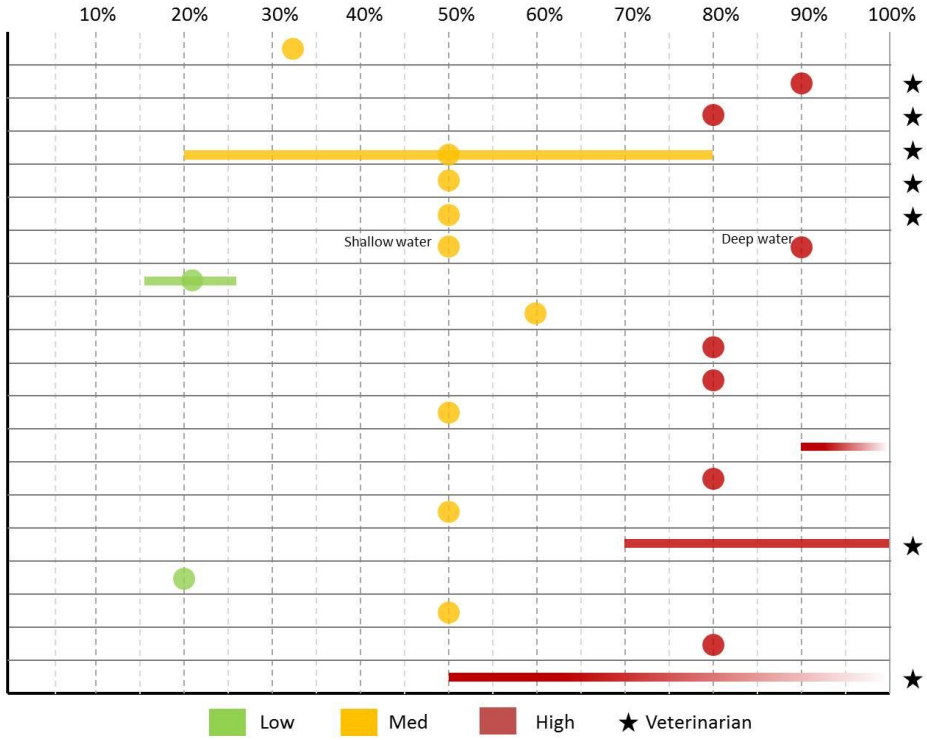
2 - Moves little or remains stationary when brought on board, but actively responds and/or crawls if moved, handled, or tagged



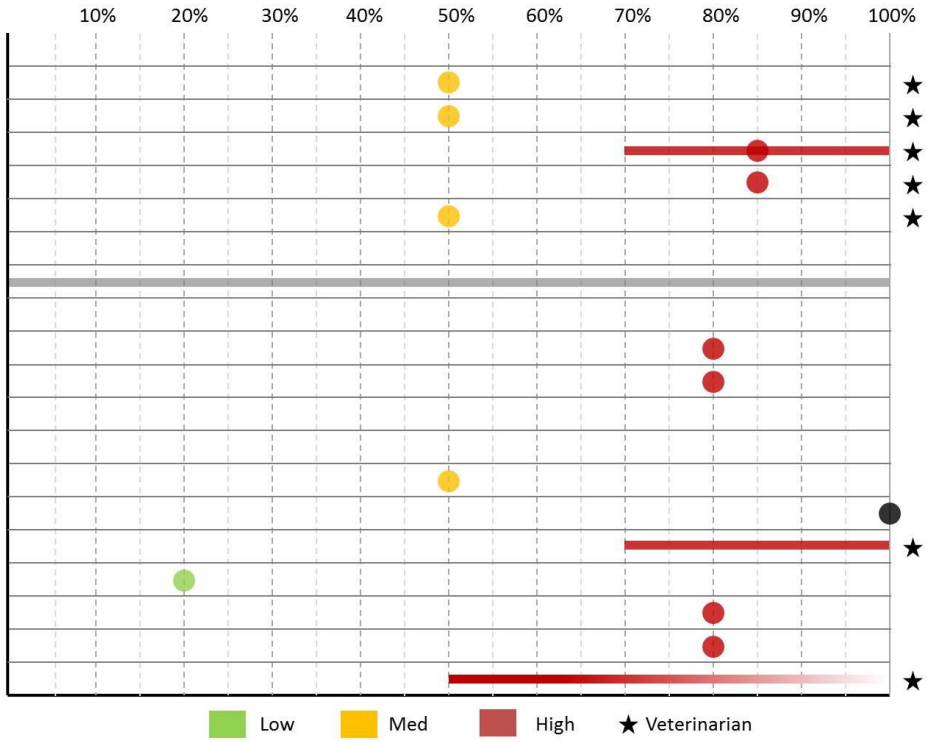
3 - Movements generally appear slow, sluggish, or weak at any time while on board



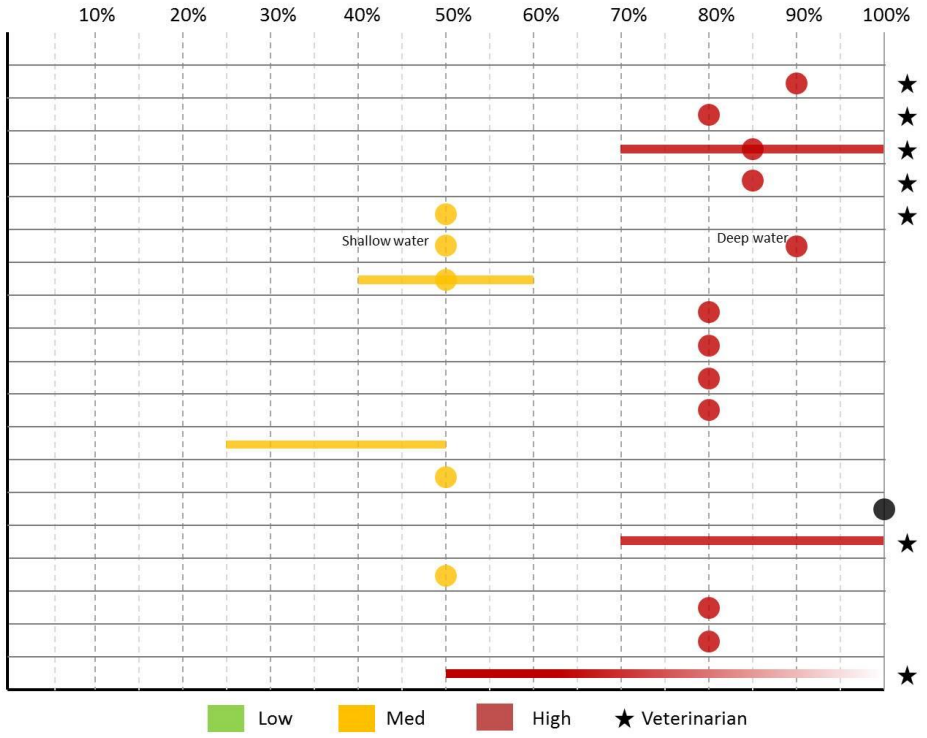
4 - Responds slowly or sluggishly to being moved, handled, or tagged



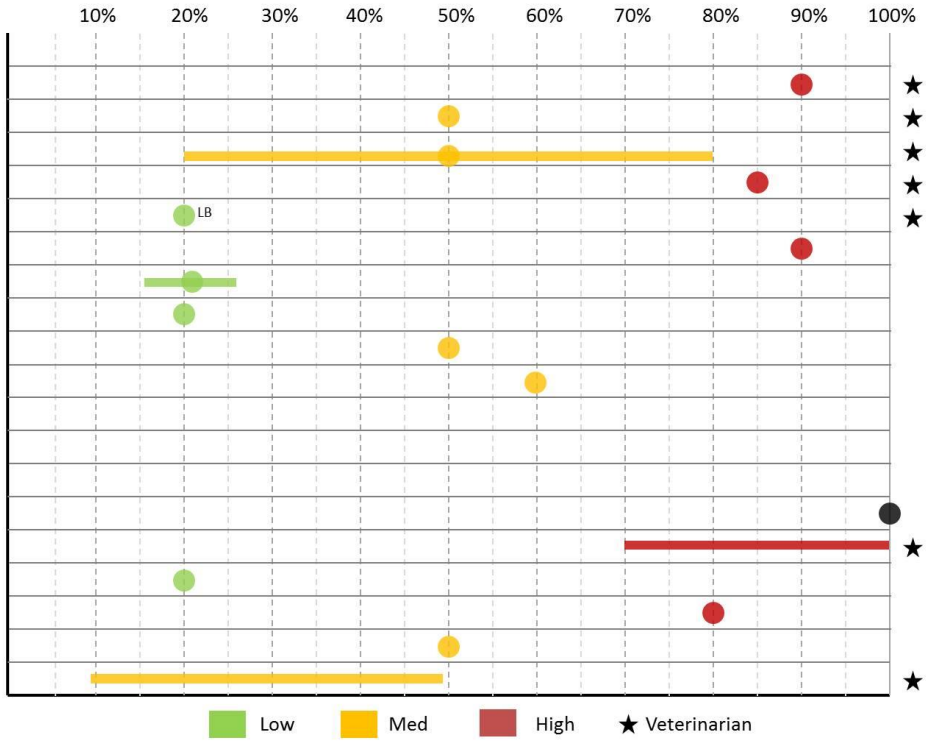
5 - Water or froth discharges from mouth or nares



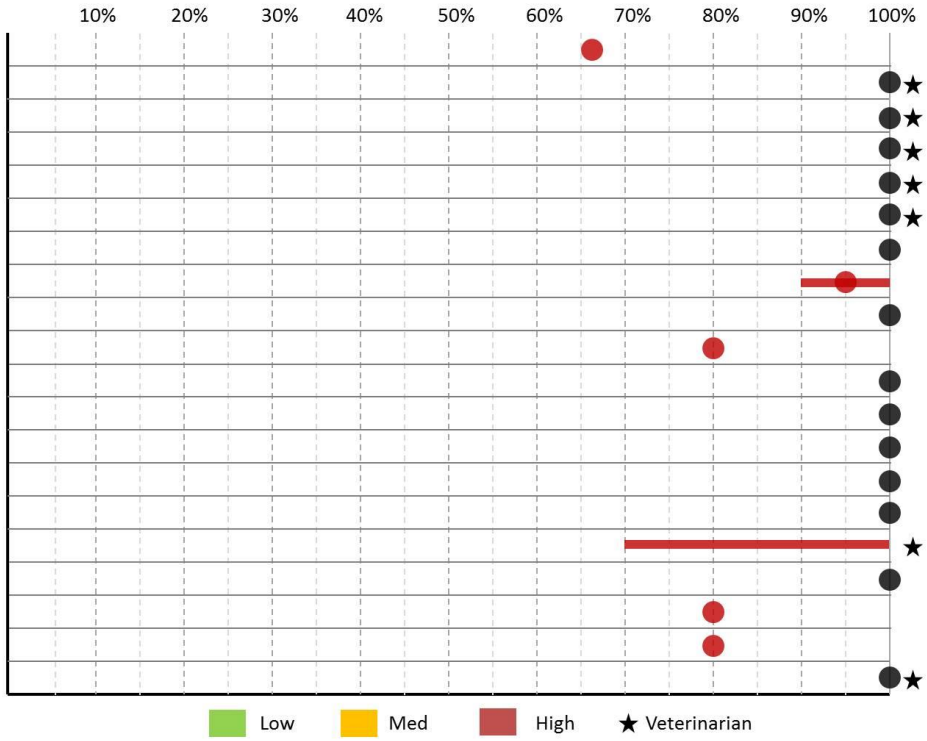
6 - Difficulty breathing, including extension of neck and gulping behavior



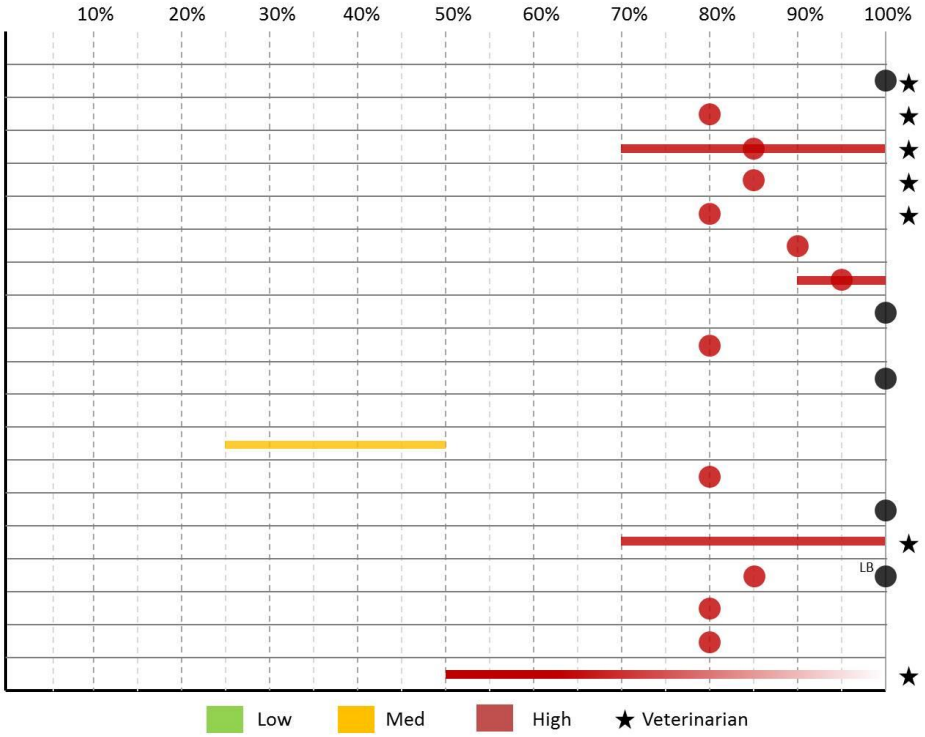
7 - Eyes are continuously closed for seconds or more at a time



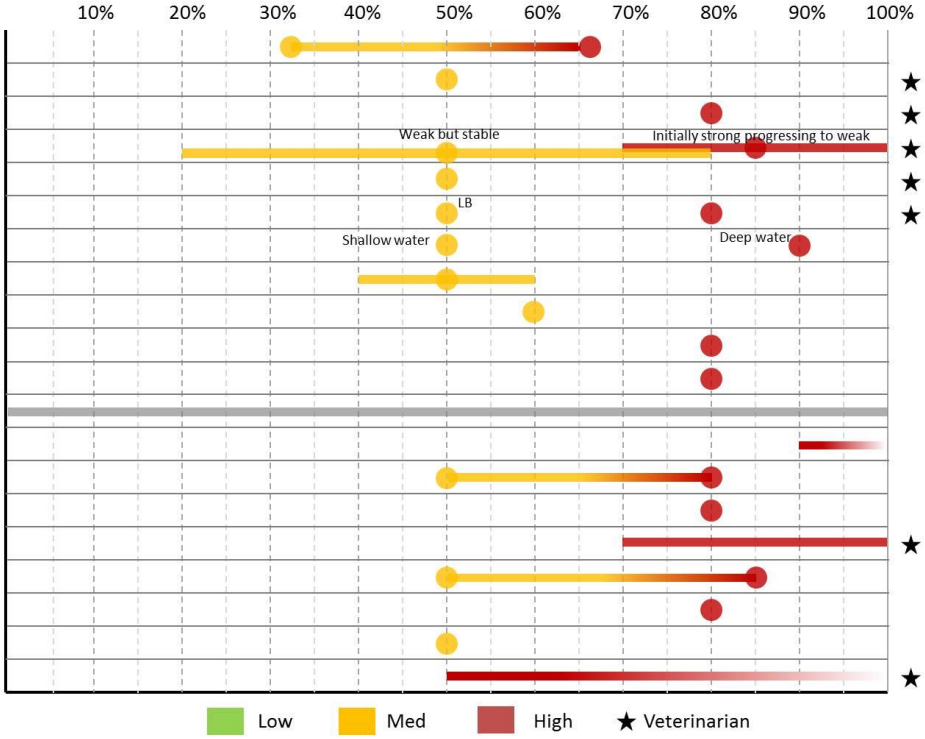
8 - Does not appear conscious/responsive (does not move) when moved, handled, or tagged at any time while on board



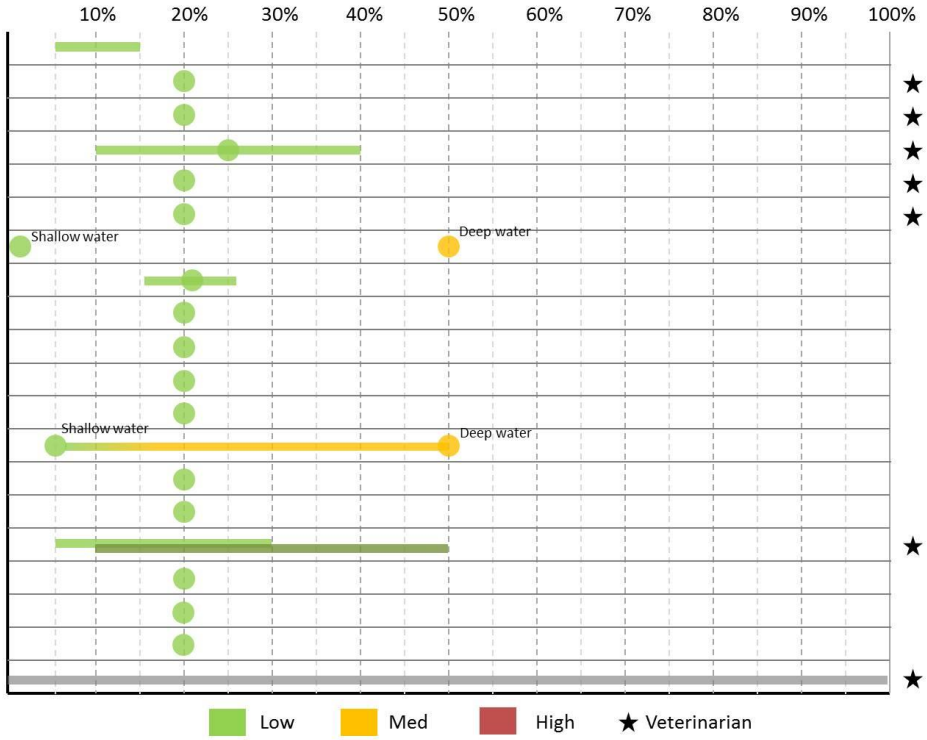
9 - Exhibits abnormal neurological signs, such as circling, head tilt, tremors, or uncoordinated movement



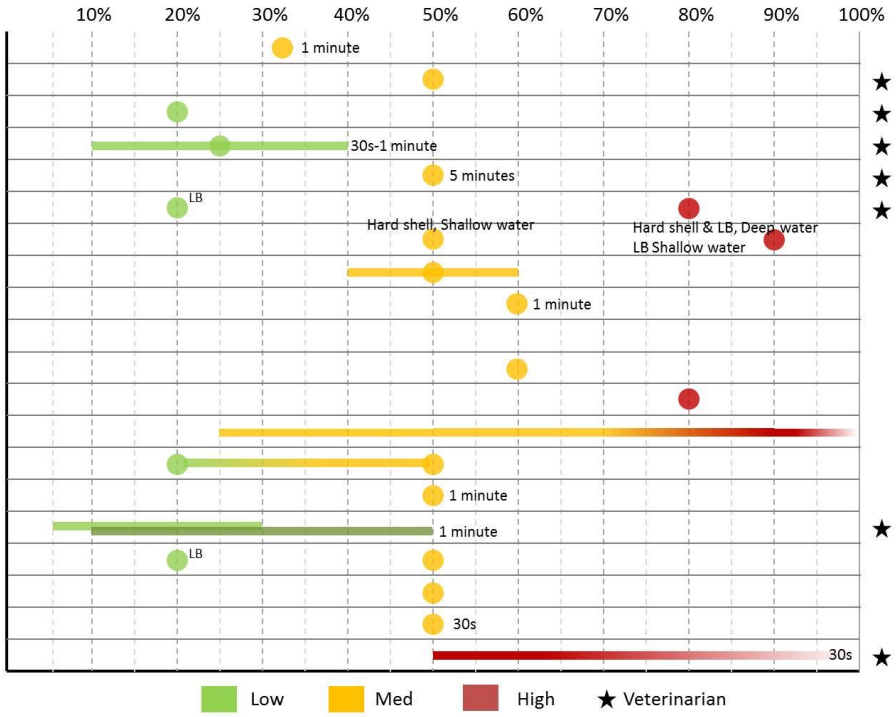
10 - Movements generally appear slow, sluggish or weak immediately before release (just prior to placing back in water)



11 - Immediately dives or swims deliberately away from vessel when released

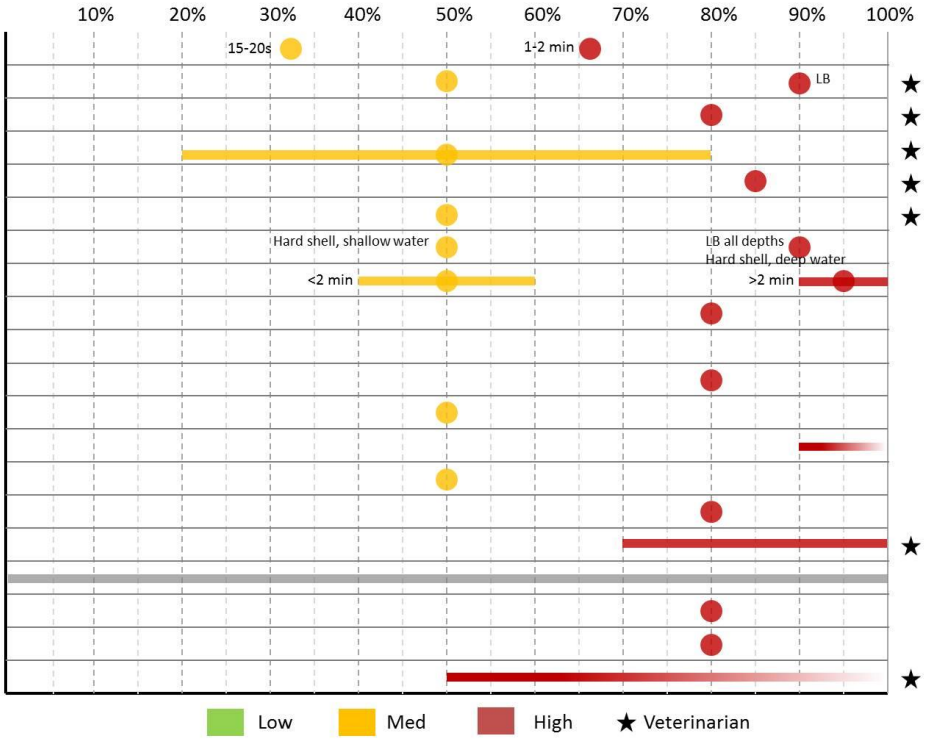


12 - Remains at surface and/or does not swim deliberately away from vessel for up to 2 minutes

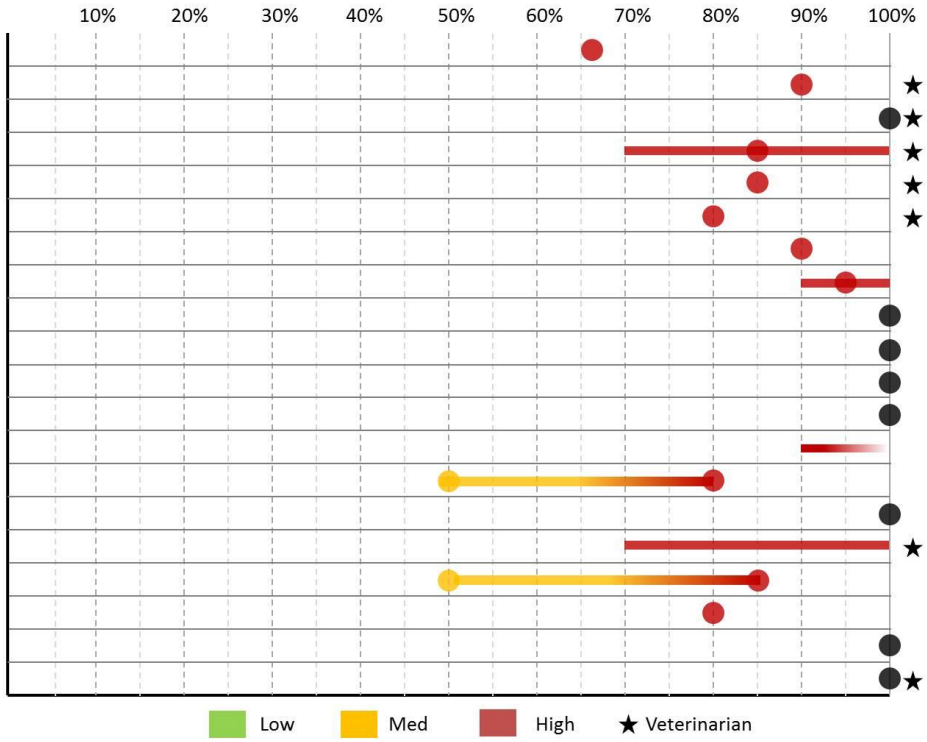


13 - Remains at surface and/or does not swim deliberately away from vessel for greater than 2 minutes

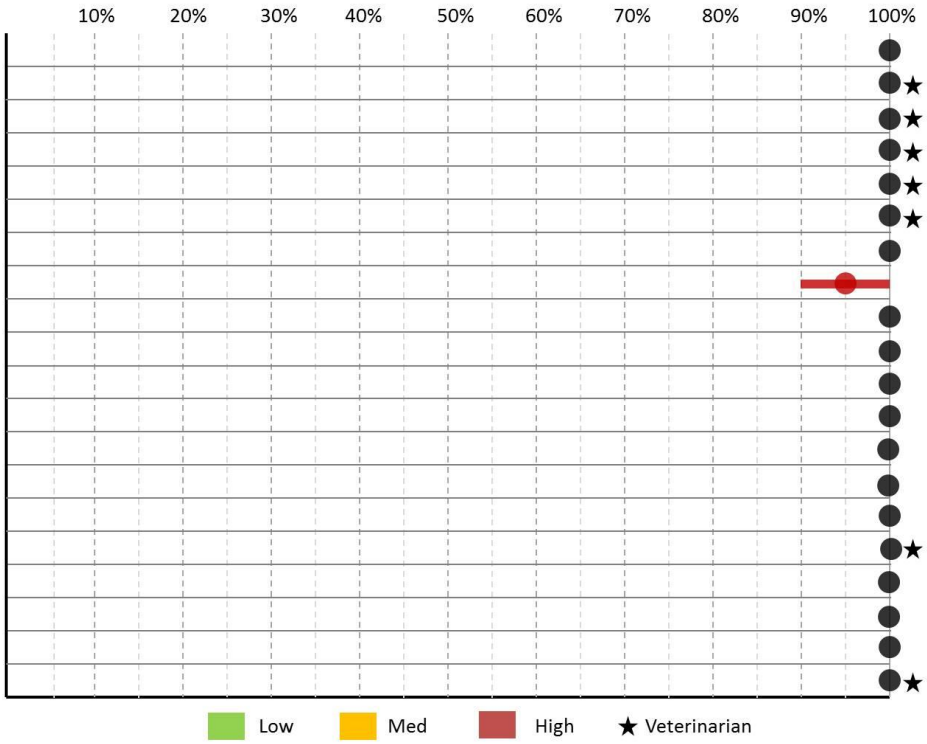
14 - Swims erratically



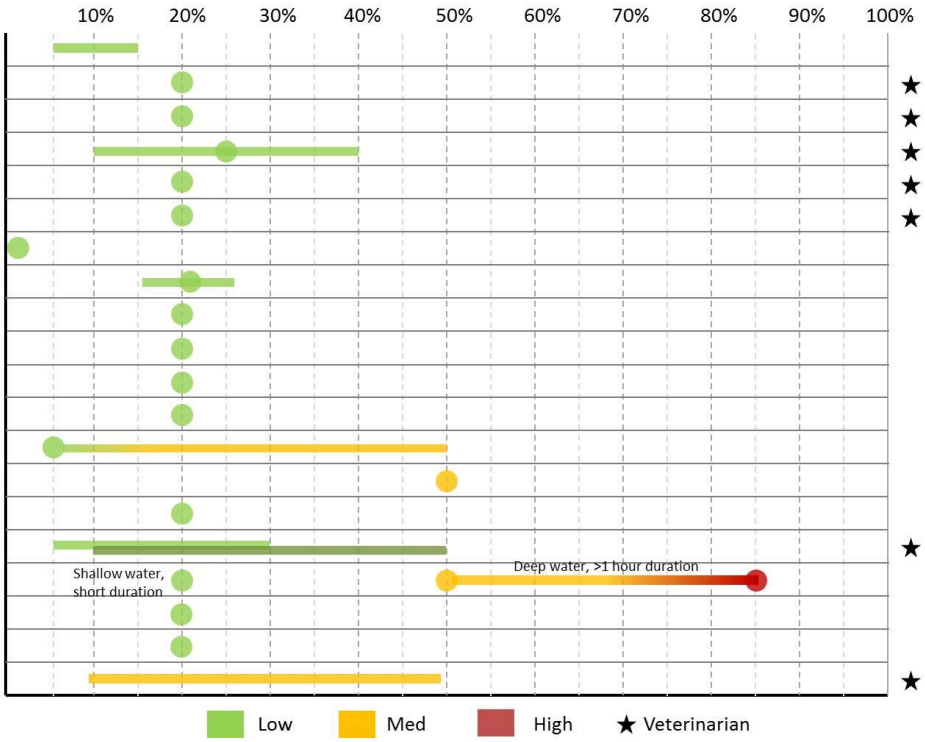
15 - Lists, rolls, or unable to right self when placed in the water



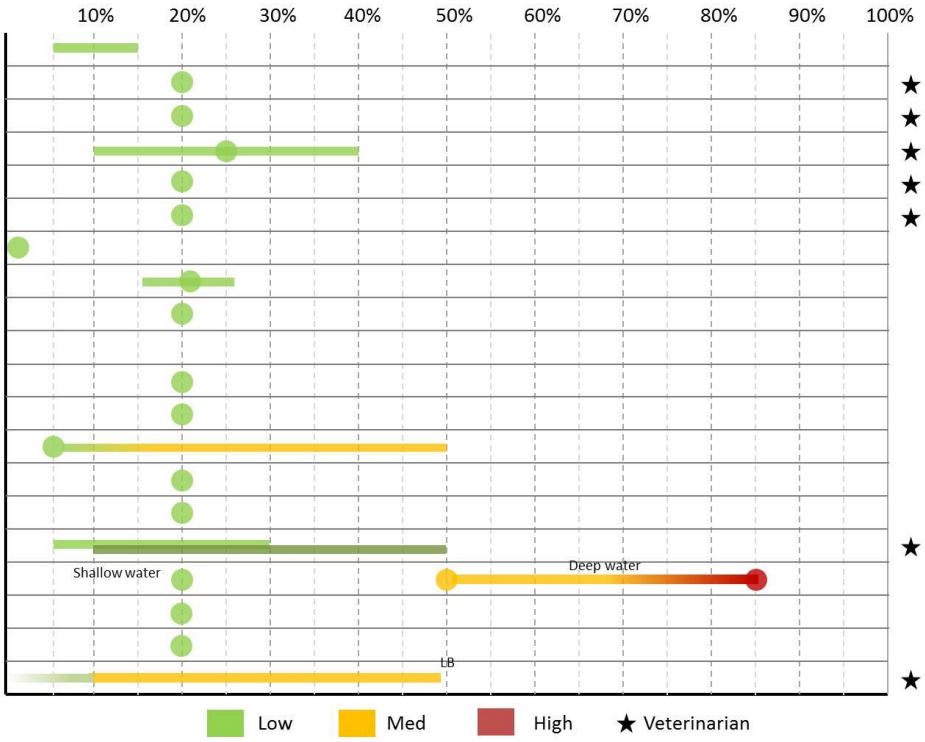
16 - Does not appear conscious/responsive (does not move) upon release; and/or sinks (exhibits no swimming motions)



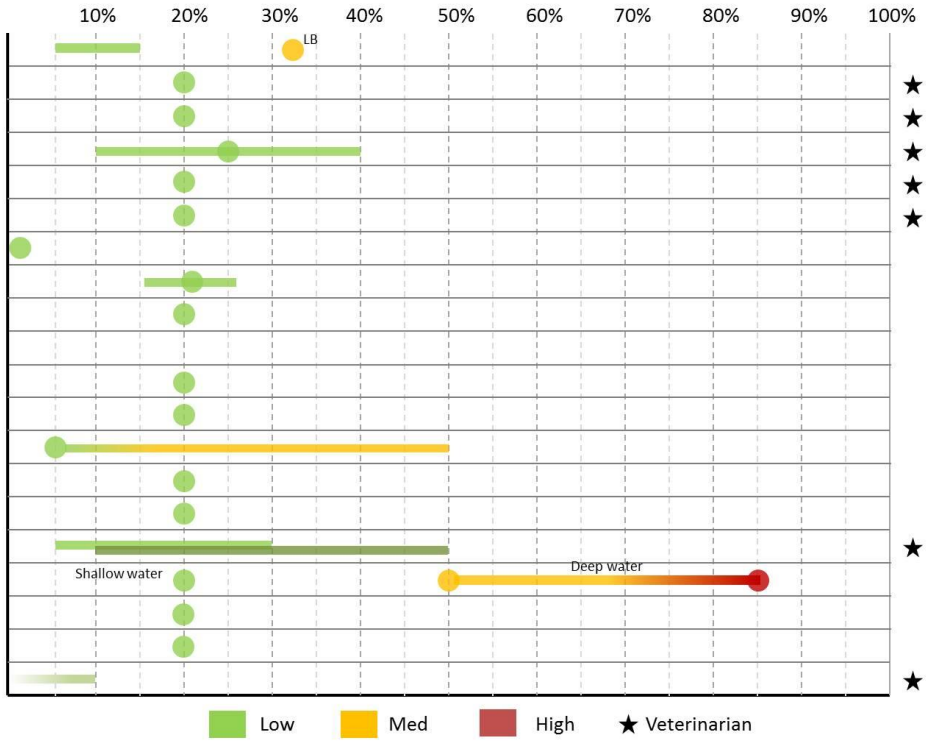
17 - No apparent injuries



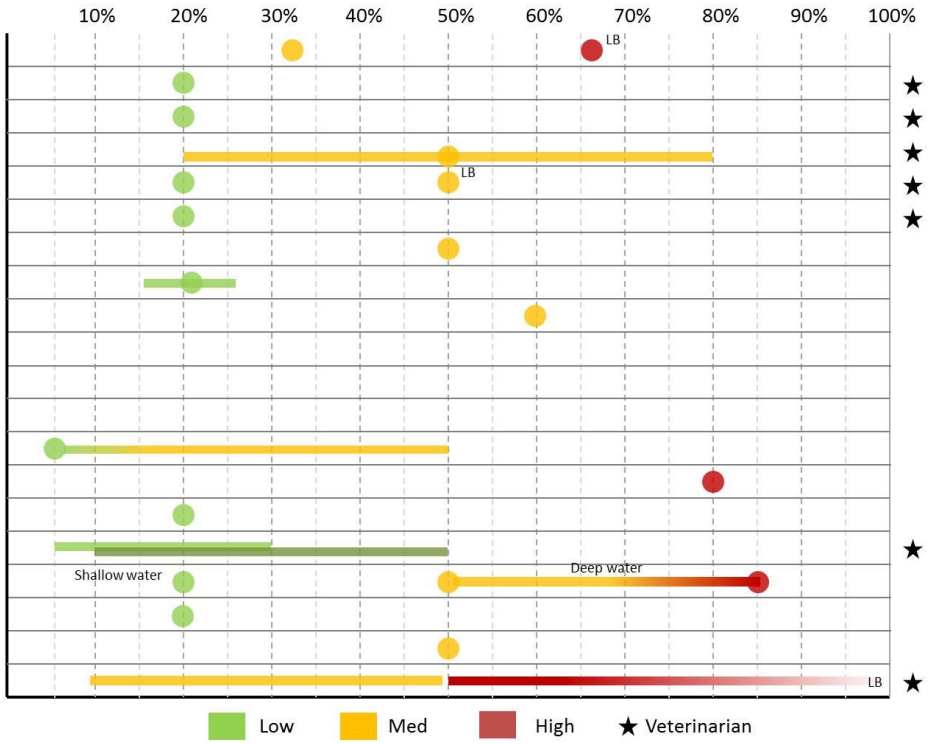
18 - Superficial abrasions, chips, or scuffs to carapace or plastron



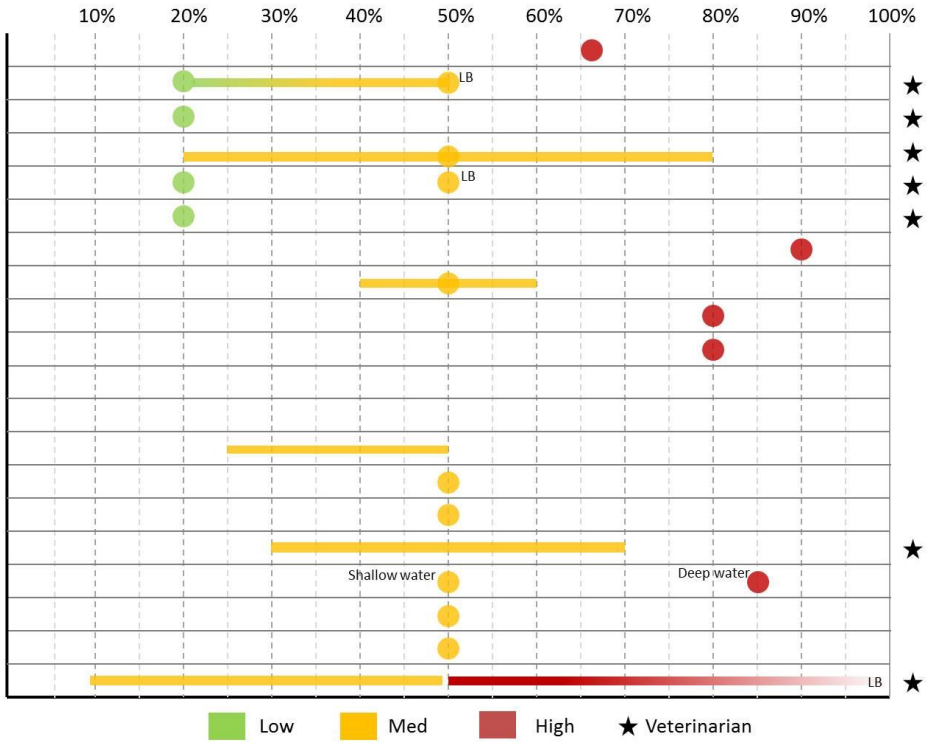
19 - Minor or superficial injuries to skin



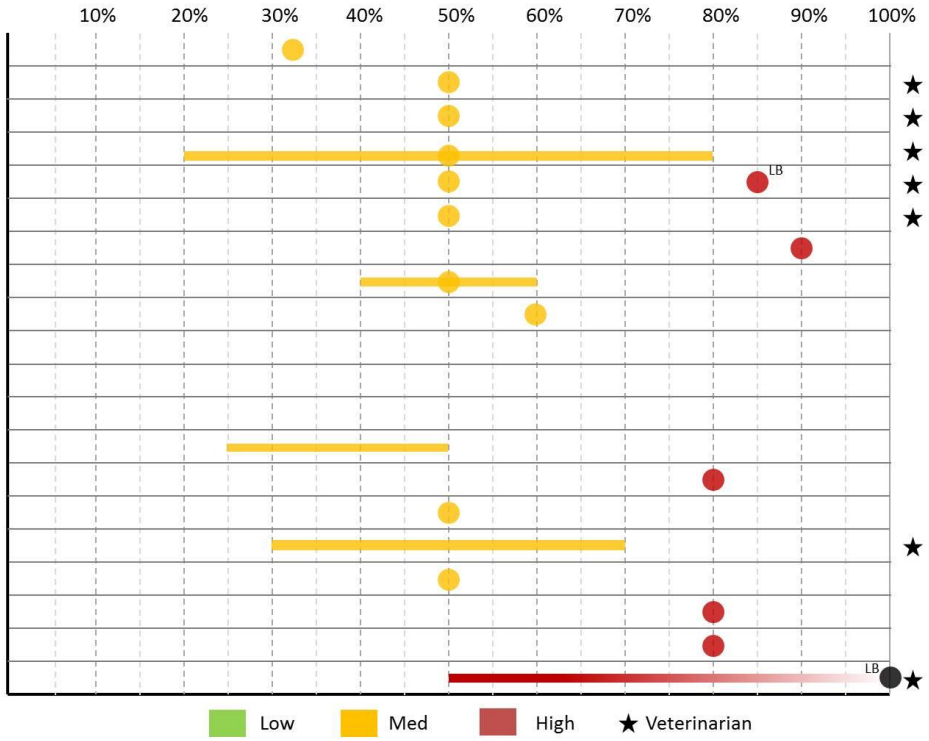
20 - Fractures of shell margin involving <50% width of marginal or pygal



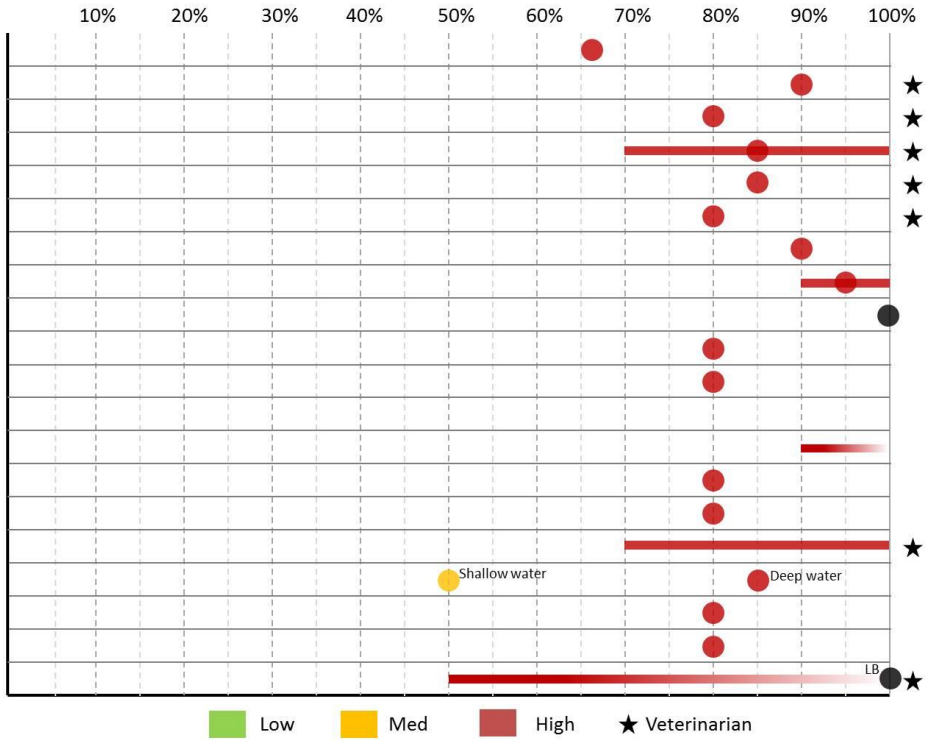
21 - Fractures of shell margin involving >50% width of marginal or pygal



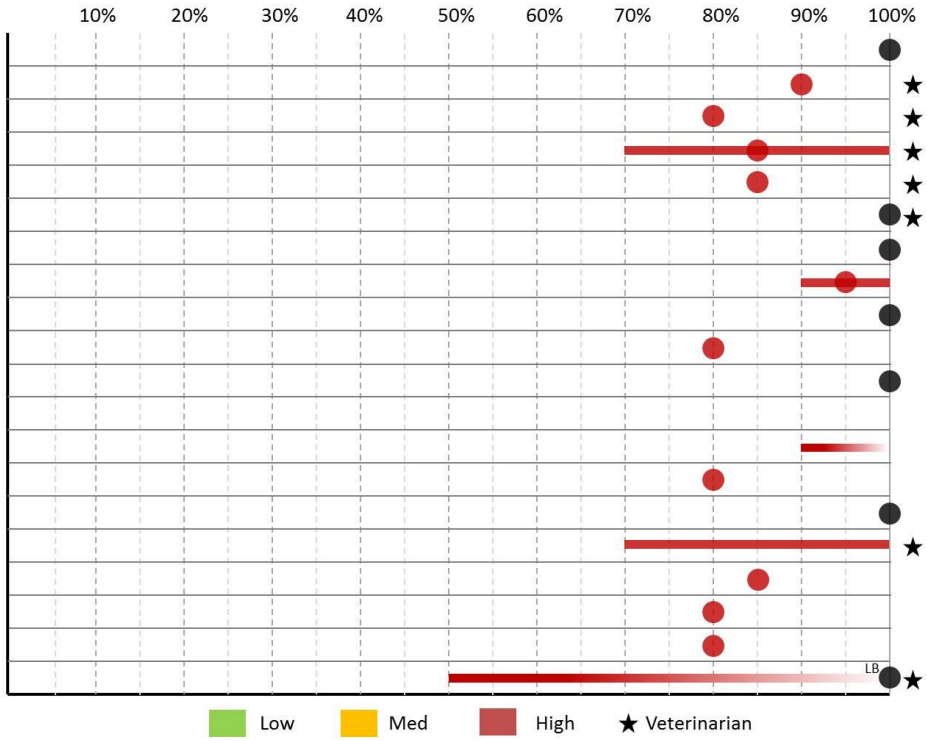
22 - Any shell fracture involving bones other than marginal/pygal bones, but not involving the dorsal midline



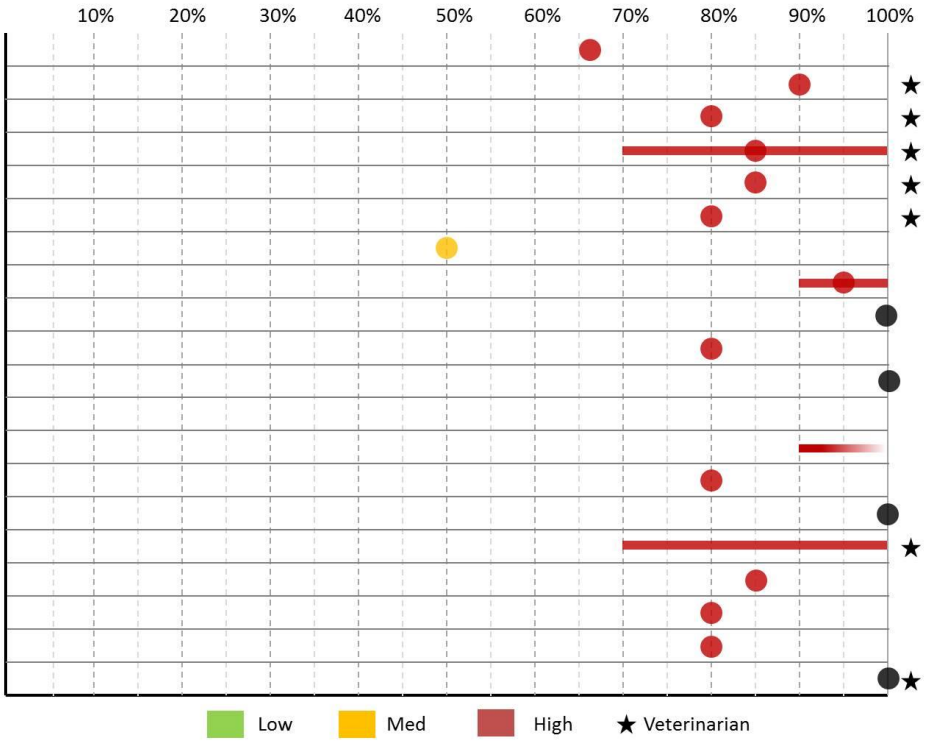
23 - Any shell fracture that crosses the dorsal midline



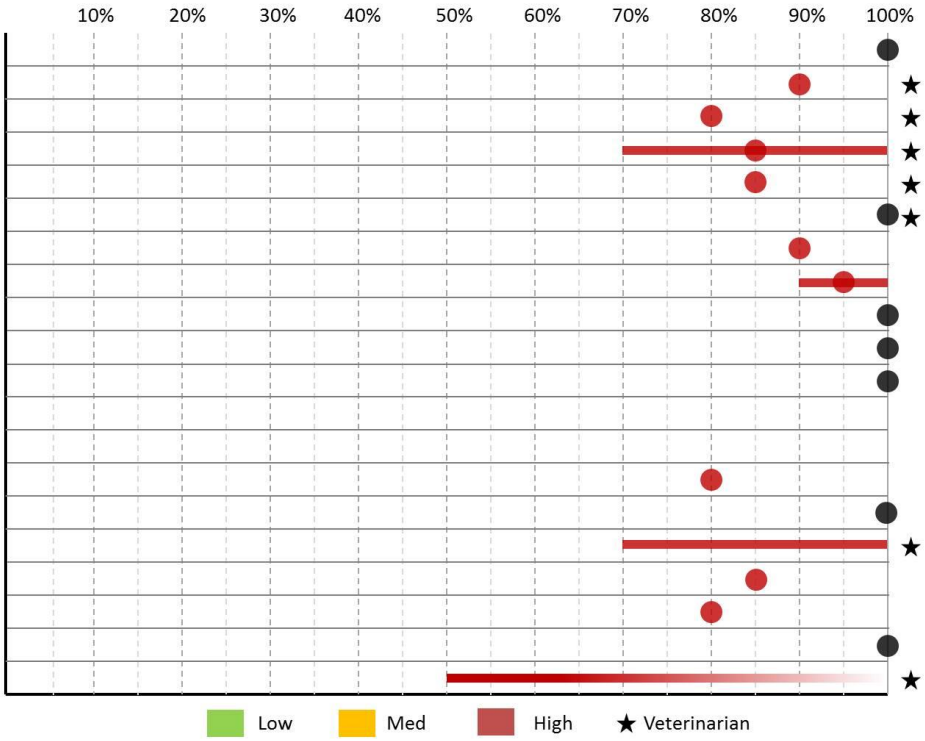
24 - Fractures or wounds penetrating the body cavity OR exposing visceral organs



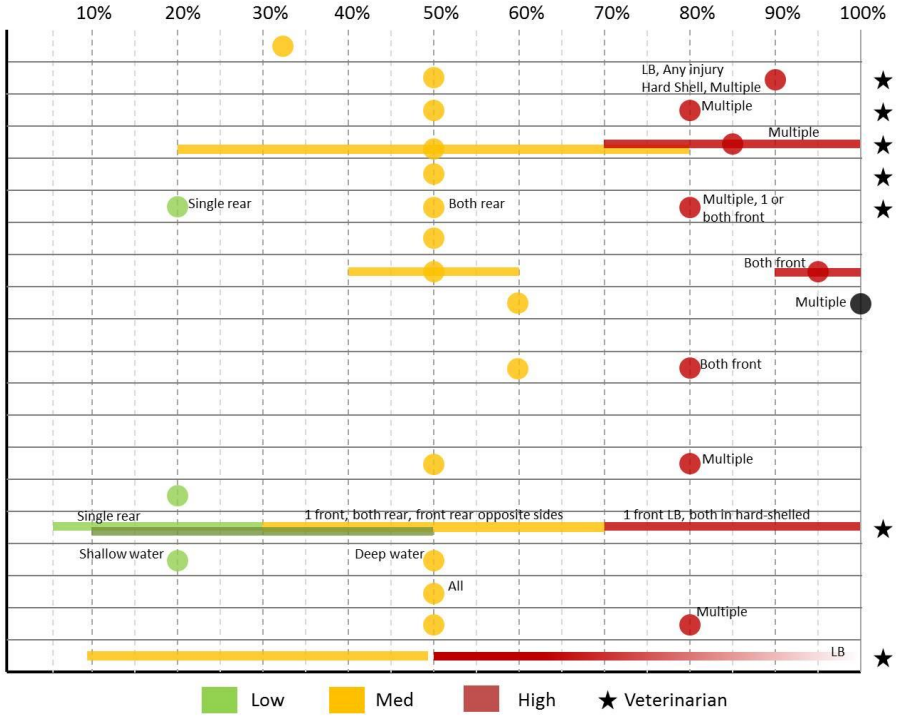
25 - Skull or mandibular fracture



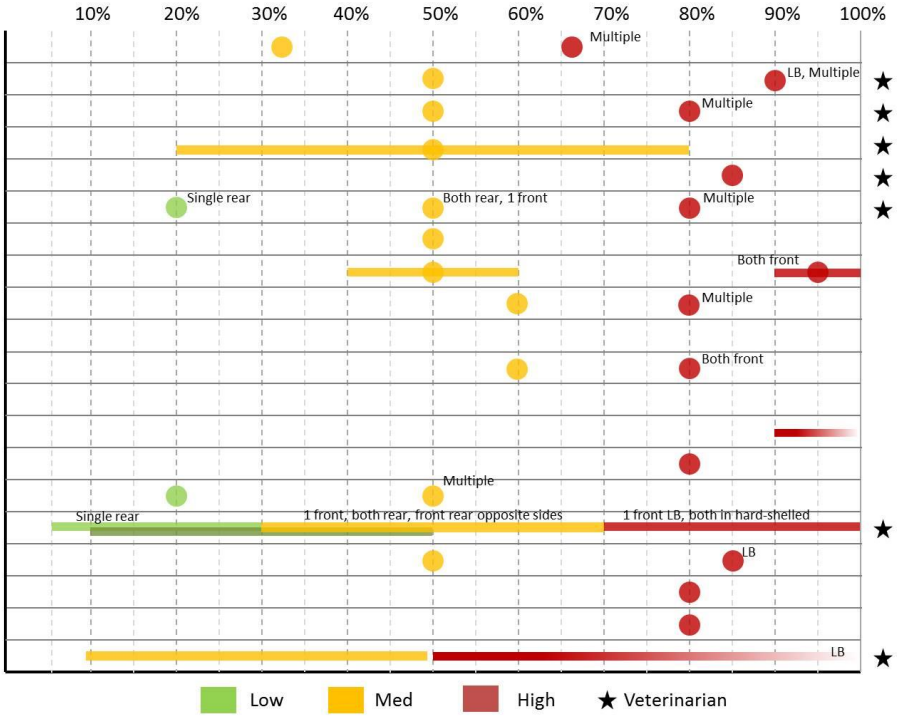
26 - Injuries to neck affecting spinal cord, major blood vessels, or airway



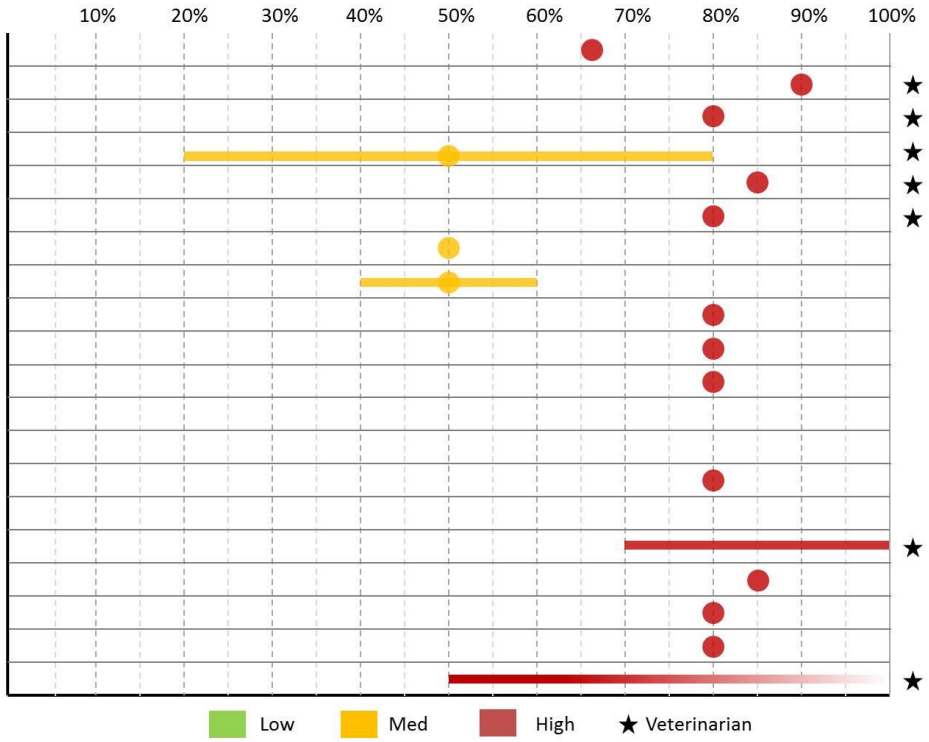
27 - Injuries to flipper(s), which may impair movement or function (note: please comment on concerns related to front, rear, or multiples)



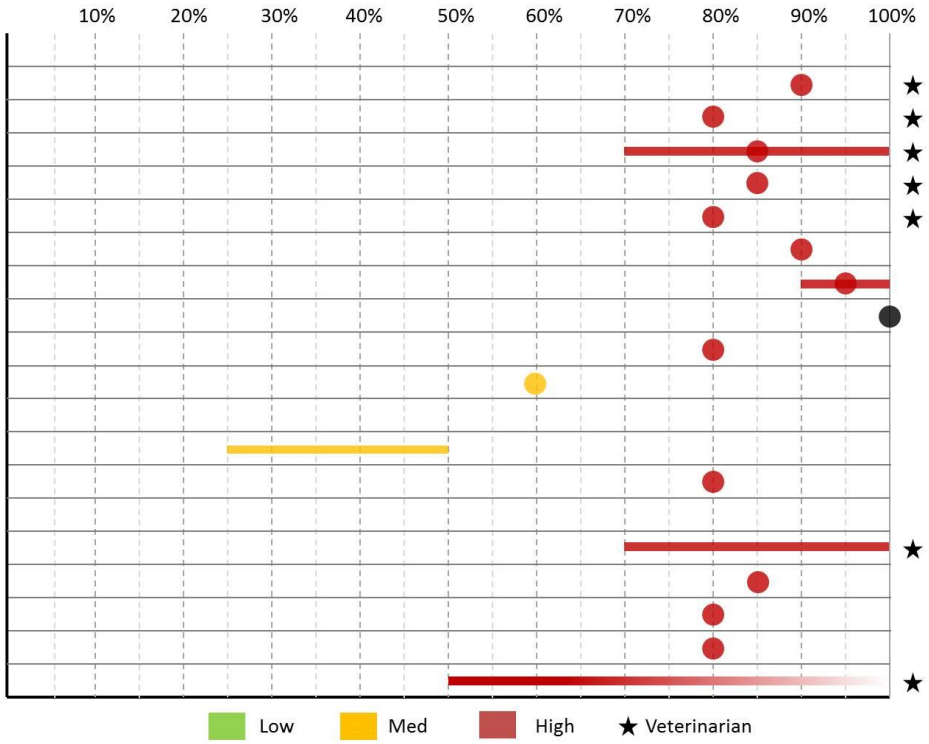
28 - Amputation of half or more (at carpus/tarsus) of one or more flippers (note: please comment on concerns related to front, rear, or multiples)



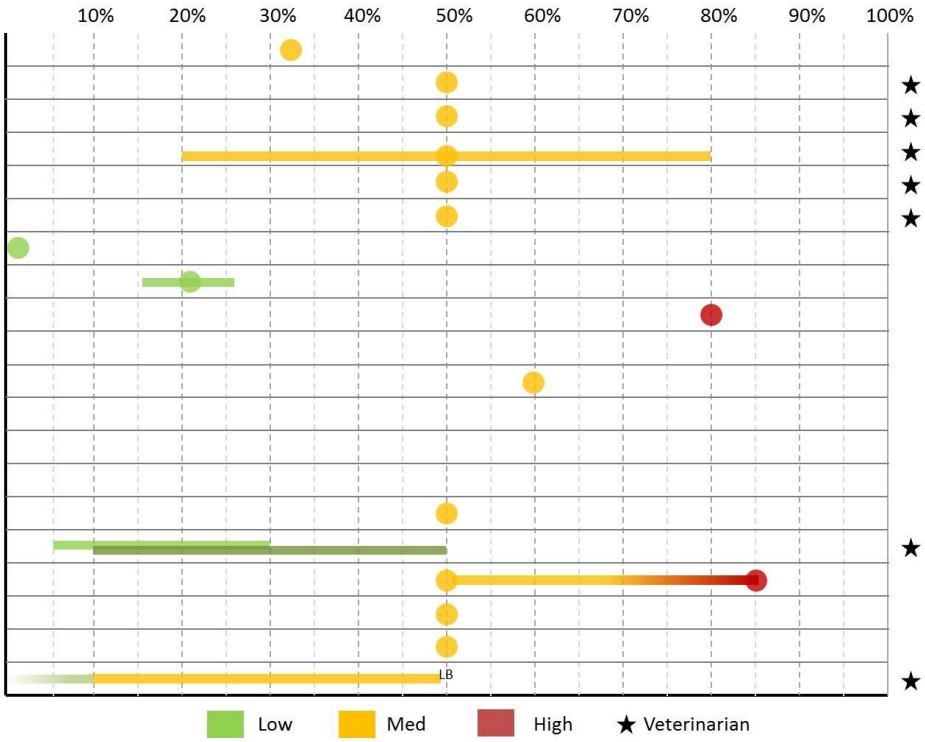
29 - Any open fracture of major long bones



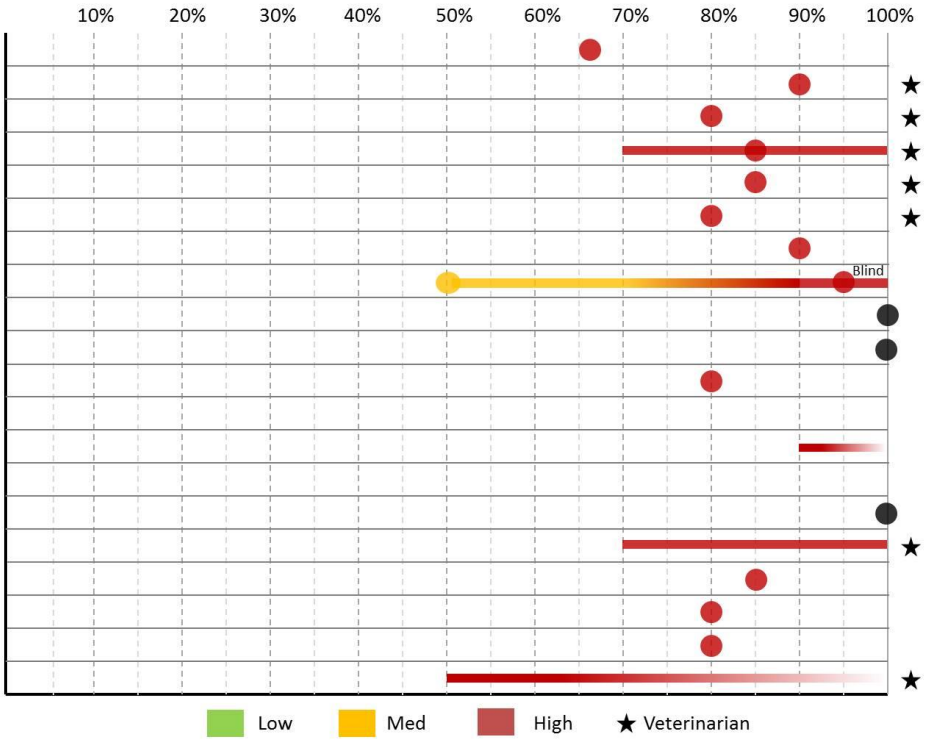
30 - Evidence of bleeding from cloaca, nares, eyes, or oral cavity, unrelated to superficial wounds



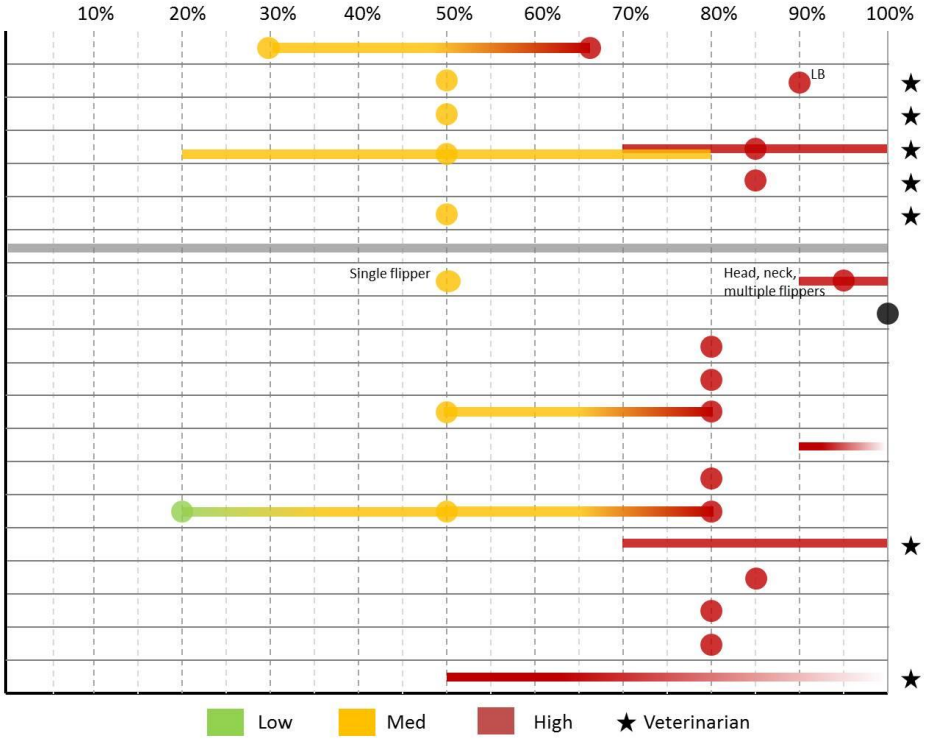
31 - Injuries to cornea, sclera, and/or globe of one eye



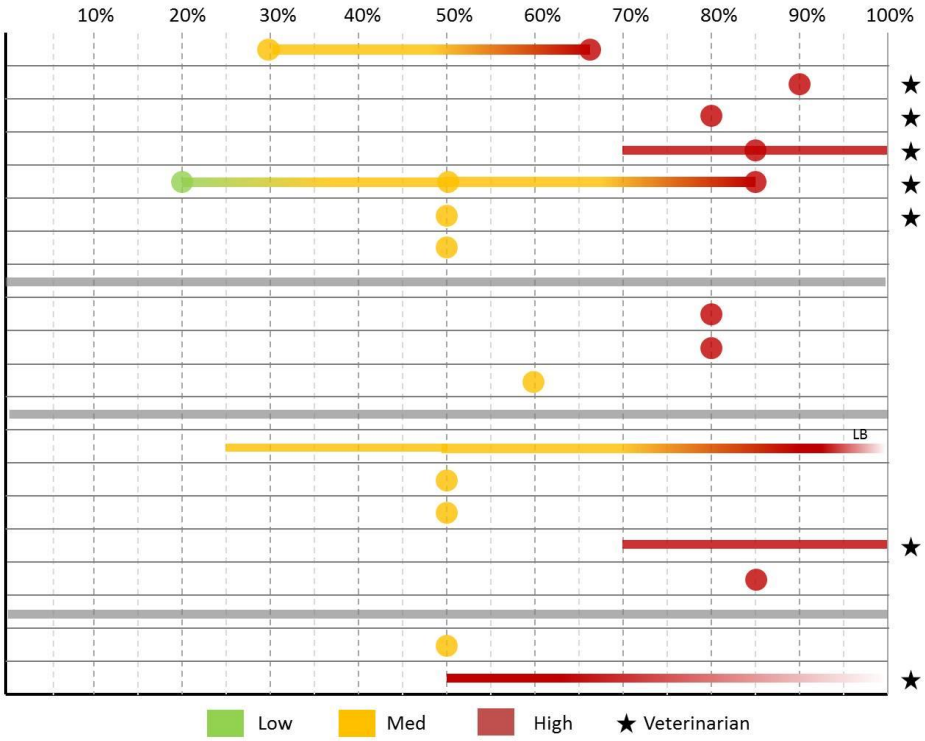
32 - Injuries to cornea, sclera, and/or globe of both eyes



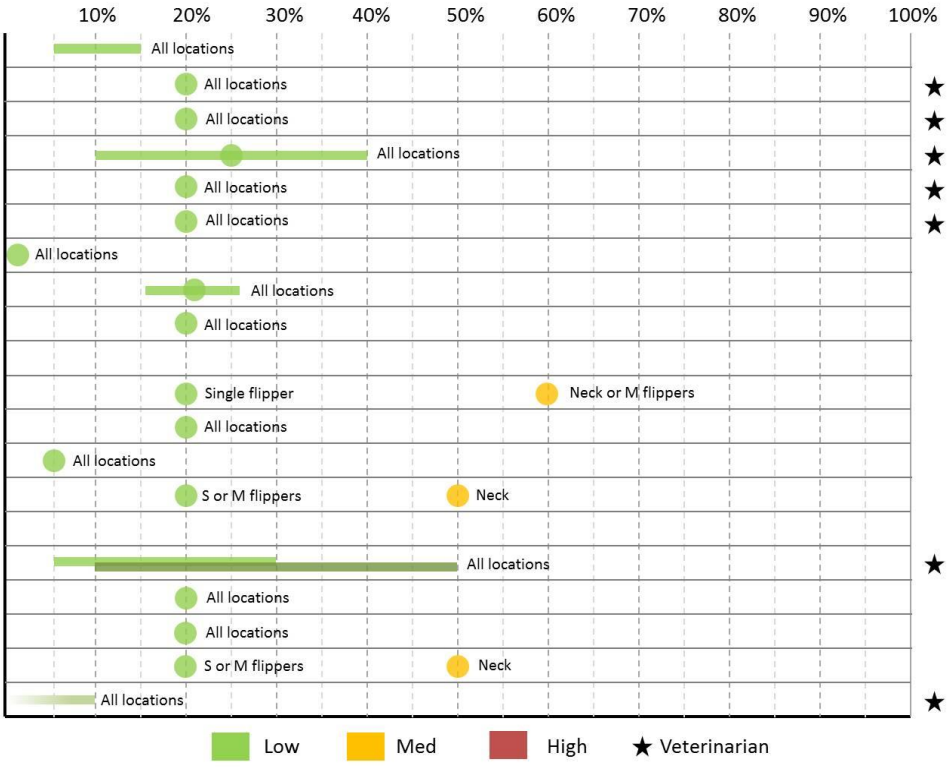
33 - Gear remaining on animal at release



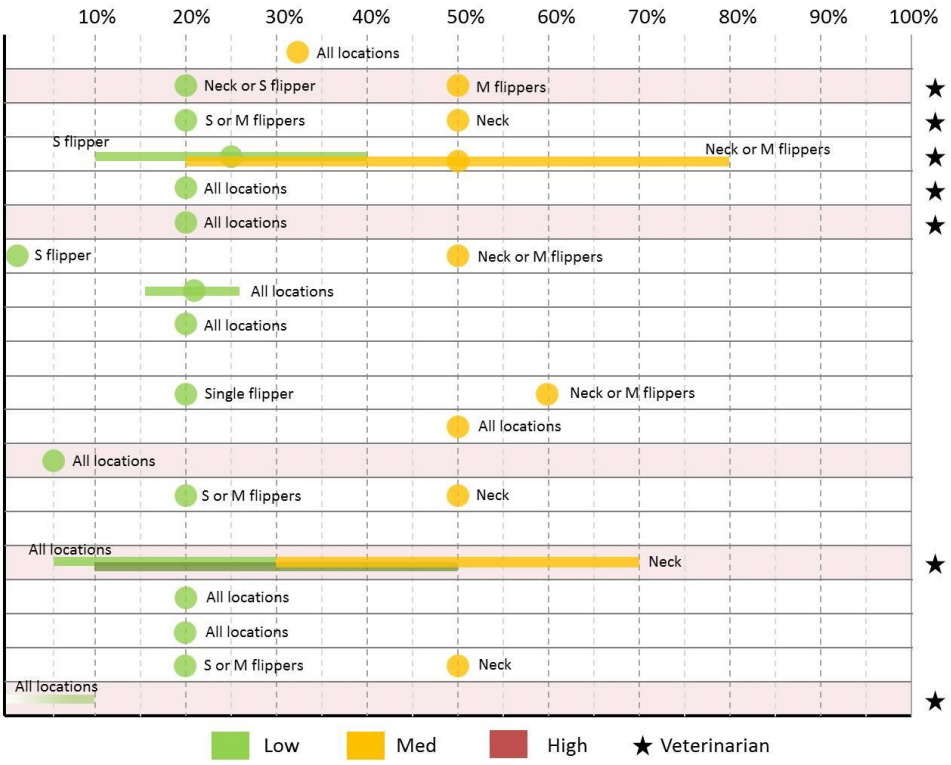
34 - Trauma inflicted during boarding, while on deck, or at release, including turtle hoisted onto or off of deck by lines tied to flippers, turtle lifted by flipper(s) distal to the elbow, and/or turtle dropped onto deck, or buried under heavy catch



35 - No visible compression or damage to the skin after removal of gear Hard-shell & Leatherback

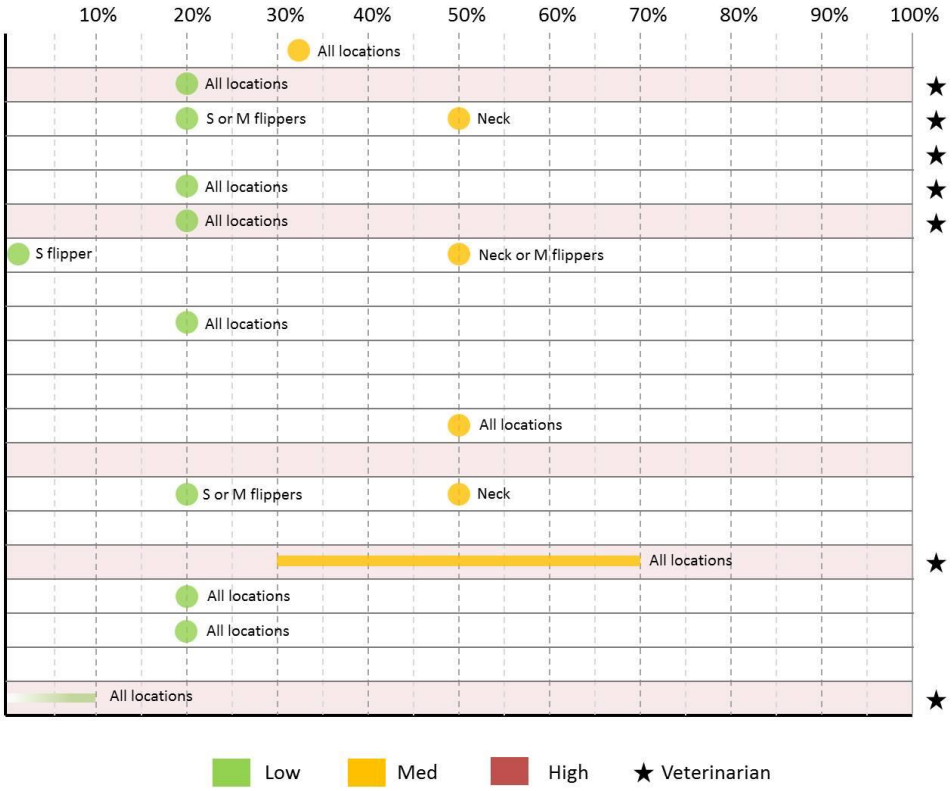


36 - Ligature impression visible, but skin not damaged Hard-shell



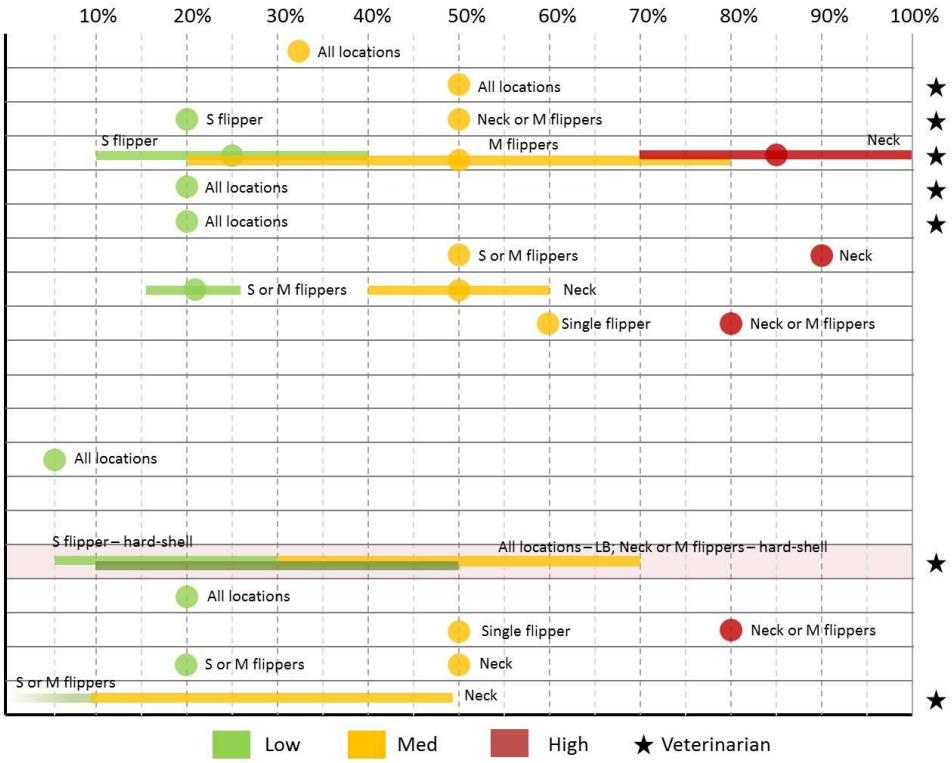
36 - Ligature impression visible, but skin not damaged

Leatherback

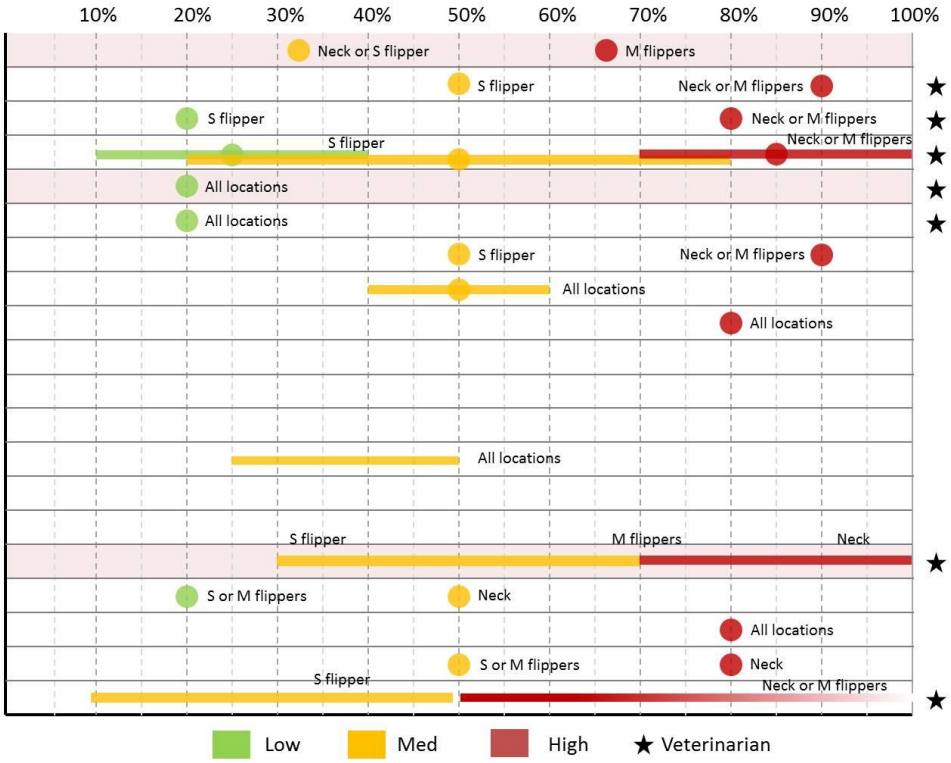


37 - Skin abraded or ulcerated, but does not expose muscle

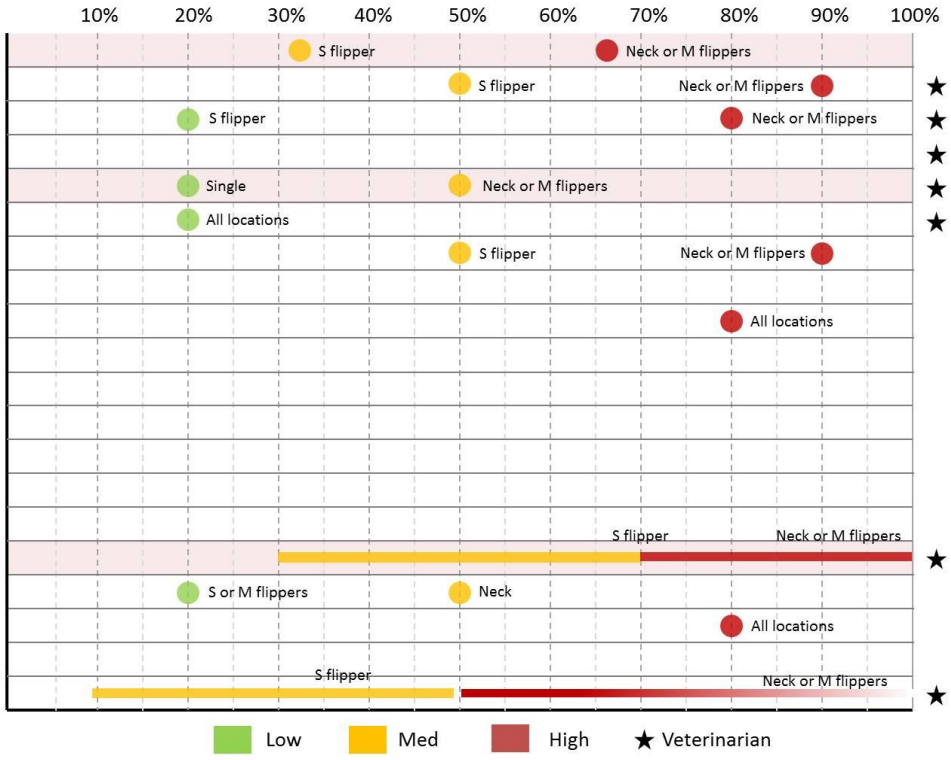
Hard-shell & Leatherback



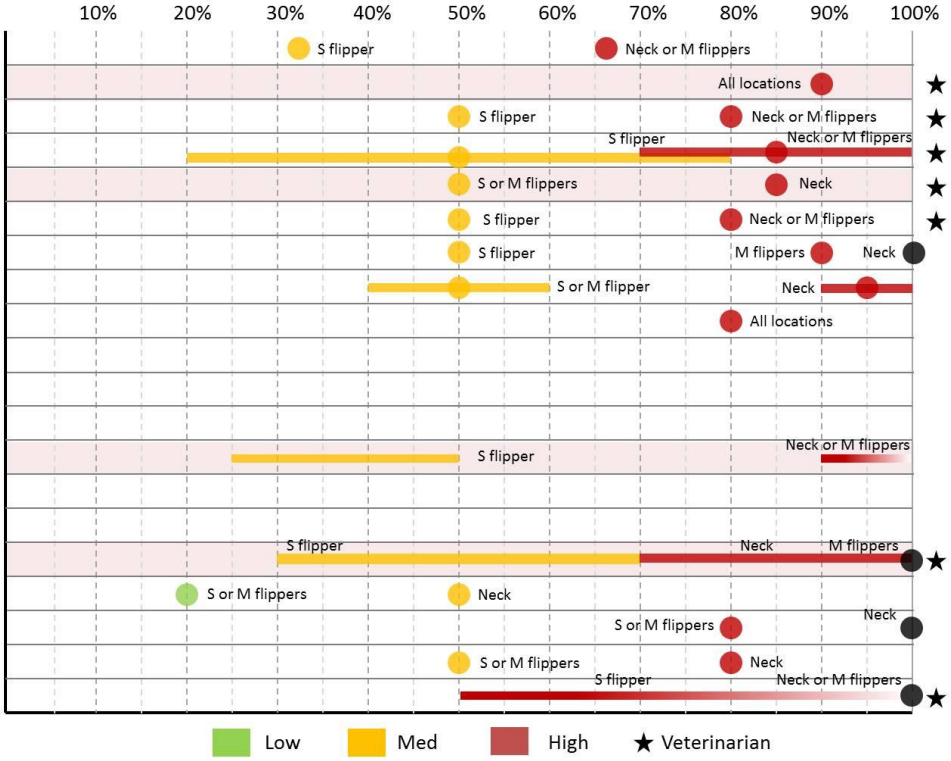
38 - Skin ulcerated with exposure/injury of muscle Hard-shell



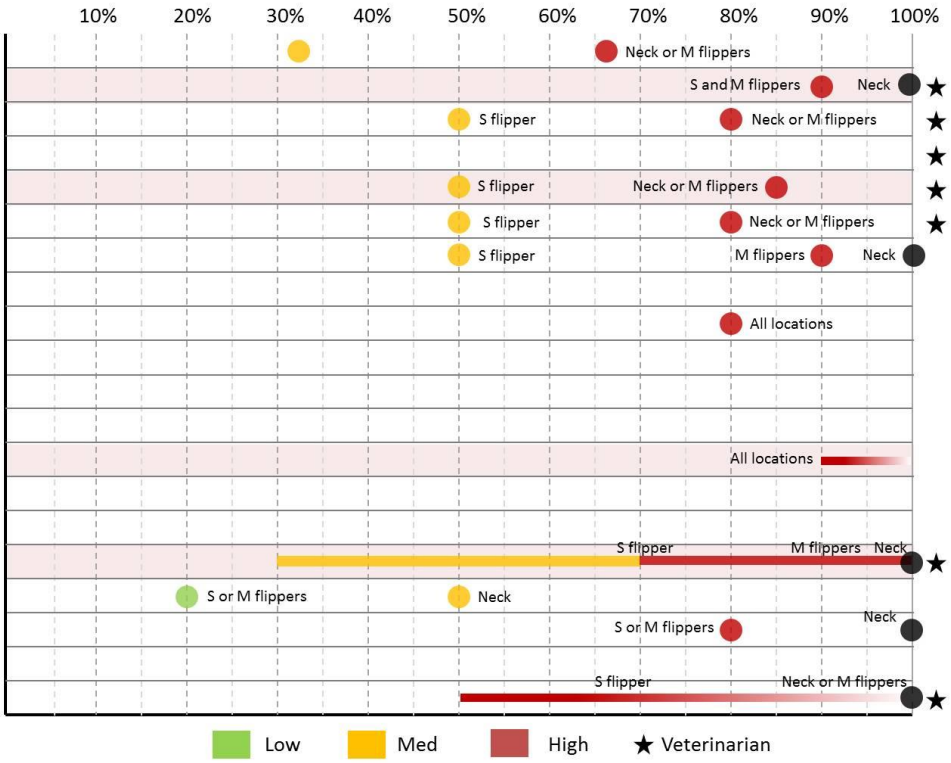
38 - Skin ulcerated with exposure/injury of muscle Leatherback



39 - Skin ulcerated with exposure/injury of bone Hard-shell

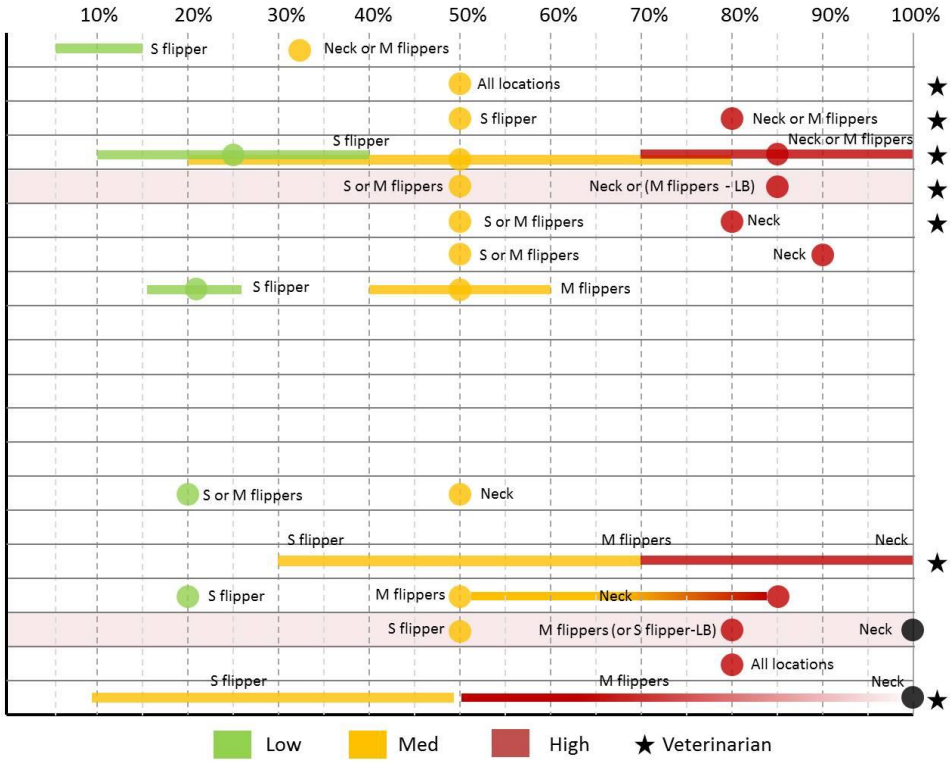


39 - Skin ulcerated with exposure/injury of bone Leatherback



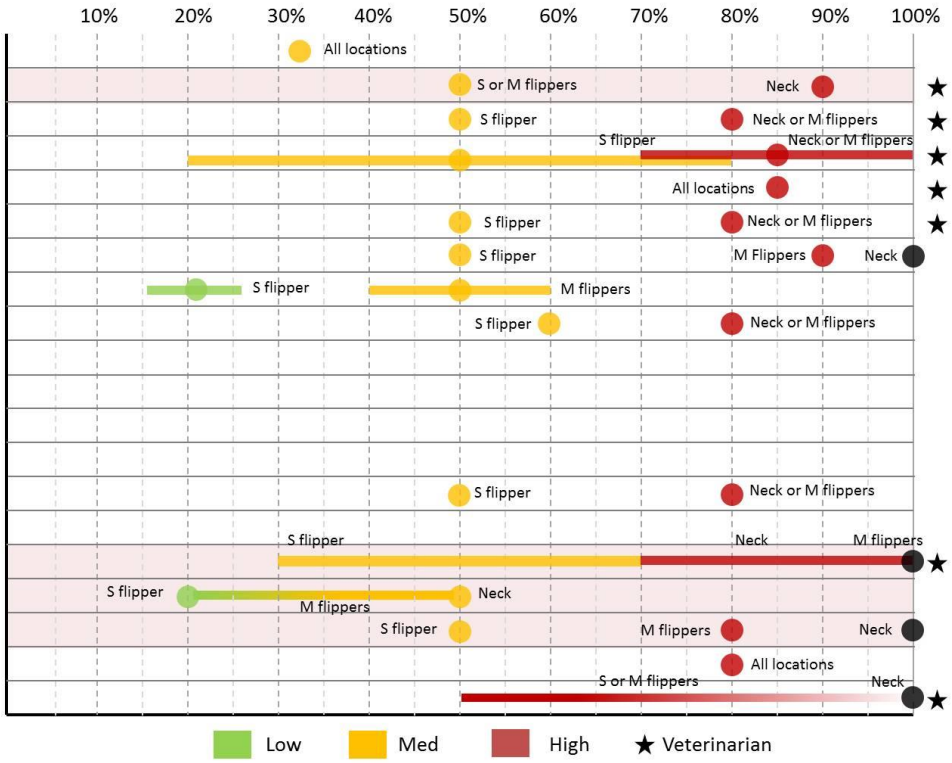
40 - Swelling distal to entanglement

Hard-shell & Leatherback

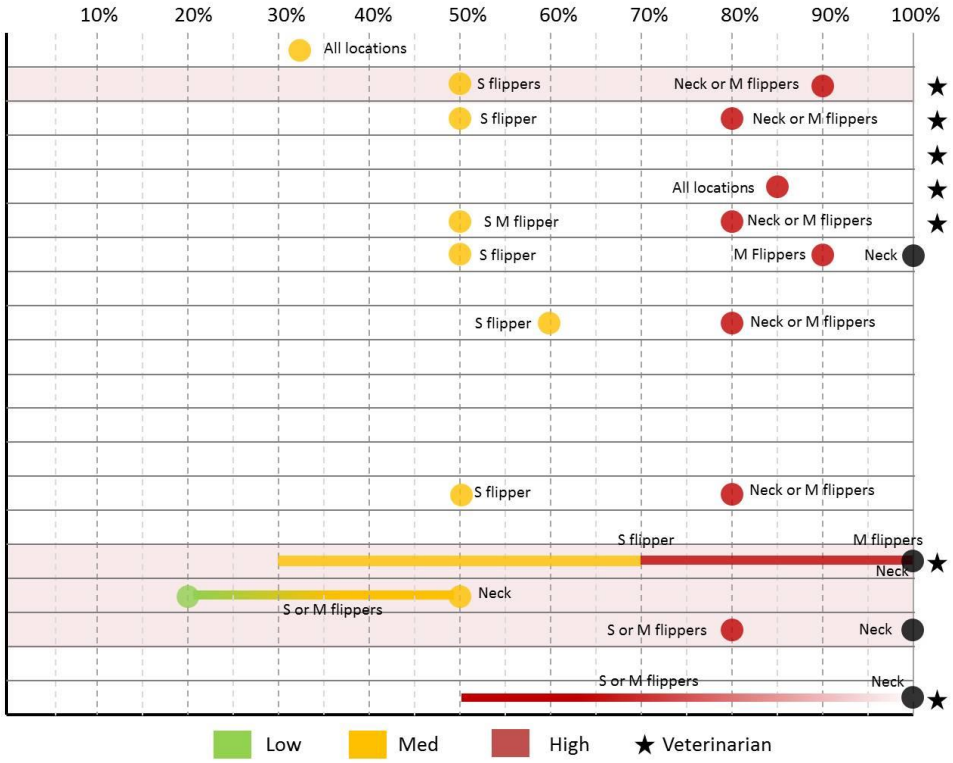


41 - Discoloration distal to entanglement

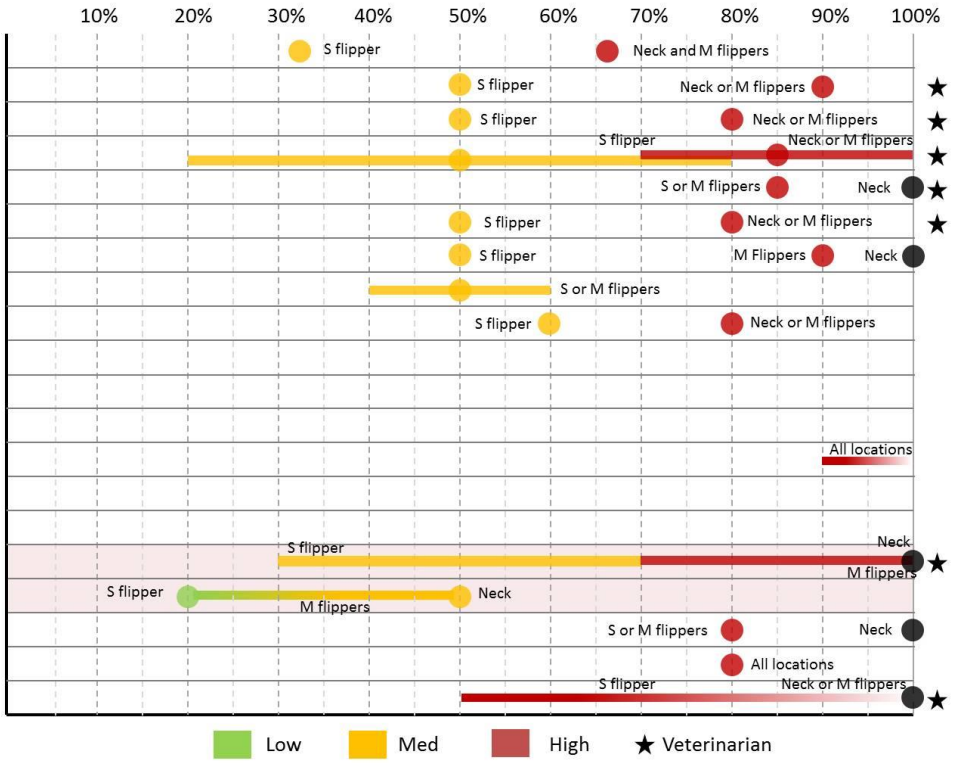
Hard-shell



41 - Discoloration distal to entanglement Leatherback

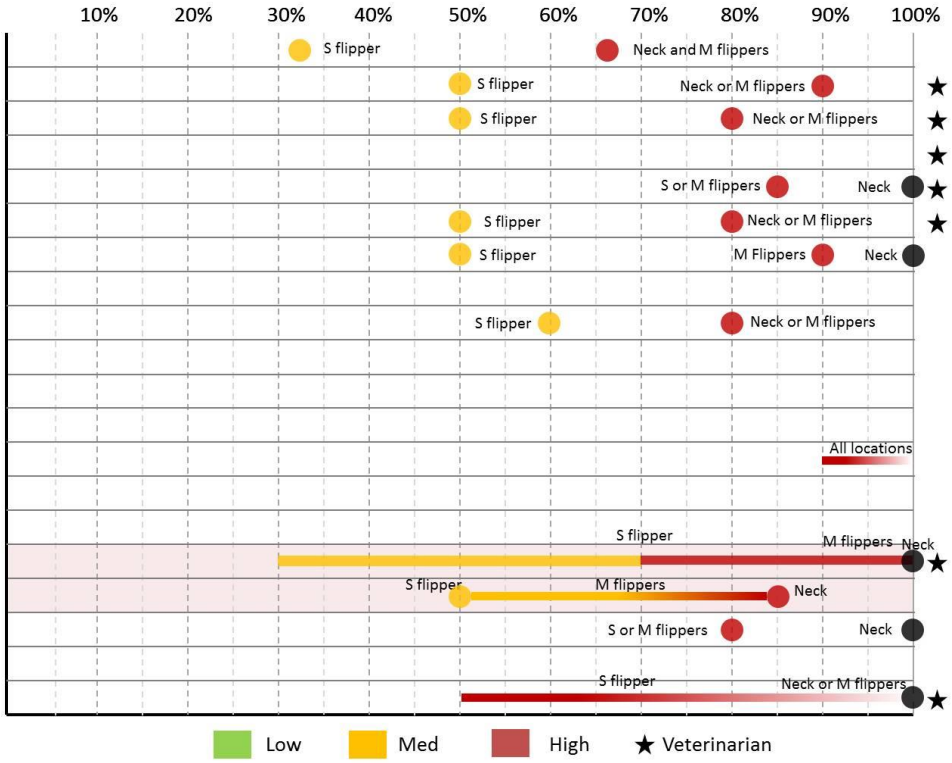


42 - Necrosis distal to entanglement Hard-shell



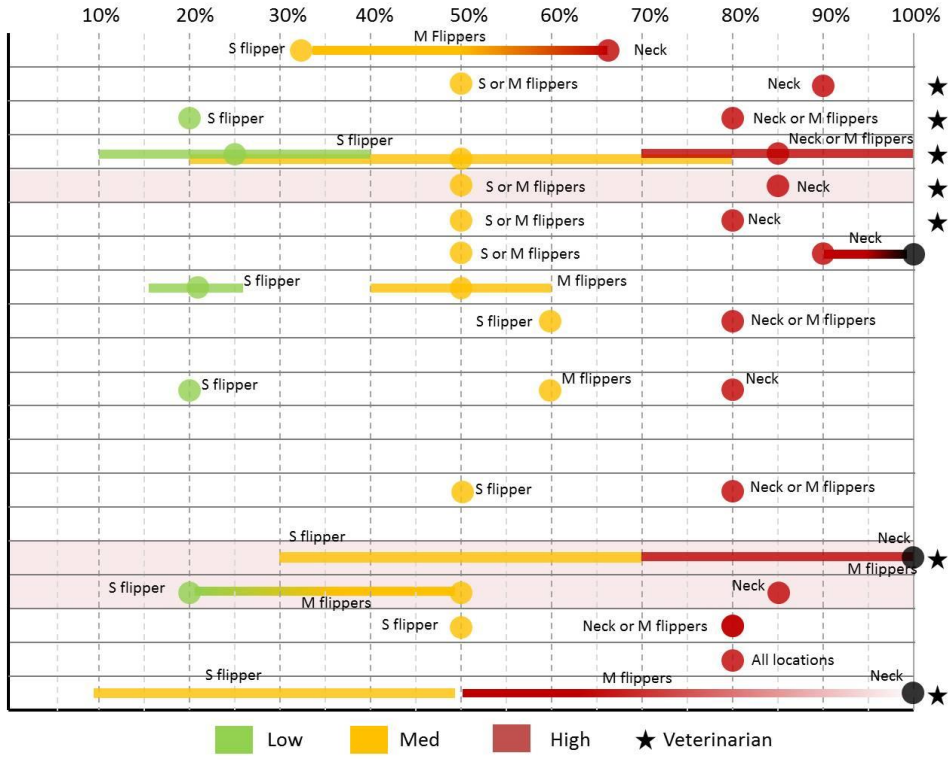
42 - Necrosis distal to entanglement

Leatherback



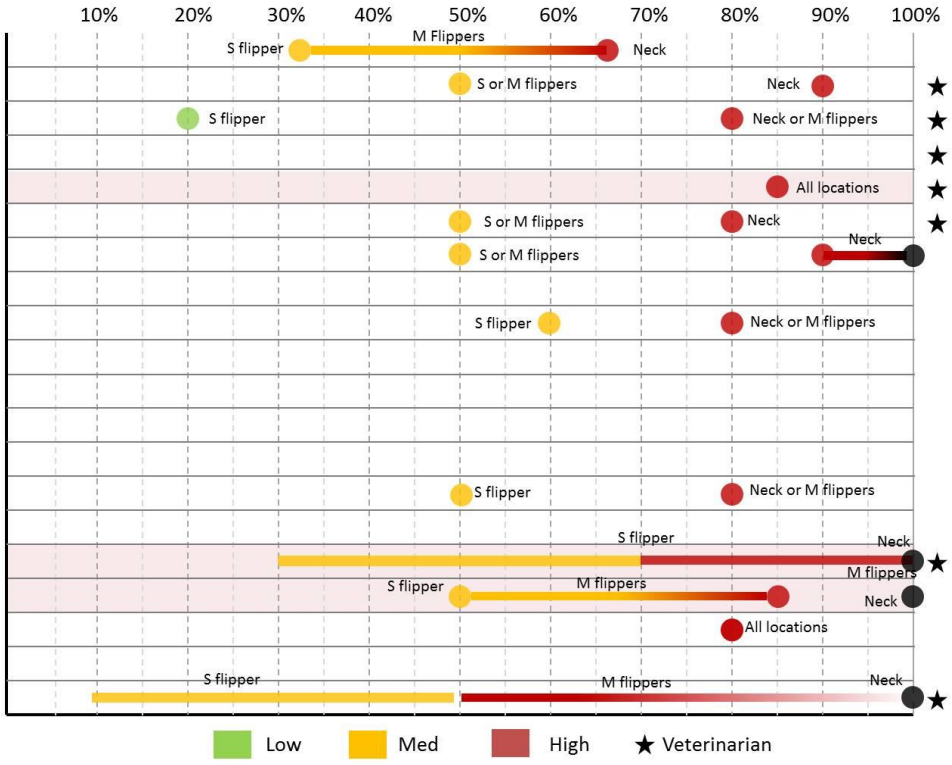
43 - Voluntary movement of entangled appendage is abnormal (for flippers, movement is slow, absent, or stiff compared to unaffected limbs)

Hard-shell



43 - Voluntary movement of entangled appendage is abnormal (for flippers, movement is slow, absent, or stiff compared to unaffected limbs)

Leatherback



Appendix E – Results of Feedback Instrument - Part 2

1. Which of the following non-gear parameters, if obtainable from observer data, do you believe would make a meaningful difference in the probability of mortality? Provide narrative thoughts on how the parameter is (or is not) relevant and how important you believe it is relative to influencing the probability of mortality.

Most participants seemed to respond to the question of whether a given variable was generally important and did not necessarily indicate whether it would be relevant in terms of assigning mortality percentages as presented in the exercise in Part 1. Some participants; however, commented very specifically as to whether parameters could realistically be considered in assigning mortality risk. For example, with regard to maximum duration of submergence, some respondents considered this generally important with regard to mortality, whereas others considered the uncertainty of submergence duration as preventing consideration in individual cases and thus ranked this parameter as less important.

General comments most often described the ranking approach used by the respondent. One of the participants felt that turtles given the lowest mortality ranking, i.e. those outwardly regarded as apparently healthy and uninjured, warrant the most nuanced treatment and may be the category that requires the most refinement based on non-gear parameters.

The number of respondents reported for each section excludes participants who left a section blank or commented that a particular question was outside of their expertise.

Size of turtle (21 responses)

All participants felt that size of turtles is important to post-interaction mortality citing differences in aerobic capacity, strength to escape from gear, and risk of injury. Twelve respondents made specific comments related to size of turtles, noting that smaller animals are more susceptible to the effects of forced submergence. Three participants noted that larger turtles would be at greater risk for some injuries. Four participants provided scaled responses, two felt size was less important relative to other parameters; two felt it was very important. Five participants, including three of seven veterinarians, agreed that size is an important factor, but would not affect mortality risk assigned to a given observation. In other words, turtles of different sizes might be more or less susceptible to a given injury, but this parameter would not change the assigned mortality for the same observation.

Species (19 responses)

Most (n=17) respondents felt that species differences affect post-interaction mortality and referenced at least a distinction between hard-shelled species and leatherbacks. Eight respondents referenced specific species examples, most often noting the sensitivity of smaller green turtles to exertion and injury (n=9) or that leatherbacks are more or less sensitive to some forms of trauma or forced submergence. Nine respondents, including four of seven veterinarians and two of three physiologists felt

that differences would not change the assigned prognosis or that insufficient information was available. Three participants specifically noted the importance of species in interpreting behaviors, an additional respondent made similar comments under "behavior."

Behavior (21 responses)

Nineteen respondents indicated that behavior was important to assessing post-interaction mortality. These participants considered behavior as important, highly important, or essential, one pointing out that it is often all that is available to consider.

For the other respondents, the response on the importance of behavior was less clear. It was unclear whether one respondent regarded behavior as important – the comments primarily described species differences in behavior and noted that multiple effects have similar behavioral manifestations. One respondent felt that behavior was too variable, documented too inconsistently, and the experience of observers was too variable for interpretation. Five participants noted that timing of behaviors and changes in behaviors are important. One participant also felt specification of the duration of time over which observers monitor turtles would be helpful in comparing behaviors across interactions and would provide important context. Other participants also described expected changes in behavior as animals calm down after being captured.

Ten respondents considered all three time periods (initial behavior on board, just prior to release, and in-water just after release) proposed for assessing important behavior, three considered behavior at release the most important, two considered just prior to release to be the most informative, and one respondent felt behavior upon capture was the most important. Others thought behavior upon initial capture and prior to release were the least informative. Various explanations were given. One participant noted that the least information is often available for behavior upon release, so they considered the period relatively less informative.

Nature or extent of visible injuries (22 responses)

Twenty respondents commented on the importance of these observations, and 19 (including all veterinarians) felt it is important. One of these participants commented that it was important for significant injuries that may impair function or cause secondary infections, and less important for minor injuries. One participant felt that injuries were less important compared to fishing parameters and specifically mentioned turtles caught at deeper depths and subjected to longer submergence times. Two veterinarians specifically commented on the potential for unapparent injuries, one stating that this may be more likely in hard-shelled species compared to leatherbacks. Five respondents emphasized the importance of photographs or video to inform a confident assessment. Individual comments included general consideration that sea turtles are susceptible to the same complications from injuries as other species and that consideration of pre-existing injuries is also important.

Length of time retained on board (21 responses)

This factor was added to the Feedback Instrument at the recommendation of some participants. Originally, it was voiced to be important because it provided context for other observations, especially behavior. During completion of the Feedback Instrument; however, participants responded somewhat differently with regard to how they view time on deck and its relevance to post-interaction mortality. Eleven participants specifically commented on its importance with six considering it important (one specifying if the turtle is resuscitated) and five regarding it as less important. Three respondents, all with relatively significant familiarity with the observer programs, felt that too many factors determine how long an animal is onboard for it to be very useful, but acknowledged some value in case-by-case assessments. Six respondents included in their comments that time on board allowed assessment of changes in behavior over time and considered this important, and two additional participants felt that longer time on board allowed detection of abnormalities that may be missed if animals are released soon after capture. Five of seven veterinarians also weighed the benefits and harm of time on deck, and had different opinions on this point. Two viewed additional time on deck as being potentially harmful, one citing various concerns about compromised cardiovascular and other functions while out of water (in addition to risk of injury and exposure while on board the vessel) and the other referenced potential worsening of decompression sickness and delayed recovery of metabolic derangement.

Two veterinarians felt a lengthier time on board was generally helpful to turtles because it allowed animals to recuperate from acidosis and hypoxia. One of these respondents felt that additional time on board is unlikely to exacerbate decompression sickness and noted the rapidity of gas production in the central nervous system and expressed doubts that animals would be capable of re-pressurizing themselves after a capture event. An additional veterinarian expressed similar opinions that time on board benefits responses to hypoxia and acidosis, but worsens decompression sickness. Five individuals mentioned ambient temperature in the comments, three as factors that influence behavioral observations and two as concerns related to exposure while on deck.

Maximum time of submergence (21 responses)

Most (n=16) respondents considered maximum submergence time to be important and four participants felt it to be less important (one did not provide further comment). For those who saw time of submergence as less important, the reason given (and often cited as a caveat by those that felt it was important) was that the actual duration of submergence is indeterminable, as it is never known when an animal was caught during its natural dive and at what point of the tow/soak. Five respondents felt that mean submergence time or a quantitative or semi-quantitative approach could be used to augment mortality estimates. An additional respondent felt that this parameter has

value for general correlation with mortality, but adds little value to individual assessments due to the uncertainly.

Maximum depth of submergence (20 responses)

Eighteen respondents commented that this parameter is important. Most respondents referenced decompression sickness as the basis for their response. Four veterinarians and one of the physiologists felt that this was especially relevant to turtles without injuries that appeared relatively normal upon capture. One of the respondents further noted that it would be most important for deeper fisheries given the relationship between time and depth in the development of decompression sickness. Few participants made specific comments as to how depth may be incorporated into mortality estimates. Three suggested an ordinal process of categorization or defined a range of depths to be considered. Two participants felt depth was less important; one citing concerns regarding unknown duration of submergence and depth of capture and the other commenting that behavioral indicators of effects were more useful. One of the participants that regarded depth as important also commented on the uncertainty of depth of interaction.

Water temperature (20 responses)

Most respondents acknowledged that temperature was an important environmental parameter that influences many factors related to mortality, including: risk of decompression sickness (n=4), physiology (n=3), behavior (n=3), immune function/healing (n=2), and exposure to extreme temperatures (n=2). However, most participants that provided detailed responses considered temperature less important relative to other parameters for assessment of mortality based on the current level of understanding. Seven respondents mentioned uncertainty or conflicting data or effects (e.g., lower risk of DCS at lower temperatures, but higher winter mortality in one trawl study). Of the five respondents that considered temperature to be important, one felt it was generally important to record, another qualified its importance and discussed significant uncertainty, one respondent expressed concerns about releasing debilitated turtles into colder water; the other two respondents did not provide additional comments.

Other parameters (8 responses)

Comments by the 8 respondents included:

- Two respondents commented on the importance of safe handling practices by fishermen.
- The type of fishery may be significant with regard to the level of stress of capture. The current understanding of decompression sickness suggests that greater stress response presents a higher risk.
- The timing of observation relative to capture and release should be clearly noted.

- Documentation should include thorough observer notes, quality photos and good video of the turtle when brought on board, when responding to stimuli prior to release, and at release.
- One respondent outlined a hierarchical risk assessment approach incorporating multiple parameters (including depth and duration of submergence) into assignment of mortality.
- Location of the turtle in the gear (for net and pot/trap gear) may be useful for informing post-interaction mortality as it may relate to the turtle's ability to reach the surface to breath. This respondent also felt colder temperatures could affect turtle behavior during a bycatch event (also included in comments under temperature).

2. Relative to information currently collected by observers, do you have any recommendations for improvements that would help to better inform assessments of post-interaction mortality of sea turtles in trawl, net, and pot/trap gear? (22 responses)

Twenty-one respondents offered recommendations and one respondent had no recommendations. Eleven respondents suggested that additional video and standardized protocols for collection would be beneficial. Some participants also mentioned the value of still photographs for injuries and nutritional condition. One participant suggested the use of Gopro™ cameras to facilitate collection while completing other duties and another emphasized a preference for the value of good video over observer notes. A single participant felt that additional video would not be helpful, citing variability in the behavior of turtles (this sentiment was generally reflected in this individual's entries for Question 1 as well).

Seven respondents recommended greater consistency in the observer data forms across programs, one citing lack of comparability among the case examples shown. Two commended the GARFO approach and felt this should be adopted by other regions. One respondent thought that the codes should be standardized, but that the forms could remain different in order to be compatible with existing databases. The need for streamlining forms was also frequently included in comments (n=7). Recommendations including use of checkboxes (n=6), reducing superfluous natural history data (n=2), and use of a tiered reporting structure (n=1). Two respondents were concerned that cameras could be lost, so complete data still needed to be collected on written forms.

The importance of training was cited by three participants, including familiarity of normal turtle behavior, best practices in photography and videography, and wound recognition. One of the respondents noted that the inclusion of observer training/exposure to wild turtles (non-bycaught) would be valuable to familiarize observers with behavior of healthy/normal behaving turtles. Other comments from individuals included the following: use of timely expert review to evaluate interactions, recovery/salvage of bycaught turtles to study decompression sickness, inclusion of entanglement information on the GARFO datasheet, minimized trauma data fields for fisheries where trauma is rarely observed, and

clarification of the timing of release. Some participants emphasized the importance of parameters from Question 1, including temporal aspect of observations (n=9) and depth/duration of submergence (n=2). One respondent suggested a format for a checklist and timing of observations that has been useful for marine mammal injury documentation and assessment.

3. Are there any sub-lethal effects (for example: reduced fitness, delayed maturation due to depressed growth rates, decreased reproduction, etc.) that should be factored in to an assessment of post-interaction mortality? If so, how would you incorporate sub-lethal effects into post-interaction mortality criteria? (19 responses)

Respondents that specifically commented on the importance of sublethal effects generally felt that they are important, but ten participants considered them very difficult to quantify and two remarked that sublethal effects are outside of the scope of the Workshop focus on mortality. Some participants with a management background commented on the difficulty of incorporating sublethal effects into the assessment of mortality for management purposes. Six participants suggested that sublethal effects could be accounted for in the mortality estimates, one suggested this as a rationale for reporting "non-zero" numbers. Reproductive losses were most frequently mentioned (n=9), especially flipper loss that impedes mating or nesting. Other concerns expressed by individuals included additional compromise of turtles with subclinical problems, persistent tissue damage from gas embolism, and sensitivity of gravid females to injury. Another respondent commented that depth of capture might be the most informative, presumably referring to effects resulting from decompression.

4. Are there focused studies or analyses that could help refine post-interaction mortality criteria in the future? Please identify the most critically important and potentially informative, feasible studies/analyses that you would recommend. (22 responses)

Participants considered study feasibility in their responses to various degrees. Eleven respondents included discussion of satellite tagging in their comments as a measure of actual mortality. One of these respondents noted that it would not be feasible for all fisheries, one expressed the need for rigorous study design to ensure the results are most useful for assessing mortality, and another discussed the caveats associated with inferred mortality, specifically tag failure. The latter participant felt that it could be most useful in studying leatherbacks entangled in near-shore pot/trap fisheries.

Seven participants felt decompression sickness was an important area of future research. Six participants (4 of 6 veterinarians) discussed medical assessments of sea turtles aboard vessels (two referenced actual deployment of veterinarians or technicians, or data collection that would require such training). One of these respondents commented that such activities are unlikely to be feasible. Five respondents suggested recovery of bycaught live and/or dead turtles for clinical evaluation or necropsy, all of whom also discussed the importance of gaining a better understanding of decompression sickness. One participant commented on the value of data obtained from capture during in-water studies; however,

one of the veterinarians felt that these studies represented a best case scenario and that working aboard actual fishing vessels and collaboration to do so are needed (and provided an example of the difficulty in doing so). Two respondents suggested that laboratory studies may be helpful in understanding the effects of capture. A third respondent suggested that experimental trawl studies using different gear and conditions followed by monitoring of turtles in captivity could be used to study mortality. Individual comments included use of tanks on board vessels (similar to those used in Hoopes et al. 2000) to study natural decompression following DCS and the effects of flipper loss. Two respondents referenced manuscripts or studies that are ongoing or have been completed, including chronic effects of decompression sickness in sea turtles, mortality in turtles captured in Brazilian trawl fisheries (discussed during the Workshop as Monteiro et al.(in preparation)), and use of molecular markers for injury. Two participants felt that there needed to be a more complete compilation of all available data, one stated that it could be further synthesized into estimates. Another participant suggested that there are existing recapture data for Mexican shallow-water gillnets that would be useful and suggest high rates of survival.

5. Please provide any additional comments or recommendations you have relative to assessing post-interaction mortality in trawl, net, and pot/trap fisheries. (13 responses)

Comments by the 13 respondents included the following:

- Review regional data on proportions of captures by gear type in order to consider in relative contributions in the mortality estimates and to have a better understanding of the effects of individual fisheries
- Design requests for funding proposals for projects aimed at understanding post-interaction mortality and bycatch reduction
- Apply quantifiable variables (e.g., duration of submergence) despite uncertainty rather than disregarding them
- Use probabilistic modeling or other appropriate quantitative methods whenever possible
- Ensure that the use of electronic monitoring will not reduce or preclude collection of information by observers needed to assess injury
- Consider repeated interaction with pot-trap gear and plan for more nuanced case-by-case assessments of these interactions
- Focus more effort to understand the risks posed by pot/trap gear
- Consider weight and volume of gear and whether or not it is anchored in assessing entanglement injuries
- Consider the effects of multiple encounters with TEDs

In addition, some participants reiterated opinions expressed in other aspects of the instrument, including:

- Collaboration with fishermen is beneficial to study the effects of interaction, as demonstrated in DCS research
- Recovery of bycaught turtles for examination is important

- Mortality estimates require consideration of risk of decompression sickness
- Additional tagging studies are needed to measure actual mortality
- Consistency in primary data elements across observer programs is needed
- Natural mortality should be considered when assessing post-interaction mortality
- Differences in fishing parameters need to be considered
- “Normal” turtle behavior needs be incorporated into observer training

Appendix F – References & Background Materials

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