

APPENDIX J

Memorandum from D. Knowles to J. Powers re: *Marine Turtle Mortality Rates Resulting from Interactions with Longline Fisheries (with attachments)*



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

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MEMORANDUM FOR: F/SER - Joseph E. Powers, Ph.D.
FROM: *JR* F/PR - Donald R. Knowles *DK*
SUBJECT: Marine Turtle Mortality Resulting from Interactions with Longline Fisheries

The Office of Protected Resources (F/PR) was tasked by William Hogarth, Deputy Assistant Administrator for Fisheries to review information on marine turtle mortality in longline fisheries and to make a recommendation regarding the estimation of post-interaction mortality. In addition, F/PR was directed to convene a workshop to further address the issue of mortality estimation. Finally, the Southeast Region (SER) requested input on this issue in order to incorporate any new information into their analyses of the impact of the Atlantic longline fishery on marine turtles.

Summary Findings

1. F/PR recommends the use of revised serious injury/mortality criteria for defining levels of injury to turtles interacting with longline fishing gear (see below).
2. F/PR recommends that 50% of longline interactions with all species of sea turtles be classified as lethal and 50% be classified as non-lethal. The 50% lethal classification is based on our analysis and evaluation of the range of mortality discussed in several investigations for lightly and deeply hooked turtles. Our recommendation assumes additional mortality under normal fishing conditions, where turtles are infrequently boarded, and gear can be assumed to be left on turtles at a greater rate than when an observer handles a turtle for a defined experiment.

Serious Injury/Mortality Criteria

In November, F/PR received from Southeast Fisheries Science Center (SEC) staff a preliminary strawman of serious injury/mortality criteria (Attachment A). F/PR reviewed the document in consultation with SEC sea turtle staff, who agreed that a revision was needed for greater clarity and to focus reviewer comments. F/PR revised the strawman (Attachment B) and solicited input from 33 persons including veterinarians, scientists, and gear and industry experts. F/PR received a total of 7 responses from 4 veterinarians, 2 scientists, and 1 gear/industry expert. A copy of all responses is attached, including comments from Science and Technology (F/ST) staff, responding to the draft strawman developed by the SEC (Attachment C).



Reviewer Comments

Respondents were not able to quantitatively assess criteria for determining whether a particular interaction between a turtle and longline gear will result in mortality. This is not surprising given the multitude of factors involved, including, but not limited to, the nature of the interaction, the duration of the interaction (i.e., time elapsed from the interaction to removal of the animal from the gear), environmental conditions at capture, species, physiological status when captured (e.g., turtle recently surfaced, turtle attempting to surface), turtle size, turtle behavior as the gear is retrieved, how the turtle is handled and the lack of baseline information on what constitutes a healthy turtle from which criteria for injury may be established. While not providing quantitative guidance, respondents did however provide important qualitative assessments of longline interactions. These assessments ranged from likely to recover (for superficial external hooking injuries) to likely long-term impact with eventual death if not treated (for ingested hooks). In general, respondents raised more questions than they answered. These questions are useful in that they will help to develop and focus the upcoming workshop to further discuss these complex issues. Despite the questions, and range of comments, there were a number of responses in common that shed light on the assessment of lethal and non-lethal interactions between sea turtles and pelagic longline gear.

Two respondents suggested variations on the injury categories described in the strawman. Their comments generally agreed with the strawman's categories, except that both suggested an additional description for 'moderate' or 'minor' injury which would include visible injuries that are determined to be superficial, and interactions where the gear has been removed and the animal is not weakened. PR assumes that injuries described in this category would not result in mortality, but might reduce the animal's fitness. Therefore, a new category of observed "minor or moderate" injury is proposed.

The remaining comments can be grouped into three general categories: hooking, hooking with trailing line, and entanglement. The respondents generally indicated that the degree of damage that may result from hooking is dependant upon where on the body the hook penetrated, the depth of penetration, and the length of time the hook is present. Infection, whether localized or systemic, was another important factor in determining whether the turtle would survive the hooking event. One respondent stated that he had seen turtles with ingested hooks that were apparently healthy while other ingested hooks can cause death. Another respondent stated that any turtle with an ingested hook could be in grave danger. Physiological stresses resulting from the hooking event (e.g., fighting the hook) was also pointed out as a concern. Respondents categorized trailing line (i.e. line that is left on the turtle), particularly line that is trailing from an ingested hook, as a significant risk. Line trailing from an ingested hook is likely to be swallowed which may occlude the gastrointestinal tract and lead to eventual death. Trailing line may become snagged and may result in further entanglement with potential loss of appendages which may affect mobility, feeding, predator evasion, or reproduction. Several respondents felt that the level of risk is dependant on the size and robustness of the turtle in relation to the length of line

that is left on the turtle. Characteristics of the monofilament line may also play a role in the risk of further entanglement.

F/PR believes that the reviewer's responses clearly indicate that interactions with longline gear pose a risk to the turtle and that many variables affect that level of risk. These variables cannot be quantitatively ascertained from the existing observer records. Assigning a mortality level to each specific type of interaction based on existing records and current knowledge would be extremely difficult. Revised criteria for determining injury are provided below.

Revised Criteria for Determining Injury for Sea Turtle-Longline Fishery Interactions

I. Non-serious injuries:

1. Entanglement in monofilament line (mainlines, gangion line, or float line) where there are no visible injuries (cuts and/or bleeding), the gear is completely removed, and the turtle swims strongly away from the vessel.

II. Minor or Moderate injury:

1. Visible injuries determined to be superficial and interactions where the gear has been removed and the animal is not weakened (this category would not include ingested hooks under III. 4, below).

III. Serious injuries may result in mortality, or reduced ability to contribute to the population when released alive after the interaction:

1. Entanglement in monofilament line (mainline, gangion line, or float line) that directly or indirectly interferes with mobility such that feeding, breeding or migrations are impaired.
2. Entanglement of monofilament line (mainline, gangion line, or float line) resulting in substantial wound(s) (cuts, constriction, bleeding) on any body part.
3. Hooking external to the mouth resulting in substantial wound(s) (cuts, constriction, bleeding) with or without associated external entanglement and/or trailing attached line.
4. Ingestion of hook in beak or mouth (visible), with or without associated external entanglement and/or trailing attached line.
5. Ingestion of hook in the mouth, throat area, esophagus or deeper, with or without associated external entanglement and/or trailing attached line.

Estimating Post-Interaction Sea Turtle Mortality

F/PR has reviewed the results of research on post-hooking mortality of sea turtles interacting with longline fisheries and has discussed results with several experts. The research to determine post-hooking mortality is based primarily on satellite tracking of hard-shell turtles after their treatment for hooking/entanglement and release. The transmitters are placed on the carapace of

the turtle and data are downloaded from a satellite link at pre-determined intervals when the turtle is on the surface. Some transmitters also measure the turtle's diving behavior. The lack of any satellite transmission after 30 days may be categorized as an unsuccessful track and probable turtle mortality. Properly functioning transmitters should operate anywhere from 9-18 months. The failure rate of transmitters is minimal and attachment to the turtle shell is certain, so that the sinking of the turtle after death is assumed when transmissions are no longer received after 30 days. However it is important to note that this one-month criterion cannot be evaluated for its direct relation to mortality and the actual "cut-off" for assuming mortality may be significantly higher or may be lower.

Post-Hooking Studies: Hawaii

Studies aimed at elucidating post-longline hooking mortality using satellite telemetry devices are ongoing in the Hawaii longline fishery operating in the north central Pacific. These studies have focused on olive ridleys, loggerheads, and to a lesser extent green turtles (Balazs, pers. comm.). Turtles selected as part of the study are limited to those that are lightly hooked or have deeply ingested hooks. The term "lightly hooked" refers to hooks that are imbedded externally on the turtle or imbedded in the mouth or beak, and that can be removed with relative ease and without causing additional injury. The term "deep ingested" implies a hook that is not visible when the mouth is open or only part of the hook can be seen when viewed in the open mouth, in either case the "deep ingested" hook cannot be removed in the field without causing further harm. Turtles selected to carry transmitters are boarded using dip nets. Observers remove the hook and all line before beginning the transmitter attachment on lightly hooked turtles. The treatment of turtles that have deep ingested hooks differs in that the line is removed to a point as close to the hook as possible, but the hook (and in some cases attached line) remains. The transmitter attachment procedure takes several hours from start to finish, after which the turtle is released. There were no turtles studied that were entangled only and no control turtles (i.e., non-hooked, wild turtles) in the same environment have been tagged as part of this study. Ongoing studies in the Eastern Tropical Pacific (ETP) may provide a control group of turtles against which to compare those tagged in the north central Pacific. However, ETP sample sizes remain small and life history stages differ for some species (e.g., mature adult olive ridleys intercepted during their breeding migrations in the ETP) thus complicating comparability (Dutton, pers. comm.).

Results of the Hawaii-based study, to-date, are summarized in a November 2000 report by the NMFS Southwest Fisheries Science Center (NMFS, 2000a). The data are complex and some of the tracking is ongoing. However, initial results are available. The study included 35 loggerheads, 11 olive ridleys, and 3 green turtles. Of the 49 turtles outfitted with satellite transmitters (30 deep ingested, 19 lightly hooked), 30.6% (n=15) produced no transmissions or transmissions that did not exceed one month in duration (these are not considered "successful trackings"). Of these 15 turtles, four were lightly hooked (21.1%) and 11 were deeply hooked (36.7%). Analyses to test for differences in transmission time distribution, mean transmission time and mean distance traveled in the Hawaii-based study between lightly hooked and deeply hooked turtles revealed no significant differences. Twenty-seven percent (27%) of the lightly

hooked loggerheads and 42% of the deeply hooked loggerheads were classified as non-successful tracks. Seventeen percent (17%) of the lightly hooked olive ridleys and 20% of the deeply hooked olive ridleys were classified as non-successful tracks. Sample sizes of green turtles (n=3) were too small to produce meaningful results.

Reliability of transmitters is an important consideration in studies employing satellite telemetry to elucidate the behavior and migrations of sea turtles. Four "types" of transmitters were used in the Hawaii-based study. No significant differences were found in the comparison of different duty cycles or battery types for the duration of tracking for turtles that produced successful tracks (NMFS, 2000b).

We believe the cessation of transmissions within a one-month period and the absence of transmissions post-release (collectively termed "non-successful tracks") from 30.6% of the tagged turtles can be considered a minimal indicator of post-hooking mortality in this study. We believe it is unlikely that mechanical failure of the transmitters or separation of the transmitter from the turtle would cause such a result. Satellite telemetry studies on post-nesting hawksbills in the Caribbean, utilizing similar, though not identical units, resulted in only one tagged turtle (2.5%) from which no transmissions were documented and catastrophic failure of the telemetry unit is suspected (Schroeder, pers. comm.). Studies deploying over 100 similar, though not identical tags (primarily Telonics ST-14 units and a smaller number of Wildlife Computer SDR units) on post-nesting loggerhead and green turtles in Florida and studies on post-nesting green turtles in Hawaii and elsewhere in the Pacific have resulted in no total failures (Balazs, pers. comm. and Schroeder, pers. comm.). In these studies, cessation of transmissions within short periods of time (e.g., less than one month, but not total failure) are also relatively uncommon when proven attachment techniques and transmitter designs are used.

Post-Hooking Studies: Eastern Atlantic

Similar, though not identical studies are being conducted in the eastern Atlantic in an attempt to elucidate post-longline hooking mortality of immature loggerheads. This research includes wild-captured turtles (i.e., not hooked) from the same area as turtles incidentally captured in the Azores swordfish longline fishery (considered "control turtles") and was conducted in two discrete segments - Fall 1998 and Summer 2000 using Wildlife Computers satellite-linked Time-Depth Recorders (Bjorndal et al., 1999; Riewald et al., 2000). Sample sizes are considerably smaller than the Hawaii-based study, 9 turtles have been wild-captured, 3 were lightly hooked (in mouth), and 6 turtles were deeply hooked. As in the Hawaii-based studies, turtles captured incidental to the swordfish fishery were "treated" - for lightly hooked turtles, hooks and all gear were removed and for deeply hooked turtles the monofilament line was cut at the wire leader. Turtles in the Azores study were typically released within 2-4 days of capture as opposed to several hours post-capture in the Hawaii-based study. Results from the Fall 1998 study indicated that several months after capture and release all of the turtles continued to transmit, though one of the control turtles was transmitting only sporadically and with insufficient to obtain location fixes (Bjorndal et al., 1999). Results from the Summer 2000 study indicate that as of the end of

October 2000, two of the four transmitters on control turtles and five of the six transmitters on hooked turtles continued to function. Using criteria similar to the Hawaii-based study for "successful tracks", one of the control turtles and one of the hooked turtles ceased transmitting within one month after release. Analyses to date have focused on diving behavior and movement patterns and directions. A diurnal pattern in dive behavior was evident for most hooked and control turtles, distribution of dives for hooked turtles were skewed toward longer dives and shallower dives and hooked turtles did not show the bimodal distributions of maximum dive depths that were characteristic of control turtles (Riewald et al., 2000). Riewald et al. (2000) opines that transmitters that provide dive profiles are necessary to determine whether transmitter failure is due to mortality or mechanical causes and describes the diving activity of one of the hooked turtles (still transmitting) as indicative of a dead, floating turtle, buffeted by waves. Data analyses are ongoing by the contractor.

Post-Hooking Studies: Mediterranean

A third study approached the question of post-hooking mortality in a different way. Aguilar *et al* (1995), working in the western Mediterranean kept in captivity sea turtles that had been incidentally captured in the Spanish longline fishery with the aim of estimating the mortality rate of individuals with hooks still in their bodies. While the exact details of the study are not clearly elucidated, the assumption is that turtles held in captivity for observation had ingested a hook. It is unclear whether line attached to these hooks was removed to the maximum extent possible, but it is reasonable to assume that this was the case. Of 38 turtles reported by Aguilar (1995) 11 died in captivity, 6 expelled the ingested hook prior to their release (range of days to expulsion 53-285), 15 turtles were released prior to expulsion of the hook (range of days to release 81-123), and 6 turtles taken in 1991 remained under observation at the time the paper was written and the fates of these turtles are unknown. Excluding the 6 turtles for whom the fates are unknown, 34.4% died, 18.8% expelled the hook and 46.9% were released without hook expulsion (see ranges of days in captivity above). As with the Hawaii-based study and the Azores-based study, turtles used in this study also underwent some level of "treatment", including removal of trailing line (reasonably assumed though not explicitly stated), maintenance in a captive environment where food was regularly provided and where predator avoidance was not a factor. While it may be argued that turtles are further stressed under captive conditions, we believe that the captive environment represents a less stressful environment for an injured turtle (i.e., one that has ingested a hook). Additionally, the Aguilar study assumes that the 15 turtles (46.9%) released before hook expulsion survived, an assumption that cannot be quantitatively determined. One respondent to the request for comments on mortality criteria opined that without definitive necropsies, Aguilar's results cannot be used to address post-hooking mortality. Based on our assessment of the study, we believe that the 34.4% observed mortality reported in the Aguilar paper is a minimal estimate of mortality for ingested hooks in the wild.

Entanglement

None of the studies discussed herein involved turtles that were only entangled, not hooked, in longline gear. The applicability of the results of the studies reviewed above to "entangled only"

turtles is a valid question to explore. Comments on the draft strawman suggested that the characteristics of longline monofilament make it unlikely to remain on an “entangled only” turtle once the turtle is cut free from the gear. Data from the Hawaii longline fishery observer program from 1994-1999 indicate that the overwhelming majority of interactions involving hard shelled turtles involve hooking, not entanglement only (Table 1). Hawaii longline observer records indicated that leatherback turtles are more frequently only entangled in the gear, although nearly 75% of the time, hooking is involved (Table 1). Of the eight leatherbacks observed “entangled only”, 25% (n=2) were dead, 37.5% (n=3) were recorded as “okay”, and 37.5% (n=3) were recorded as “injured”.

Table 1. Breakdown of type of gear interaction, hooked (includes lightly hooked, deeply hooked) vs. entangled only (no hooking involved), 1994-1999 Hawaii longline observer program (McCracken 2000).

Species	Hooked	Entangled Only	Not Recorded	TOTAL
<i>C. caretta</i>	143 (97.3%)	3 (2.0%)	1 (0.7%)	147
<i>D. coriacea</i>	29 (72.5%)	8 (20.0%)	3 (7.5%)	40
<i>L. olivacea</i>	32 (100%)	0	0	0
<i>C. mydas</i>	8 (100%)	0	0	8

Data from the Atlantic HMS longline fishery observer program indicate similar levels of “entanglement only” for loggerheads and leatherbacks. The vast majority of loggerheads are hooked while leatherbacks interact with the gear slightly differently - a greater percentage are “entangled only” (Table 2). All of the leatherbacks observed “entangled only” were alive when the gear was retrieved.

Table 2. Breakdown of type of gear interaction, hooked (includes lightly hooked, deeply hooked) vs. entangled only (no hooking involved), 1999 Atlantic longline observer program. (Data source: J. Hoey (unpublished report, 2000) summary of 1999 NMFS observer data for HMS Atlantic longline)

Species	Hooked	Entangled Only	Not Recorded	TOTAL
<i>C. caretta</i>	60 (93.8%)	1 (1.6%)	3 (4.7%)	64
<i>D. coriacea</i>	26 (57.8%)	12 (26.7%) ¹	7 (15.6%)	45
Unknown	1 (33.3%)	2 (66.7%)	0	3

¹ Four of eight turtles may have been hooked in addition to entangled, hooking location unknown.

Conclusions and Recommendations

The Aguilar results and the results of the Hawaii-based study, for mortality from deeply ingested hooks, 34.4% and 42% respectively, are similar. Preliminary data from the Azores study, with very limited samples sizes, indicating a 33.3% mortality from deeply ingested hooks is also in the same range, assuming one month criteria and contractor interpretation of diving behavior.

Whether these results are corroborative or purely coincidental cannot be qualitatively determined. The mortality range for lightly hooked and deeply hooked hard-shelled turtles in the Hawaii-based study is 17 - 42%, based on a one-month criteria established for successful vs. non-successful tracks. This one-month criterion cannot be evaluated for its direct relation to mortality and the actual "cut-off" for assuming mortality may be significantly higher or may be lower. It is important to remember that the turtles used in all studies underwent a level of treatment (e.g., line and/or hook removal as well, recuperative time on deck, captive maintenance) that undoubtedly improved their survival outlook. We believe that mortality rates in the wild, under actual fishing conditions are likely higher than mortality rates indicated by the studies reviewed herein. Given the available information, as well as adopting a risk-averse approach that provides the benefit of the doubt to the species where there are gaps in the information base², F/PR recommends that 50% of longline interactions be classified as lethal and 50% be classified as non-lethal. The 50% lethal classification considers the range of mortality discussed above for lightly and deeply hooked turtles and assumes additional mortality under normal fishing conditions, where turtles are infrequently boarded, and gear can be assumed to be left on turtles at a greater rate than when an observer handles a turtle for a defined experiment. Observer efforts to disentangle turtles and to remove trailing line can sometimes be described as heroic and while we believe that some fisherpersons will undertake similar efforts, others will not. As discussed above, most of the respondents to the NMFS request for comments/information on post-hooking mortality characterized gear left on turtles as a serious problem, especially trailing line which would be a significant risk to the turtle, especially when ingested hooks are involved. While these studies are limited to hard-shelled turtles, in the absence of evidence to suggest that interactions with leatherbacks would result in higher survival rates, we recommend that the 50% mortality figure be applied to leatherbacks as well as hard-shelled turtles. One respondent to the request for input on mortality criteria commented that leatherbacks are not as resilient as hard-shelled turtles and that actions such as hooking, lifting from the water, and ingestion of hooks and lines may have more damaging and long lasting impacts. Our review of the available information does not suggest that a differential mortality estimate can be applied to lightly hooked vs. deeply hooked vs. "entangled only" turtles at this time. While we believe that lightly hooked turtles and "entangled only" turtles, especially those that have trailing line and hooks

²The Endangered Species Act Section 7 consultation process requires NMFS to use the best available scientific and commercial data. The Services established criteria to ensure that the information used in the Section 7 consultation process was reliable, credible, and representative of the best available data (59 FR 34271; July 1, 1994). To the extent practicable, NMFS must use primary and original sources of information including, but not limited to, anecdotal, oral, and gray literature as well as published documents. If data gaps exist that would help determine the impacts to listed species and the action agency intends to proceed with the proposed action, NMFS must proceed with the existing information and is expected to provide the benefit of the doubt to the species concerned with respect to such gaps in the information base (H.R. Conf. Rep. No. 697, 96th Cong., 2nd Sess. 12 (1979)).

removed have a greater chance of survival than deeply hooked turtles, the data do not exist to provide for a differential apportionment. In reality, the figure may be higher than 50% for deeply hooked turtles and lower than 50% for lightly hooked and "entangled only" turtles. In the future, refinements to these estimates can be made if additional information is gathered and further evidence can be provided to quantitatively define post-hooking mortality. Data collected by observers must be standardized and of sufficient detail and description to assess and categorize the interaction. F/PR intends to convene an expert workshop in early 2001 to further discuss the question of sea turtle survival following interactions with longline gear and to refine, if possible, post-interaction survival rates.

Literature Citations

- Aguilar, R., J. Mas, and X. Paster. 1995. Impact of Spanish Swordfish Longline Fisheries on the Loggerhead Sea Turtle *Caretta caretta* Population in the Western Mediterranean. In: Richardson, J.I. and T.H. Richardson (Compilers). 1995. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Mem. NMFS-SEFSC-361. pp: 1-5.
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- National Marine Fisheries Service (NMFS). 2000a. Post-Hooking Survival Research of Marine Turtles. NMFS-SWFSC, November 2000. 20 pp.
- NMFS. 2000b. Post-Hooking Survival Research of Marine Turtles: Duty Cycle and Battery Configuration Analyses. NMFS-SWFSC, October 2000. 8 pp.
- Riewald, B., A.B. Bolten, and K.A. Bjorndal. 2000. Use of Satellite Telemetry to Estimate Post-Hooking Behavior and Mortality of Loggerhead Sea Turtles in the Pelagic Longline Fishery in the Azores. NMFS-SWFSC Final Report Order No. 40JJNF900114. 28 pp.

ATTACHMENT A

Interim Guidelines for Determining Serious Injury of Sea Turtles Taken Incidentally by the Pelagic Longline Fisheries

The development of guidelines for determining serious and non-serious injuries is essential because NMFS is mandated to reduce the levels of mortality and serious injury as mandated by the Endangered Species Act. The pelagic longline fisheries, targeting swordfish and tuna, have interactions with leatherback and loggerhead sea turtles. Although there is a low rate of observed mortality, there is a high likelihood of serious injuries.

Leatherback turtles seldom consume baited hooks, but often become entangled in the gangions. Fishermen usually attempt to remove all entangled gear, but the large size and robust nature of the leatherback often make this dangerous and difficult to do. Loggerhead turtles, on the other hand, usually consume the baited hooks and are either hooked in the mouth or throat and are usually cut free with some monofilament leader attached.

Criteria for determining serious and non-serious injuries of marine mammals have been developed (Angliss and Demaster, 1998). However, the criteria for marine mammals and sea turtles are undoubtedly different and need to be developed. Sea turtles, unlike marine mammals, are apparently able to sustain considerable injuries and still survive. Loggerhead turtles are able to keep feeding with multiple hooks imbedded in their mouths (Argano et al, 1992) and are even able to expel swallowed hooks (Aguilar et al., 1995). Loggerheads commonly survive severed limbs (Gramentz, 1989).

The injuries commonly observed and recorded by NMFS observers will be categorized as non-serious, serious, and serious with associated mortality.

I. Non-serious injuries:

1. Entanglement of monofilament line (mainlines, gangion line, or float line) where there are no visible injuries (cuts and/or bleeding) and gear is completely removed.

II. Serious injuries meet any the following life threatening criteria:

1. Entanglement of monofilament line (mainline, gangion line, or float line) could directly interfere with feeding
2. Entanglement of monofilament line (mainline, float line, or float line) could interfere with mobility
3. Entanglement of monofilament line (mainline, gangion line, or float line) resulting in substantial wounds (cuts, constriction, bleeding) on any body part.

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4. An animal ingests hooks in beak or mouth (visible) could interfere with feeding.
5. An animal is hooked externally in neck or flippers resulting in wound.

III. Serious injuries (with associated mortality) are those animals that:

1. Animal is hooked inside throat/esophagus hooked (28.9%) (Aguilar et al., 1995)
2. Are beak/mouth hooked with substantial line attached (>3 feet loggerheads and >6 feet leatherbacks) (unknown mortality rate).

The following are commonly observed injuries and suggested injury classification:
NS= non-serious injury, SI= serious injury, SM= serious injury with associated mortality.
(* = unknown mortality rate)

Leatherback turtles:

Entangled (cut free)	NS
Entangled (line trailing >6 feet)	SI
Hooked Externally (line trailing >6 feet)	SI
Hooked Mouth (line trailing <6 feet)	SI
Hooked Mouth (line trailing >6 feet)	SM*

Loggerhead (hard-shelled) turtles:

Entangled (cut free)	NS
Hooked Externally (line trailing)	SI
Hooked Externally (cut free)	SI
Hooked Externally (hook removed)	SI
Hooked Beak/mouth (line trailing <3 feet)	SI
Hooked Beak/mouth (line trailing >3 feet)	SM*
Hooked Beak/mouth (cut free)	SI
Hooked Beak/mouth (hook removed)	SI
Hooked Throat/esophagus (line trailing)	SM*
Hooked Throat/esophagus (cut free)	SM (28.9%)
Hooked Throat/esophagus (hook removed)	SM (28.9%)

ATTACHMENT A

References

Aguilar, R., J. Mas, and X. Pastor. 1995. Impact of Spanish swordfish longline fisheries on the loggerhead sea turtle *Caretta caretta* population in the western Mediterranean. NOAA-NMFS-SEFSC-Tech. Memo. 361:1-6.

Angliss, R.P. and D. P. DeMaster. 1998. Differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations: Report of the serious injury workshop 1-2 April 1997, Silver Spring, Maryland. NOAA Tech. Memo. NMFS-OPR-13, 48 p.

Argano, R., R. Basso, M. Cocco, and G. Gerosa. 1992. Novi dati spostamenti di tartaruga marina comune (*Caretta caretta*) in Mediterraneo. Boll. Mus. Ist. Biol. Univ. Genova 56-57:137-163.

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ATTACHMENT B

Developing Interim Guidelines for Determining Serious Injury of Sea Turtles Taken Incidentally by the Pelagic Longline Fisheries

Sea turtles are listed as either endangered or threatened under the U.S. Endangered Species Act (ESA). The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) share jurisdiction for sea turtles under the ESA. Section 7 of the ESA requires federal agencies to consult with either NMFS or USFWS when their actions are likely to affect listed sea turtles. In the case of domestic pelagic longline fisheries managed under a federal Fishery Management Plan, the NMFS Office of Sustainable Fisheries must consult with the NMFS Office of Protected Resources relative to the effects of the fishery on sea turtles. Sea turtles are incidentally taken as bycatch in federally-managed pelagic longline fisheries. Observers accompany a small percentage of pelagic longline trips and record data on sea turtle bycatch, among other things. Since mid-1999 observers have used the attached observer reporting form to record the condition of bycaught turtles. Table 1 provides an example of the comments recorded by observers on board pelagic longline vessels. NMFS analyzes observer data to estimate the total lethal and non-lethal take of sea turtles in the fishery. These estimates are critical to understanding the population-level effects of this bycatch and the estimates are used to monitor sea turtle bycatch relative to take levels authorized in the Incidental Take Statement of the Section 7 Biological Opinion, under the ESA. While there is a low rate of observed mortality (i.e., turtles dead when the longline is hauled in), there is a high likelihood of serious injuries which may or may not eventually result in the death of the animal.

NMFS defined "Serious Injury" for marine mammals as *"any injury that will likely result in mortality"* and defined "Injury" as *"a wound or other physical harm. Signs of injury to a marine mammal include, but are not limited to, visible blood flow, loss of or damage to an appendage or jaw, inability to use one or more appendages, asymmetry in the shape of the body or body position, laceration, puncture or rupture of eyeball, listless appearance or inability to defend itself, inability to swim or dive upon release from fishing gear, or signs of equilibrium imbalance. Any animal that ingest fishing gear, or any animal that is released with fishing gear entangling, trailing or perforating any part of the body will be considered injured regardless of the absence of any wound or other evidence of an injury."* (50CFR §229.2). Requirements of the Marine Mammal Protection Act (MMPA) resulted in the convening of a workshop to differentiate between serious and non-serious injuries of marine mammals (Angliss and Demaster, 1998 - enclosed). The definition of "injury" for marine mammals and sea turtles are not likely to be identical and, thus, NMFS recognizes the need to review its current methodologies and to develop sea turtle specific definitions and criteria to determine which interactions between sea turtles and pelagic longline gear are likely to result in injuries leading to mortality (serious injuries) and which are not.

The result of sea turtle interactions with pelagic longline gear include entanglement and/or hooking (external or internal). The at-sea "treatment" that a captured turtle receives is variable and depends on conditions including, but not necessarily limited to,

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federal regulatory requirements, turtle size and species, the presence of an observer, the sea/weather conditions, experience and motivation of the captain and crew, and nature of the interaction. A general description of the Atlantic pelagic longline fishery and a report of gear, environment and fishing practice parameters which may influence sea turtle interactions are enclosed for your information.

For discussion and review purposes the following categories are proposed:

I. Non-serious injuries:

1. Entanglement in monofilament line (mainline, gangion line, or float line) where there are no visible injuries (cuts and/or bleeding), the gear is completely removed, and the turtle swims strongly away from the vessel.

II. Serious injuries that may or may not result in mortality when turtles are released alive after the interaction:

1. Entanglement in monofilament line (mainline, gangion line, or float line) that directly or indirectly interferes with mobility such that feeding, breeding or migrations are impaired.
2. Entanglement of monofilament line (mainline, gangion line, or float line) resulting in substantial wound(s) (cuts, constriction, bleeding) on any body part.
3. Hooking external to the mouth resulting in substantial wound(s) (cuts, constriction, bleeding) with or without associated external entanglement and/or trailing attached line.
4. Ingestion of hook in beak or mouth (visible), with or without associated external entanglement and/or trailing attached line.
5. Ingestion of hook in the mouth, throat area, esophagus or deeper, with or without associated external entanglement and/or trailing attached line.

NMFS is seeking comments and input on the effects of these types of interactions on the health and viability of turtles involved in such interactions. Recommendations on apportioning mortality based on detail-specific criteria are sought.

ATTACHMENT C

John Hoey
Comments on SEC
initial draft criteria

Draft criteria for determining serious injury and/or mortality for sea turtle - pelagic longline interactions (October 10, 2000 e-mail draft from Wayne Witzell).

This initial draft reflects the decision rules that were used in the June 20, 2000 biological opinion, i.e. that almost all sea turtle - longline interactions cause serious injuries. While only a few were coded as serious injury with associated mortality I think there are additional non-serious injury conditions that are reasonable and would help encourage careful handling. Given the limited post-release data available the assumption that "there is a high likelihood of serious injuries" seems questionable. Given the text references in the third paragraph to turtle hardiness and resilience, the phrase "high likelihood" should be replaced by "varying levels of risk depending on the species and type of interaction". This would seem to be more in line with NMFS technical memo - SEFSC-222 which appeared to emphasize internal wounds.

Despite reference in paragraph 3 to the serious injury workshop on marine mammals and the "undoubtedly different" criteria for serious injury for sea turtles, the categorizations presented at the bottom of page 1 reflect discussions on marine mammal injuries and interactions primarily with gillnet gear and pot warps from lobster gear. As I mentioned at the serious injury workshop and in more recent discussions and written comments, there are very important gear differences between gillnets and lobster pot warps that must be acknowledged.

In the marine mammal serious injury discussions, the interaction types that are listed under item II - i.e. Serious injury with respect to entanglements that interfere with feeding, mobility and cause substantial wounds - referred specifically to heavy multi-filament nylon lines in single strands and multiple strands that wrapped around appendages and/or through the jaw with the resulting drag and friction cutting through soft tissue and bone. The diameter, number of strands, weight in water, and drag associated with these gears is very different than those same characteristics and others associated with the types of monofilament lines used in the U.S. pelagic longline fishery.

The monofilament used by the longline fleet is designed to have negligible resistance and drag and extremely low weight despite having great strength. In 1998 and 1999 gangion pound tests were usually ≥ 300 lb. test (only one set with 250 lb. test), whereas mainline pound tests were usually ≥ 600 lb. test. These characteristics must be factored into the serious injury criteria along with the fact that very few longline observer comments (based on my partial examination of Atlantic interaction forms) note cutting or tearing wounds on appendages, whereas this is frequently noted for marine mammal interactions with gillnets and lobster warps. I think it is critically important to draw a distinction between the different weights, pound tests, for the monofilament line that is associated with turtle interactions. George Balazs included information on monofilament strangulation for Hawaiian Green turtles on page 130 of the Honolulu lab program review 2000 document. The illustrated entanglement was attributed to recreational shore-line fishing with 6-lb. test monofilament. I believe there have been similar observations associated with jetty fishing in the Gulf of Mexico and Atlantic. It should be part of the standard sampling protocol for monofilament samples to be taken for all stranded or nesting turtles that

have attached gear.

As I mentioned at the serious injury workshop and in discussions with SEFSC and PR turtle scientists, monofilament line has memory (stretch) characteristics, especially for the pound test used for mainlines (usually ≥ 600 lb. test) and gangions (usually ≥ 300 lb. test), that make it very difficult to knot or twist and tangle strands so that the knot or tangle will hold once tension is eliminated from the line. Because of these characteristics fishermen rely on crimps to connect sections of line, especially the heavier mainline. In those cases where entangled turtles are released with trailing loops of monofilament that do not include an attached hook that is impeded in an appendage or shell, it would be very likely that the gear will simply fall off once line tension is released.

In those cases where an external hooking has occurred or where the hook is in the beak, jaw, or tongue (externally visible) and the turtle is released with limited line attached, the size of the turtle and length of attached line should be considered. There are no reports that I am aware of that specifically identify a line length threshold of 1 meter for loggerheads and 2 meters for leatherbacks, nor is rationale provided in the draft for these arbitrary length thresholds. These lengths may be reasonable targets now that the fleet is required to carry line cutters, but this hasn't been the case in the recent past and it should be discussed with observers who have experience with conditions aboard vessels especially freeboard height and hauling practices. Since the 1995 Hawaii workshop emphasis has been placed on not pulling or putting tension or pressure on the line that is entangling the turtle. Fishermen therefore chose to leave slightly more line on the turtle when freeboard was high or weather conditions limited the Captains ability to maneuver because they thought that was better for the turtle than dragging the turtle closer to the boat. This would be particularly true for leatherbacks especially when they were active. A 5 meter threshold for leatherbacks would reflect reasonable handling distances aboard US commercial vessels where an attempt to avoid straining the line and dragging the turtle is probably being made. Five meters of monofilament would probably weigh less than a pound or two in the water which would seem to be a negligible drag on a several hundred pound leatherback. Some of this concern about a line length threshold relates to post-classification (after the fact) when NMFS has not provided clear guidance to the fishermen. The same can be said for classifying all turtles as hooked by injection including those clearly noted as hooked in the mouth when the observer guidance described in Technical memo SWFSC - 222 indicated that hooks were considered injected if the hook was "past the mouth cavity and in the esophagus".

If all turtles that are released are all categorized similarly as seriously injured whether they are trailing small lengths of monofilament (< 1 or 2 meters as drafted) after being either externally hooked or hooked in the jaw (hook left in), released with only the hook in the jaw (no trailing gear), and hooked turtles that are completely disentangled with the hook removed, these criteria will undermine efforts to encourage careful handling and extra effort to maximize survival. I can't see how this risk averse decision would be consistent with previous agency actions relative to other fisheries, handling or resuscitation guidelines, and the limited post-release data that is available.

Post-release mortality studies include Anguilar's study of survival of deeply hooked turtles

from the Spanish Mediterranean fishery which uses very small hooks and baits and provides the 28.9% mortality rate listed on page 2 of the draft. Information from tracking studies from the Hawaiian longline fishery need to be reviewed. In the Honolulu lab program review 2000 document (page 130) it is noted that satellite transmitters have been deployed on 38 loggerheads, 11 olive ridleys, and 3 green turtles (a total of 52). "Twenty seven of the deployments have resulted in pelagic trackings ranging from 0.2 to 8.2 months duration covering distances of 13 - 7,282 km. The remaining 13 deployments have produced no tracking data, and all of these involved turtles that were classified as "deeply hooked" (hook lodged in the esophagus and impossible to remove)." This last sentence seems to be an incomplete thought and the total of 27 and 13 is 40, so an obvious question remains about the remaining 12 tracks. The next two sentences in the program review are as follows: "Of the 39 tracked turtles, 22 were deeply hooked and 17 "lightly hooked" (the hook was in the jaw or elsewhere externally allowing easy removal). There were no significant differences between these two groups for the duration of transmissions in months or the distance the turtles traveled." Additional information on these tracking results are critically important. If all 13 of the turtle deployments that produced no tracks were deep hooked what other condition notes were recorded and are these included in the total of 22 listed as deeply hooked or in addition to the 22? What was the species breakdown for the lightly and deeply hooked turtles and for the no track turtles?

If the 13 no tracks are in addition to the 22 deeply hooked then we have 39 tracked turtles and 13 no track turtles (total 52) with 35 deeply hooked and 17 lightly hooked. If the 13 no tracks only reflect short-term mortality as opposed to transmitter or battery failure or another co-variate, then 37% of the deeply hooked turtles may have died. The obvious questions include what the additional condition notes might include and whether the no track deployments all share a common characteristic (same trip, same month, similar area, similar size and species, transmitter lot, battery lot, etc.). In any case given the number of observations in both the Anguilar and Balazs studies it would seem that this data could justify assigning a mortality rate between 30% and 40% for deeply hooked turtles. I would assume given similar tracking distances and speeds a much lower mortality rate (some might argue a negligible rate) would be justified for lightly hooked turtles. Those turtles that are completely disentangled should not be categorized as injured unless wounds or trauma are evident.

In light of the preceding I would offer the following alternative categorizations of interaction types:

1. **Not Injured** - Turtles that spit hooks and baits while the gear is being retrieved and entangled turtles where hooks are not involved and where the turtle is released with no gear attached.
2. **Non-serious Injury (lightly hooked)** - Disentangled externally hooked turtles (not in jaw, beak or tongue) released with limited¹ gear attached. Also include turtles hooked in the jaw, beak, or tongue (externally visible) if the hook was removed for those sizes of turtles that could be brought aboard with dipnets and there was no other tissue damage or bleeding noted. Externally hooked (not in jaw, beak, tongue, or neck - only carapace, flippers or tail) large turtles released trailing gear longer than the limited¹ gear

thresholds but less than 5 meters in length.

3. **Serious Injury - level 1 (deeply hooked but limited gear).** - Hook lodged in the esophagus and impossible to remove with the turtle released with limited¹ gear attached and observer notes indicating active and reasonable condition. Externally hooked turtles released with limited¹ gear attached and with non-critical tissue damage or limited bleeding noted, including turtles hooked in the jaw, beak, or tongue (externally visible). Different mortality ranges should be provided for these two groupings.
4. **Serious Injury - level 2 (deeply hooked with excessive gear).** - Hook lodged in the esophagus and impossible to remove with the Turtle released with more than the limited¹ gear attached and/or wounds noted to the eyes or neck. If an attached buoy was left trailing that would be a serious injury level 2 along with any turtles where the observer notes reference struggling or weak condition or a visible serious wound more extensive than a hook puncture.

Assigning rough quantitative ranges for mortality rates to the preceding categories will require a thorough review of the condition notes associated with the Honolūlu tracking studies and any other information that has been developed over the last few years. This should be a topic for more extensive discussions including a range of people with greater experience than I have on events at-sea as well as vets and other biologists. It would seem reasonable however for the mortality rates for serious injury - level 1 deeply hooked turtles and serious injury - level 2 deeply hooked turtles to be different and preliminary range estimates might be reasonably established once the tracking study results are more thoroughly reviewed. I would also obviously have a 5th category for dead turtles.

¹ Refers to line distances of <1 meter for loggerheads and <2 meters for leatherbacks.

Developing Interim Guidelines for Determining Serious Injury of Sea
Turtles Taken Incidentally by the Pelagic Longline Fisheries

Comments

1. It is clear from the Final Report 50EANA700063, that not only do the terms "injury, non-injury, and serious injury" need to be defined, but that the observations and nomenclature to describe the observations must be standardized. Here are some recommendations:

a. **Serious Injury**: having a negative effect on turtle survivorship or negative effect on the animal's contribution to the population.

b. Definition of **Injury** for marine mammal and sea turtle should be the same. The causes may be different. **Injury**: damage inflicted to the body by an external force (from Dorland's Illustrated Medical Dictionary).

c. While by process of elimination, a **non-serious injury** would be an injury that is not defined as a serious injury, still this needs definition.

d. A definition of "**foul-hooking**" needs to be included in any document.

2. Major problem is that we can't determine the extent of injury without establishing criteria for a healthy marine turtle. A group has been formed at the University of Florida to establish the "gold standard" for sea turtle health assessment. This will take several years to define. So when an attempt is made to try and categorize or establish criteria for injury, both serious and non-serious, realize that we are limited in our ability to stringently categorize animals. Clearly an animal that is moribund and appears to be near death because of obvious massive injury is easy to categorize. The difficulty is with those animals that appear to have minimal external damage but may have significant internal damage or are septic as a result of the injury. As all of us in medicine know, trying to get a handle on these cases is extremely challenging. So everyone needs to

know what the limitations are. To come up with a more meaningful way of categorizing these animals, ultimately turtles with certain types of injuries need to be followed through time using satellite monitoring. This will be the only way to get a scientifically based handle on outcome of injured animals. Categories of injuries can be established and criteria then developed to allow some type of categorization. Hopefully this will be an outcome of your proposed meeting.

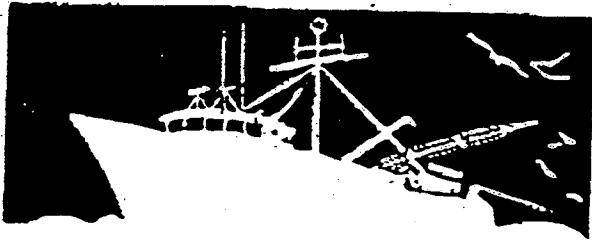
3. We believe that any animal that is released with an intact attached hook, is at risk, especially if line is still attached. The more line, the more risk of being snagged underwater and drowning. The level of risk of drowning is dependent on the size and robustness of the turtle, as well as the area hooked. Of the 30 stranded turtles evaluated in a study done by us, at least 10% had evidence of fishing line injury severe enough to explain the cause of death. One had swallowed line, resulting in imbrication of the intestinal tract. One had a hook lodged in the larynx, associated with necrotizing laryngitis. One had an abscess ventral to the tongue which could have resulted from a fish hook lodging there. I think the abscess impacted on the turtles ability and desire to eat. It should be assumed that if a turtle is entangled, that a hook could be internalized. The only way to dismiss this would be to radiograph these turtles. Even if a hook was found externally, that would not preclude an internal hook. A turtle with a swallowed hook could be in grave danger.

4. Questions to be answered:

- a. How long does it take for hooks to rust out?
- b. How stable is the monofilament line relative to disintegrating in salt water?
- c. Is it possible to salvage any of the turtles for rehab, to conduct a parallel study with radiotransmitters?
- d. In the report, there was a suggestion that some turtles could be entangled multiple times in longlines. What is the likelihood of this happening?

e. How toxic are light-sticks if they are swallowed? Are they ever swallowed?

5. There was no mention in the "Description of Longline Fishery" paper of what is used to weigh down the lines in the water. I assume that no toxic metals (for e.g., lead) are used.



HI-LINER

FISHING GEAR AND TACKLE, INC.

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UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
National Marine Fisheries Service
Attn.: Office of Protected Resources
Room 13630,
Silver Spring, MD 20910

November 16, 2000

Dear Ms. Conant,

Thank you for the opportunity to participate in your initial solicitation of input concerning sea turtle-pelagic long-line interactions. HI-LINER Fishing Gear is the largest US exporter of pelagic monofilament long-line materials to the world pelagic swordfish/tuna long-line fleets. We maintain several offices in many coastal nations to provide local inventory, product support and technical expertise. Currently, we remain the key supplier to a majority of pelagic long-line vessels fishing from Spain, Portugal, South Africa, Brazil, Uruguay, Mexico, Chile, Australia - to name a few. It is the purpose of this letter to establish the position and standing of HI-LINER among the world-wide pelagic long-line fleets, principally those plying the North/South Atlantic oceans.

HI-LINER has maintained a long history of product introduction, development and extension. The evolution of this style of fishing equipment has not been limited to the US. Acceptance of this material by other more traditional fishing nations has produced advancements and improvements in both equipment and technique. HI-LINER's emphasis on the operational success of individual international fishing vessels has left us uniquely qualified to comment on long-line gear principles, dynamics and continued product evolution.

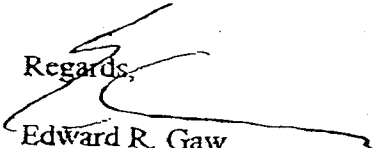
However, your solicitation specifically requested input concerning injuries and their relative short/long term implications. It remains my strong belief that our subjective contribution to this phase of your investigation would contribute little to the attainment of the true goal of your discussions, Minimization/Avoidance of Sea Turtle/Pelagic Long-line Harmful Interactions. I would formally request that HI-LINER be consulted directly prior to any discussion of gear modifications, operational gear parameters and dynamics relative to sea turtle interactions. Combinations of traditional foreign fishing techniques

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Spain: 900931156

with modern monofilament pelagic long-line gear has proved the flexibility and malleability of this style of fishing

At your convenience, your review would be greatly appreciated.
Please advise your requirements. Thank you for your time and considerations.

Regards,


Edward R. Gaw

HI-LINER FISHING GEAR, Inc.

United States Department of the Interior

U. S. GEOLOGICAL SURVEY
National Wildlife Health Center
Honolulu Field Station
300 Ala Moana Blvd, P. O. Box 50167
Honolulu, Hawaii 96850
Phone: 808 541-3445, Fax: 808 541-3472
E-mail: thierry_work@usgs.gov

November 20, 2000

FAX

TO: Therese Conant

FROM: Thierry Work

Total Pages: 3

Dear Ms. Conant

Thank you for the opportunity to review the material on long line and marine turtle mortalities. In an attempt to make this issue more tractable, consider the following simple model:

Line is set → turtle is attracted to line → turtle gets hooked → turtle dies or survives

Line setting:

What factors are conducive to turtle being hooked and how could these be prevented? Contract report 50WANA700063 outlines some of these including depth of line, time of set, temperature, use of light sticks, area of set, date of set.

Attraction:

What is it exactly that attracts turtles to bait? Are there certain bait types that would be equally attractive to fish but less so to turtles? Could artificial baits be developed that are repellent to turtles but not target fish? Could sonic devices be placed around lines that repel turtles? This would call for research on olfactory and visual cues that attract turtles to bait.

Hooking:

According to the contract report, this appears to be one area

where more information could be gathered.

2

Once an animal is hooked or entangled in the line, how severe is the injury? The NOAA-NMFS-OPR-13 goes some way into defining that for marine mammals. Defining injury based on hook placement alone in marine reptiles may be misleading. For example, lightly hooked turtles (hook on beak only, no visible trauma) may still drown from forced submergence. On the other hand, we have seen turtles with traumatic amputations of the forelimb from fishing line that survive quite well. Also, some turtles considered deeply hooked and tracked by satellite have been shown to survive many months. Finally, an animal may be hooked in the flipper (survivable injury) but released with several feet of leader thus posing potentially lethal risk of the leader wrapping around limbs or neck and causing strangulation or limb amputation. Perhaps consider standardizing criteria to define an animal as uninjured, moderately or severely injured using something like the following criteria.

Uninjured-Animal vigorous, breathing is unremarkable, hook on beak only (easily removed with no visible trauma) and no evidence of external trauma from line or hook.

Moderately injured-Visible trauma from hook on beak, flipper or shell. Visible trauma from line around flipper (e.g. abrasion or cutting into flipper). Animal vigorous, breathing is unremarkable.

Severely injured-Hook in soft tissue of mouth (tongue, soft palate), or deep into esophagus. Leader wound tightly around limb with a partial avulsion or amputation. Alternatively, no visible injuries but animal weak.

Documenting: Following data would probably be helpful to standardize reporting. Items (*) are those used to decide whether animal is uninjured, moderately, or severely injured. Items (*, **) may be useful for long term prognostication:

- Hook number and type
- Date and time of set
- Water temperature
- Type of light stick used (color, make)
- Hook location*
- Photo of hook set in turtle or of line-induced injury*
- Length of turtle
- Hooked removed (Y/N)**
- Animal (vigorous, weak, dead)*
- If hook not removed, length of lead left on hook.**

Any dead animals should be stored frozen and returned to a laboratory for complete post-mortem exam. Alternatively, observer puts animal aside and performs a necropsy taking appropriate samples in formalin and frozen once catch is finished

3

(how realistic this is depends on conditions on the boat). Perhaps NMFS needs to dedicate observers to do this task only (documenting extent of injury and doing necropsies).

Other avenues of pursuit: Given that hooks are set in 24 hour periods, are there materials that can be used to make hooks that will have similar tensile strength as steel but will degrade or dissolve, in, say 7-10 days? For example, some darts used to immobilize animals have a needle with a barb made of a material that dissolves once it contacts body fluids thus causing less injury when the dart is removed. The key would be to find a material that would dissolve, just more slowly (>24 h) allowing desirable fish to be caught.

Turtle dies or survives:

(how realistic this is depends on conditions on the boat). Perhaps NMFS needs to dedicate observers to do this task only (documenting extent of injury and doing necropsies).

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Turtle dies or survives:

Efforts should be made to satellite tag animals in uninjured, moderate, and severely injured category to evaluate long-term outcomes. Perhaps this could most readily be done in fisheries that consistently catch large numbers of turtles. A model animal could be something not critically endangered like the loggerhead.

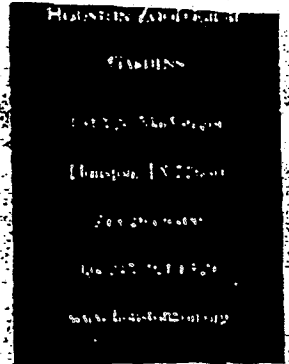
I hope this is of some use.

Sincerely,

Thierry M. Work
Wildlife Disease Specialist

QUICK

Date: 4 Dec 00	To: Donald Knowles	From: Houston
Subject: Director/Office of Protected Resources	Phone: 301-713-0316	Phone: 713-284-1334
		Phone: 713-284-8542



4 Dec 2000

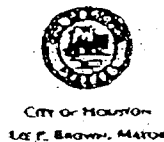
Donald R. Knowles
 Director
 Office of Protected Resources

Dear Dr. Knowles,

I have been working with sea turtles for approximately 16 years through the National Marine Fisheries Service Galveston Laboratory. During that time I have seen a number of sea turtles (mostly Kemps Ridleys) which have been caught on hook and line in the recreational fisheries here on the upper Texas coast. These turtles by and large, have ingested hooks and are presented within a day of capture.

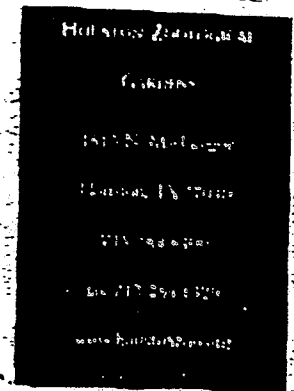
Presentation has varied with size of the turtle, type of hook (size, shape, material), presence or absence of a leader, and quantity of line present. My approach to treatment has varied with the actual location of the hooking. At presentation, the hook may be present in the oral cavity, any point in the esophagus, or in the stomach. The damage done by the hook will vary with the point in the body that is hooked, the depth of hook penetration, and the length of time the hook has been present. I am never presented with animals that have had hooks for more than a few days.

In general, with a simple hook, the deeper (farther into the esophagus or stomach) the animal is hooked, the greater the chance of damage or potential damage. Important exceptions to this are animals that are hooked in the oral cavity with the point of the hook penetrating into the orbit or globe of the eye, or animals that are hooked into a major blood vessel. Hooks that penetrate through the gut wall can cause variable damage, depending on what area or which organ the hook impacts. I have observed hooks that have punctured the major vessels near the heart, resulting in nearly immediate death of the animal. The point of a hook may cause a localized



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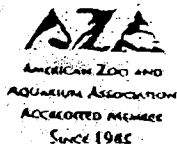
infection at the point of penetration. This infection could remain quiescent, and ultimately resolve without long term harm to the animal, or could result in a generalized infection and death. It is possible that a hook without a significant length of attached line can pass through the digestive tract without harming the turtle. I cannot guess at what percentage of cases this may occur.

Hooks anywhere in the gastro-intestinal system that trail fishing line can lead to plication of the intestines and potential peritonitis (coelomitis) with a linear foreign body. I consider any length of trailing line to be a significant risk to the health of a turtle as the line passes into the intestinal tract. Long lengths of line trailing from the oral cavity can entangle the turtles neck or appendages and result in physical harm to the animal. Loss of a flipper may reduce the animals feeding efficiency, its ability to evade predators, or impact its ability to reproduce.

Animals hooked in locations other than the gastro-intestinal system have a lower risk of adverse health effects due to the hooking incident. Hooks penetrating skin or superficial muscle groups are likely to establish a localized infection, but are likely to slough with infected tissue. The turtle will heal, albeit with a defect where it was hooked. If hooked in or near a joint, the injury will be more severe. Penetration of a joint may impact the animal's mobility and is more likely to result in systemic infection.

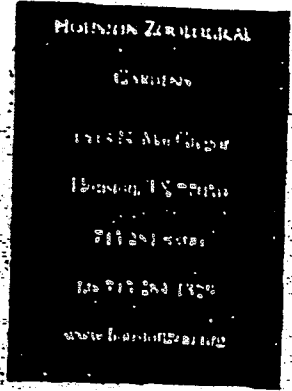
Hooked turtles can suffer from harm caused indirectly as a result of their capture. Animals that are hooked and fight the hook may over-exert themselves, exhausting muscle energy sources and causing a severe metabolic acidosis. These animals may appear normal, may fight with great force when handled, but may not have the ability to recover if returned to the sea in an exhausted condition. The longer an animal fights, or the greater the intensity of the fight, the more likely it will have problems recovering from the hooking incident.

If an animal is hooked and is unable to surface, it will obviously drown within a relatively short period of time. The time will depend on the length of time since the animal last surfaced, the water temperature, the size of the turtle, and the amount of struggling the animal does on the line.



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Turtle interactions with hooks are traumatic incidents. Although some individuals may survive relatively unharmed, the vast majority will suffer significant injury and potential mortality as a result of being hooked.

If you have any further questions please contact me directly. I apologize that this response is tardy, but I was away when the package of information arrived.

Sincerely,

Joseph P. Flanagan DVM
Senior Veterinarian
Houston Zoological Gardens
1513 North MacGregor
Houston, TX 77030
houzoovet@juno.com



CITY OF HOUSTON
LIZ P. BACHMANN MAYOR

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Donald R. Knowles
Director, Protected Species
National Marine Fisheries Service
Silver Spring, MD 20910

24 November, 2000

Dear Dr. Knowles,

Thank you for the opportunity to submit comments on the materials that your office forwarded re. effects of interactions between longline fishing gear and sea turtles.

NMFS is doing the right thing by developing criteria describing long line gear interactions that are specific to sea turtles. Although marine mammals and sea turtles share the distinction of being air-breathing vertebrates, they have very different behaviors and susceptibilities or responses to human interactions. Since we don't have all of the answers regarding gear interactions and sea turtles, it will be productive to have a suite of descriptions that accurately characterizes a sea turtle's condition, and disposition of gear left on the animal. Only then will all parties have the necessary information to proceed with mitigation that will limit or eliminate harmful interactions, and reduce burdens for fishermen if and when it is appropriate to do so. Specific comments follow below:

I. "Non-serious injuries" This category is contradictory and misleading. A "non-serious injuries" cannot be equal to "no visible injuries". If the animal is not injured, the observation should clearly state it as such.

1. Suggested alternatives to non-serious injuries that would describe animals that have run into gear but that have no visible injuries and are not suspected to have had them:

Gear Interaction 1, resolved (trailing or entangling gear has been removed)

Gear Interaction 2, gear not completely removed.

2. "Visible injury, minor (superficial)

Any visible injuries such as cuts, minor lacerations- that are not likely to jeopardize the health or impair the movements or behavior of the turtle. This type of injury would be expected to spontaneously heal/resolve.

II. Serious Injuries The five types of interactions could all be construed as serious. However, there are still some grey areas. For example, Entanglement in monofilament line.. That interferes with mobility... such that feeding, breeding or migrations are impaired." Does this mean that the turtle is released with the monofilament, or that it was impossible to free it of binding gear? If yes- then of course, this is serious injury. But if the animal were freed of the mono and then showed signs of strength and normal swimming/behavior, would the designation of serious injury still hold true? [I hope that we all are working to making this situation go away. If still alive, all badly entangled animals need to be freed of gear. I need to know/understand whether there are cases where a longliner crew would be unable to free the turtle? If the turtle is attached via float line to rest of gear, doesn't the boat always have some line to the animal that can be retrieved?]

Regarding 4. Ingestion of hook in beak or mouth... does this mean that the observer can see the hook? There are cases where sea turtles have hooks in the keratinized tomium, but because it's not in the soft tissue, there may be little or no impairment, and the hooks eventually get dislodged. This is different than cases where the hook is in the soft tissue, where it is likely to be pushed further into the tissue.

Possible alternatives could be

Gear Interaction- Hooking

1. Visible, external, no obvious injury [no mortality expected]
2. Visible, external, injured [injuries serious, mortality could result]
3. Internal/Gut hooked; serious injury suspected or likely. [mortality could result]

From Table 1 1999 NOAA Fisheries Sea Sampling Program, observers can obviously provide descriptive information that can be used to make an assessment of a turtle's status, especially in regard to serious vs. non serious injury, and whether a turtle is injured at all. There's plenty of room for improvement. For example, "hooked in mouth"- does this mean in the tomium, or in the soft tissue? Another one "swam off readily, although seem tired." My impression is that with explicit training, observers could provide unambiguous information. Photographs are also useful as supporting information.

The information provided by the Hoey report was extremely helpful. His analysis provides a good place to start to examine environmental relationships between sea turtles and longline gear, and where they are most likely to converge. However, we need more details, as temperature ranges were quite broad. We had this same problem in trying to find relationships between leatherbacks and real-time ocean frontal conditions, using limited aerial survey data from right whale and other surveys. For example, depending on geographic area, leatherbacks were found in SST's ranging from 10-23 °C, even though the average SST from right whale survey databases was 16 °C (Distribution of Leatherback Turtles in relation to the Environment, Cooperative Agreement #40GENF400229, report to NMFS SEFSC, M. Lutcavage). Most of our observations came from inshore surveys, and are not particularly helpful in identifying offshore habits. I understand that the NMFS SEFSC recently funded a study by Morreale to examine SST's and location of longline sets that had interactions with sea turtles. It would be very helpful if these results were made available for review. It would also be important to see Scott Eckert's results of diving habits and travel patterns of leatherbacks that he's tracked with satellite transmitters in the Atlantic and elsewhere, particularly if this study were funded by NMFS and if a technical report were available for distribution.

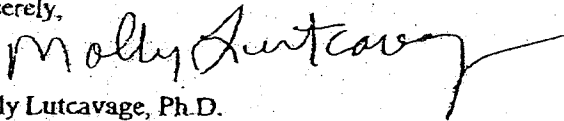
I was dismayed to see NMFS incorrectly use a report prepared by Greenpeace (submitted to the Sea Turtle conference but not subjected to peer review), in the recent Biological Opinion (Jun 30, 2000). Page 35 states "Perhaps a better way of looking at the data is to apply the 29% mortality estimate provided by Aguilar (1995) to the average annual estimated take of 715 animals (Yeung et al., *in prep*) which indicates that an average of 207 animals annually either die or are seriously injured by pelagic longlines in the U.S. fleet." There is no way of knowing whether the Yeung et al. data is convincing, because the reader is unable to see it. The Aguilar et al. paper provides useful (although very general) information on turtles taken in the Spanish longline fishery, but is extremely flawed as a scientific paper on post release mortality or survivorship. The data shown in their Table 1, which suggests that "20-30% of sea turtles may die after having been captured by a longline" is based on turtle survivorship of animals kept in "large aquaculture pools with the aim of estimating the mortality rate of the individuals released with hooks still in their bodies...". The authors of this study did not conduct necropsies to establish cause of death, which is an absolute requirement, nor did they conduct control experiments that would establish whether the captured turtles had a lower survivorship than animals not subject to capture but also held in the tanks. Anyone that has raised sea turtles in captivity knows that they are subject to infections, disease, and other problems that arise from culture. Without addressing all of these concerns, this study cannot be used to establish

survivorship or post release mortality. It would not have passed peer review, and NMFS needs to be honest about using it as "best available science" when it clearly does not satisfy sufficient scientific standards for establishing cause of death. Similarly, the reference to Balaz unpublished data (page 60) on a "44% mortality estimate observed by Balaz (person. comm)" needs to come forward for evaluation. A good scientist cannot simply accept an unsubstantiated estimate for this important issue. Without a report to evaluate, there is no credibility.

The report prepared by Angliss and DeMaster was comprehensive, accurate, and very well done. It clearly sets the agenda for sea turtle/longline interactions, and it should serve as a model and guide for discussion and process for establishing distinct sea turtle criteria. For example (page 4) "Participants stressed that a thorough necropsy is necessary to determine the cause of death of large cetaceans and the degree to which an entanglement may have contributed to the mortality ... (and as a footnote... was stressed for all marine mammals in general)." The section "Collecting data on injuries" was also extremely important and clear on what needs to be done- the same holds for sea turtles: "Workshop participants identified several actions that would improve the data that observers provide on incidental injuries, such as 1) improve the training for recording interactions with marine mammals, 2) include marine mammal scientists in the debriefing... 3) encourage observers to provide more detail...". All of these points are relevant to sea turtle and long line interactions.

Although I've listed some comments above, I look forward to further discussion at our upcoming meeting. Thanks again for the opportunity to weigh in on this issue.

Sincerely,



Molly Lutcavage, Ph.D.
Senior Scientist, ERL

Robert A. Morris, MS, DVM
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November 24, 2000

Mr. Donald R. Knowles, Director
Office of Protected Resources
National Marine Fisheries Service
Silver Spring, MD 20910

Dear Mr. Knowles:

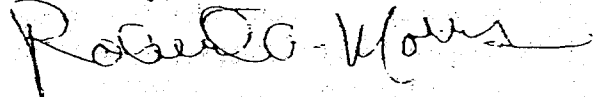
In response to your request on sea turtles and fishing gear, I offer the following observations as a contract veterinarian for sea turtles for the National Marine Fisheries in Honolulu.

1. Some hooks remain unchanged for months in the intestinal tract of turtles with no evidence of dissolving (followed with X-rays).
2. Turtles have been seen with ingested hooks and are apparently healthy. On the other hand, hooks that perforate the G. I. Tract can cause death.
3. Hooked turtles trailing monofilament line can cause serious problems with line wrapped around the flipper, resulting in tissue and bone necrosis. We have done numerous flipper amputations because of this problem. Ingestion of the monofilament line can also cause serious problems to the intestinal tract.

The most important aspect for the survival of hooked turtles is removal of the hook, and if that is not possible, cut the trailing line as short as possible. Any hooked turtle with trailing mono line is in serious trouble.

If you require additional information, let me know.

Sincerely,



Robert A. Morris, MS, DVM



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November 18, 2000



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Dear Dr. Knowles,

I have received the packet of information on the concerned interactions between sea turtles and longline fishing gear. The following comments are my initial reactions to the materials sent in the packet as well as my general sense of the importance of this particular conservation issue. Other than the information you sent, I do not have a good knowledge of this particularly fishery.

Observations:

1. Generally speaking, sea turtles are robust animals and can recover eventually from superficial external injuries such as would occur from a hook that is removed.
2. Physiologically, it is my impression that the leatherbacks are not as resilient hardy as the hard shelled turtles. This is suggested because of softer epidermal tissue, softer heads and beaks, heavier body mass and generally softer bodied food sources. Thus such actions as hooking, lifting from the water, and ingestion of hooks and lines may have more damaging and long lasting impacts on an individual leatherback.
3. Ingestion of a hook and line (depending on size) is likely to have long term impact on survivability of any sea turtle. We see lots of "floaters" in South Carolina. These turtles generally have a peritoneal infection which is causing gas to accumulate in the body cavity. Eventually these animals weaken and die unless treated. While I do not know this for a fact, hooks could be an initial cause of this problem. My concern is that ingested hooks may provide a long term irritant and source of bacterial entry. In addition, if the hook lodges in heart or lung tissue, or results in occlusion of the gut, the turtle may die directly for the event.
4. Leaving several yards of monofilament line hanging from the mouth is another source of potential problem. The line can be fouled and cause drag, swallowed causing an occlusion of the gut or wrapped around a flipper or caught on another object. Feeding will be impaired to some degree depending on several variables.

Recommendations:

1. A physiological study of naturally hooked animals could address some of these concerns. Variables to be evaluated are movement of hooks once the line is cut, impact on feeding ability, changes in stress hormone and reproductive hormone levels and susceptibility to local or internal infections. In an aquarium, under proper medical supervision, animals could safely studied. If and when they appeared to be suffering or taking a serious turn for the worse, surgical and antibiotic treatment could be applied to insure survival and eventual release.
2. Several veterinarians have experience in removing hooks. Their observations and results could be instructive in this regard.
3. Whenever possible, the entire line and any portion of the hook which can be seen should be cut out prior to release of the animal.
4. Additional observer work would seem to be important in zones 5, 6 and 7 and possibly 2.

I believe this fishery interaction is a serious problem for sea turtles.

Sincerely,



David Wm. Owens
Professor and Director
Graduate Program in Marine Biology