APPENDIX M

J.A. Musick, *Comments on Post-Hooking Mortality Estimates used by the National Marine Fisheries Service (NMFS) in its Biological Opinion for the Western Pacific Pelagic Fisheries*

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J.A. Musick

The NMFS finding of jeopardy to sea turtles is based on their estimates of the numbers of sea turtles killed in the Hawaii longline fishery. These numbers in turn are based on *estimates* of post-hooking mortality, because turtles observed dead when captured are rare (according to NMFS itself). Therefore, the accuracy of NMFS post-hooking mortality estimates are crucial to any finding. In the BiOp, NMFS first uses McCracken's (2000) post-hooking mortality rate of 29% for deeply-hooked turtles and 0% for lightly-hooked turtles. The 29% value is based on a study on juvenile loggerheads incidently taken by the Spanish longline fleet within the Mediterranean in which animals with deeply-ingested hooks were held in captivity for several months; the study recorded a mortality rate of 28.9 % (Aguilar et al. 1995). This study was somewhat flawed because no control animals were maintained, and no necropsies were performed on the dead animals to determine cause of death. Apparently no special treatment was given these animals and no veterinarian was in attendance. Thus mortality due to disease, secondary infection associated with captivity, or other factors cannot be ruled out. Therefore the 28.9 % value should be viewed as a maximum mortality estimate for deeply hooked animals. McCracken's use of 0 % post-hooking mortality for superficially hooked turtles appeared reasonable because there was little evidence to the contrary (see below).

Unfortunately, on the following page NMFS adopts a higher mortality estimate of 27% for lightly-hooked turtles and 42% for deeply-hooked turtles. This action was based on a "consensus approach" for estimating sea turtle mortality (NMFS 2001). In reality, NMFS "consensus" approach involved a meeting between Drs. W.W. Fox, D.R. Knowles, and B.C. Morehead. All are able NMFS administrators, but none has expertise on, or experience with, sea turtles. Consequently, they adopted basic post-hooking mortality estimates of 27% for superficially or lightly hooked animals and 42% for turtles with ingested hooks. These values were based directly on satellite tagging studies done off Hawaii and which asserted that turtles that stopped transmitting within thirty days were assumed dead. These studies were seriously flawed because no control animals were used and failures of the Telonics transmitters cannot be dismissed, regardless of NMFS assertions to the contrary (Knowles 2001). The original Telonics satellite transmitters used on sea turtles were developed in part in my laboratory, and my research programs have used successive models to track at least 35 turtles including loggerheads, Kemp's ridleys, and leatherbacks. Transmission failure within 30 days of deployment has been common.

Of eight Telonics transmitters deployed on uninjured loggerheads between 1992 and 2000, two ceased transmission in less than 30 days (Mansfield et al, 2001), and Keinath et al.

reported that of sixteen uninjured loggerheads and Kemp's ridleys tagged with Telonics transmitters, four quit transmitting in less than 30 days. These failure rates (25%) are similar to the failure rate (27%) reported for superficially hooked sea turtles in the NMFS Hawaii study. In a recent study in the Atlantic contracted by NMFS itself, the authors (Riewold et al. 2000) reported transmitter failures in their control animals and stated that "High rates of non-mortality related transmitter failure could preclude the use of transmitter failure as an indicator of turtle mortality."

On three occasions in 2001, I sent letters (Musick 2001 a,b,c) to NMFS apprising the agency of the problems of transmitter failure and falacious mortality assumptions. These communications were ignored. Other scientists with extensive satellite tracking experience also cautioned NMFS about using satellite transmitter failure to assume mortality. For example, writing to Donald Knowles, NMFS Director of Protected Resources, on 8 February 2001, Dr. Molly Lutcavage, Senior Scientist at the Edgerton Laboratory, New England Aquarium, noted:

"NMFS concludes that the nonreporting tags represent post release mortality. Alternative explanations for nonreporting are dismissed with the statement that since Balasz et al had nearly perfect tag reporting rates in previous tagging studies (of nesting turtles or at-sea releases, we don't know which?), there was no reason to identify tag failure as a possible alternative explanation for nonreporting.

In our experience with deployments of satellite tags and pop-up tags (sea turtles, pinnipeds, bluefin tuna), we routinely have sporadic tag component or tag replacement failures, and rare but usually catastrophic batch failures. More often than not, battery failures and damaged antennas are prime suspects. These are all possible alternative explanations for nonreporting tags. The [Knowles] Memorandum states *'We believe the cessation of transmissions within a 1 month period can be considered a minimum indicator of post-hooking mortality in the 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.'* This is a bold statement! My bet is that tag manufacturers would be loathe to substantiate it, since Wildlife Computers, Telonics, and Microwave Telemetry all warn customers that their products fail on accasion, since they cannot control hardware components, battery life, or tag attachment outcomes. Tags also fall off from insufficient curing of epoxies/fiberglass resin, displacement by the turtle itself, or from mating activity. The only citations that the Memorandum uses to support the belief that tag failure, antenna damage, or tag shedding were not possible explanations are personal

communications from the NMFS sea turtle coordinator and the study's first author. It is indeed puzzling that there are no references to tens of published tracking studies that present alternative explanations for nonreporting tags. I'm confused that alternative explanations for nonreporting *were* noted for the Hawaiian longline investigation in Balasz's peer-reviewed paper (Polvina et al). This suggests the authors of the NMFS Memorandum are unaware of these findings, or that that they chose to ignore them.

There were no controls released with hooked turtles in the Hawaiian study, which makes it difficult to evaluate the data that shows that deep hooked and shallow hooked turtles has similar reporting rates. One might expect that the deep hooked turtles would have higher post release mortality. Assuming that a turtle dies some time after release, one would expect that decomposition gases would cause the turtle to float, at least until decomposition was extreme. I witnessed this personally in Chesapeake Bay (loggerhead carcass) and off Florida (greens). The lung is under the carapace, so a bloated turtle should usually float carapace up, becoming a perfect tag radio transmission platform. There is no evidence that the Hawaii study was able to detect "floaters." The Azores study addressed this issue, and Bolton et.al. state that depth data was critical for determination of death. Given that the possibility that some of the Hawaiian tags may have failed or fallen off, it seems unreasonable to me to place so much emphasis on the findings of a 30.6% post release mortality rate. This is not to say that level is not possible with chelonids—but the reliability of this data needs to be viewed with caution."

The authors of the Hawaii study themselves have admitted that "One cannot attribute all these [transmitter] 'failures' to turtle mortality....Failure of transmitters with few to no transmissions could be due to electronics failure of the batteries, possible factory defects in the transmitters, or shipboard conditions causing poor transmitter attachment" (Parker et.al, in press). More recently, (Graves et.al. 2002), in a paper published in the NMFS peer-reviewed journal *Fishery Bulletin*, the authors used satellite tags on pelagic fishes and concluded that "non-reporting satellite tags introduce uncertainty that cannot be quantified in the estimates of post-release survival, thus compromising meaningful conclusions" (emphasis mine).

Satellite tracking studies done with controls on pelagic juvenile loggerheads in the North

Atlantic showed *no* mortality for a small sample (3) of turtles hooked in the mouth and tracked for several months (Bjorndal et al. 1999). In addition, a similar study (Riewold et al. 2000) done with control animals and six deeply hooked turtles found a mortality rate of 16.7 percent (*not* 30% as suggested by the table in NMFS 2001).

The NMFS "consensus" ignored the Aguilar, et al. 1995, Bjorndal 1999, and Riewold et al. 2000 studies and instead used the higher mortality values from the uncontrolled Hawaiian experiments. Thus their scientific mortality estimates may be inflated by 2- to 3-fold.

Outside of the flawed Hawaii satellite studies, there are no data to estimate the magnitude of post-hooking mortality in loggerheads that are superficially hooked. As noted above, the 1999 Bjorndal et al. study in the Atlantic found no mortality on three superficially hooked loggerheads (a tiny sample size). What data are available that might act as a surrogate for experiments on survivorship of loggerheads with superficial puncture wounds such as those caused by a longline hook? Hooks used by U.S. fishers for swordfish and tuna vary slightly in size and configuration, but on average have a diameter of approximately 5mm. They produce small lesions similar in size to those inflicted when a turtle is tagged with a metal flipper tag (diameter approximately 5 mm). NMFS actively supplied these tags to researchers around the world until quite recently, when the Archie Carr Center for Sea Turtle Research at the University of Florida assumed that responsibility. The Carr Center distributes an average of *6000* metal flipper tags each year (Allen Bolton, personal communication) with NMFS approval and support. Hence, one must ask, what kind of logic would suggest that the small puncture wounds caused by the longline fishery are lethal, while each year NMFS-supported tagging inflicts similarly-sized lesions on ten times as many turtles? Clearly, assuming a 27% post-hooking rate for superficially hooked loggerheads is illogical, in addition to being unsubstantiated by any data.

The use of the 27% and 42 % mortality assumptions for leatherbacks in this fishery is perhaps one of the most implausible elements of the Pacific BiOp. This assumption is based on the same flawed satellite tagging experiments carried out on *loggerheads* that for the most part were hooked in the mouth. Examination of the observer data for the period of 1994 - 1999 from the Pacific (BiOp Table IV-6) shows that only one leatherback was hooked in the mouth; most

were superficially hooked in a flipper. The inflated estimates have resulted in high estimates of lethal leatherback takes. There is no evidence that such high levels of lethal takes occurred. The use of spurious post-hooking mortality estimates on leatherbacks based on experiments on loggerheads is unjustified. Even were the loggerhead mortality estimates to be correct, leatherbacks are much larger, stronger, more robust animals whose behavior on longline gear is vastly different. Relative to leatherback longline mortality, Dr. Lutcavage (8 February letter to Knowles) has stated:

"After reviewing all of the longline data and observer summaries in my library (Witzell, Hoey, and a collection of anonymous NMFS reports), I still can't find leatherback interaction records that would suggest that possible serious injury/lethal take would be higher than 15%. While validating observers' species identification from the NMFS NEFSC observer program photo collection from 1994-1997 (for Pat Gerrior), I personally reviewed all observer photos. Most leatherback interactions seemed to be minor/superficial hooking or line wrap, and only a few turtles were wrapped in mono beyond flipper regions. Although there may be leatherbacks that occasionally fouled to the point of immobilization, this seems to be a fairly rare event. At least one of the leatherbacks was photographed on deck, so some captains may be able to deal with extensive fouling if it were to occur.

Based on our studies of the respiratory and diving physiology of leatherbacks, I would concur with Dr. Dave Evans' remarks that in some respects , these turtles are less hearty than other sea turtle species. They have shorter voluntary dive times, higher metabolic rates, and are probably more susceptible to drowning/asphyxiation after shorter periods than large chelonids if forcibly submerged. This is clear from shrimp trawler mortalities, and stranding events in the SE. But large subadult and adult leatherbacks can carry longline gear to the surface and would not be as susceptible to asphyxiation as smaller chelonids. Again, there seems to be little justification of the 50% mortality in the US longline fishery, since observer data suggests that most US LL interactions are with large individuals."

These are the opinions of a highly respected scientist who has worked with leatherback

sea turtles for more than 15 years, yet NMFS has chosen to apply post-hooking mortality rates for leatherbacks of 27% to 42 % with no supporting scientific evidence whatsoever. Clearly, by basing post-hooking mortality estimates on flawed science, the NMFS "consensus" document (NMFS 2001) did not use the best scientific information available. This has led to overestimates of sea turtle mortality and lethal takes and ultimately to a highly questionable finding of jeopardy for the longline fishery.

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