North Pacific Loggerhead Sea Turtle Expert Workshop

December 19-20, 2007
Western Pacific Regional Fishery Management Council, Honolulu, Hawaii USA

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1. SUMMARY

The *North Pacific Loggerhead Sea Turtle Expert Workshop* was convened jointly by the Western Pacific Fishery Management Council (WPRFMC) and NOAA Fisheries in Honolulu, Hawaii on December 19-20, 2007 at the office of the WPRFMC. The workshop provided a forum to highlight and facilitate the exchange of current research information on North Pacific Loggerhead sea turtles to inform management authorities of the Hawaii longline swordfish fishery.

A range of current research and pertinent topics relating to loggerhead turtles was presented at the workshop to help fishery managers with upcoming evaluations of the fishery under the National Environmental Policy Act and Endangered Species Act. Information included: population biology and nesting dynamics, oceanography and pelagic habitat utilization, population genetics, fishery bycatch and other anthropogenic impacts, policy and management, conservation and recovery efforts, and various methods in population assessments.

Additionally, a comprehensive list of reference documents was compiled prior to the meeting that was available to workshop participants on CD. These documents included information that was both presented at the meeting as well as additional documents relevant to current research and/or information regarding North Pacific loggerhead turtles.

The Council, together with the Sea Turtle Association of Japan (STAJ), has been supporting beach mitigation efforts in Japan since 2004. The workshop participants recommended that the Council Turtle Advisory Committee prioritize expanding the Council's scope for sea turtle conservation support to investigate bycatch in Japanese coastal fisheries, for example, by supporting graduate students.

Workshop participants identified priority research areas and conservation activities to address information gaps necessary to better understand North Pacific loggerhead: (i) population demography; (ii) population-level effects from anthropogenic activities; and (iii) inputs for risk assessment models. Main research and conservation priority activities included:

- **COASTAL FISHERY BYCATCH:**
  A greater understanding of *teichiami* [pound/pond/trap nets] in Japan is urgently requires. Do small pound nets have an open or closed (mid water/bottom) capture chamber? What are the impacts of large nets? STAJ has begun investigating coastal fishery impacts in three locations, but *teichiami* fisheries operate throughout Japan and their relative impacts to turtles is a critical requirement.
  Information is needed regarding fishery bycatch of loggerhead turtles in coastal fisheries in the South China Sea.
  Encourage gear technology experts to conduct experiments and commercial demonstrations of methods to reduce gillnet/turtle interactions.

- **RISK EVALUATION:**
  STABLE ISOTOPE ANALYSIS: Stable isotopes analysis of Baja/Japan/North Pacific loggerhead turtles may assist in quantifying risk assessments in these habitats.
  BAJA POPULATION SIZE: In regards to risk evaluation, how many loggerheads are in Baja? What percentage of the overall population does this represent?

- **JAPAN NESTING BEACH THREATS:** A spatial risk assessment of Japan nesting beaches is needed to quantify the impacts from beach armaments, nearshore costal fisheries, development, etc. What happens to females that are prevented from nesting by beach armaments?

- **GENETIC RESEARCH:** Encourage increased genetic research/sampling/investigations of the nesting population in Japan. This can be undertaken by supporting graduate students in Japan to analyze archived samples, and collect additional samples to expand geographic coverage to initiate an archipelagic wide study.

- **RECRUITMENT:**
  1) Obtain a greater understanding of the migratory link and recruitment between the pelagic population and coastal Baja population.
  2) Size frequency distributions will provide a link in understanding recruitment. Investigate the potential source of the documented change in the turtle size (CCL) of Baja strandings.

- **GROWTH RATES:** Growth rate data is needed for the stock. Obtaining humeri from stranded turtles for growth rate analysis.

- **MITIGATION TRADE OFFS:** Undertake theoretical work regarding offsetting or mitigation tradeoffs.

- **EFFECTIVENESS OF TURTLE WATCH:** Obtain and understanding of the Hawaii longline fishery's acceptance/perceptions of TurtleWatch. Has a voluntary change in fisheries behavior been observed based on the information provided by the program?

Participants identified the following sources of additional information on North Pacific loggerheads:

- **POST-RELEASE MORTALITY:**
  In 2008, the Hawaii-based longline fishery observers on shallow-set boats will begin double tagging any incidentally captured turtles with two satellite tags to help with research efforts to better quantify post hooking mortality while addressing or minimizing gear failure errors.
  An upcoming 2008 study by Epperly & Sasso in the Azores longline fishery is geared to provide a better understanding of the post release mortality of deep-hooked vs. control caught turtles.

- **FISHERY BYCATCH:** SEAFDEC may be a source for potential fishery bycatch information in the South China Sea.

- **GRAY LITERATURE REVIEW:** While there is not much to glean from the Western and Central Pacific Fishery Commission (WCPFC) or International Scientific Committee (ISC) bycatch working groups, there are "gray" bycatch papers from various Asian countries summarized in ISC working papers.

- **COMPILE & TRANSLATE LITERATURE:** Work with the Sea Turtle Association of Japan (STAJ) to identify, compile, and translate recent genetic research from graduate research studies, and any published Japanese documents regarding bycatch assessments or gear/fishery descriptions.

2. AGENDA

1. Introductions (Chair Jeff Polovina/Paul Dalzell)

2. Background fishery information (Paul Dalzell)

3. Analysis of Hawaii-based shallow-set longline fishery turtle interaction rates (Eric Gilman)

4. Post-release mortality of loggerheads caught in pelagic longline fisheries (Yonat Swimmer)

5. Pelagic habitat characterization of North Pacific loggerhead turtles (Don Kobayashi)

6. An update on TurtleWatch (Evan Howell)

7. Fishing Opportunities under the Sea Turtle Bycatch Caps (Shichao Li)

8. North Pacific loggerhead sea turtle status:
   a. NOAA's ESA loggerhead sea turtle 5 year review: Summary (Brandee Gerke)
   b. Population genetics (Peter Dutton)
   c. Japan
      i. Current nesting information & conservation (Yoshimasa Matsuzawa/Irene Kinan)
      ii. Coastal bycatch investigations (Ishihara)
   d. Baja
      iii. Hotspots of loggerheads based on NOAA aerial surveys (Tomo Eguchi)
      iv. Foraging demographics & bycatch analysis (Hoyt Peckham)
      v. Conservation efforts - status of Fisherman's Turtle Reserve (Hoyt Peckham)

9. Population modeling – varying approaches for characterizing population trends:
   a. Long-term temporal and spatial trends in loggerhead turtles (Milani Chaloupka)
   b. Quantitative tools to assist in jeopardy evaluation for sea turtles (Selina Heppell)
   c. Assessment of population-level impacts to loggerhead turtles resulting from potential increases in Hawaii-based longline fishery interactions (Melissa Snover)

10. Discussion & Research recommendations (Chair)

11. Other issues & Meeting wrap-up (Jeff Polovina/Paul Dalzell)

3. PRESENTATION ABSTRACTS AND DISCUSSION

A. Background fishery information. Paul Dalzell

Longline fishing in Hawaii began at the start of the 20th century and was established by Okinawan migrants to Hawaii who adapted a Norwegian method of pelagic longline fishing. Longline fishing activity after reached an apex after World War II and was on slow declining trajectory between the 1950s and 1980s. However from 1987 onwards the fishery switched from local coastally-based, wooden sampan type longline fishery, to large, steel-hulled vessels fishing many miles offshore. The fishery increased very rapidly in the late '80s to a peak of about 140 vessels by the early 1990s, then declined slightly and oscillated to about 120 to 125 vessels since then. The swordfish segment of the Hawaii fishery operated in an unconstrained manner until 1999, when litigation forced major management changes, initially area closures, and ultimately an outright closure in 2001, due to interactions with sea turtles. The introduction of large (18/0) circle hooks and mackerel type bait allowed the fishery to reopen in 2004, with 100% observer coverage, an effort cap of 2120 sets (50% of the 1994-1999 annual average), and hard caps on loggerhead (17) and leatherback (16) interactions. The fishery has operated each year since 2004, with a closure in 2006 after the loggerhead cap was attained. Sea turtle interaction rates in the swordfish fishery have been reduced by over 90%.

Discussion

Initial discussion of Dalzell's presentation focused on whether or not 100 percent observer coverage would be possible in the swordfish longline fishery if effort increased. Dalzell noted that the Hawaii Longline Association (HLA) had included the maintenance of 100% observer coverage in its petition to the National Marine Fisheries Service (NMFS), but it would be up to the NMFS Pacific Islands Regional Office (PIRO) to respond on the feasibility of 100% coverage at higher levels of fishing effort. Bill Robinson, the NMFS Pacific Islands Regional Administrator stated that at present, the observer program costs about $5.00 million dollars at the existing level of effort. Currently, NMFS PIRO does not have additional appropriated funds to provide for increased observer coverage, and this would be a an issue that would require careful consideration.

Further discussion focused on the fate of sharks caught in the shallow set swordfish fishery. Paul Dalzell responded that in the past, as many as 60-65,000 sharks were finned and the bodies discarded. However, with the passage of the 2001 Shark Finning Act, finning ceased in the fishery. At present, sharks are released and the majority, 90-95% are released alive. Dalzell added that there was very little market for shark flesh in Hawaii. However, there has been a small increase in the landings of thresher and mako sharks, but these species only make up about one or two percent of the shark catches. Almost the entire shark catch is comprised of blues sharks.

There was also discussion about the foreign longline fishing effort around Hawaii and how much of this was targeting swordfish. Chris Boggs confirmed that to the north of Hawaii were distant water fleets of Taiwan, Korea and Japan targeting albacore and bigeye tuna. It was noted that there are swordfish targeting fleets operating from home ports in Taiwan and Japan, which fish

in the western part of the Western and Central North Pacific Ocean. However, the large distant water fleets operating across the North Pacific also catch swordfish incidentally.

Dalzell also responded to a question concerning reporting of catches by foreign longline fleets. Dalzell stated that the information presented in this workshop was compiled by the Oceanic Fisheries Program of the Secretariat of the Pacific Community (SPC-OFP). SPC-OFP have estimated that over the past 20 years they have been able to compile between 70 to 80 percent of the entire fishing effort in the Central and Western Pacific. If vessels are fishing within the EEZs of member countries of the SPC, under some bilateral arrangements, then they have logbooks and they have to submit to that country and these or the data therein are passed on to the SPC-OFP. Dalzell was uncertain about data provisions for the distant water fleets fishing on the high seas. However, all fishing nations that were members of the Western & Central Pacific Fisheries Commission had obligations under the Convention to provide fishery data to the Commission.

B. Analysis of Hawaii-based shallow-set longline fishery turtle interaction rates. Eric Gilman and Donald Kobayashi

To reduce turtle interactions, regulations for the Hawaii-based longline swordfish fishery, which came into effect in May 2004, required vessels to switch from using a J-shaped hook with squid bait to a wider circle-shaped hook with fish bait. We analyzed observer data to understand the changes in sea turtle interactions since the introduction of the regulations through the end of the first quarter of 2007. Following the introduction of the regulations, significant and large reductions in sea turtle capture rates occurred. Capture rates of combined turtle species, leatherback and loggerhead turtles significantly declined by 89%, 85% and 90%, respectively. Sea turtle catch rates during the first quarter of 2007 were similar and not significantly different from turtle catch rates during the other periods since the turtle regulations came into effect. Since the introduction of the regulations, there has been a highly significant reduction in the proportion of turtles that swallowed hooks into the esophagus or deeper (deeply hooked, versus being hooked in the mouth or body or entangled) and a highly significant increase in the proportion of caught turtles that were released after removal of all terminal tackle, which may increase the likelihood of turtles surviving the interaction. During the pre-regulation period, 53% (111 of 211) of caught sea turtles were deeply hooked, while 12% (6 of 51) were deeply hooked in the post-regulations period. During the first quarter of 2007, all 14 caught sea turtles (12 loggerheads, two leatherbacks) were lightly hooked. During the pre-regulations period, 60% (106 of 178) of hooked turtles were released with terminal tackle attached, while 26% (12 of 47) were released with terminal tackle attached in the post-regulations period. During the first quarter of 2007, one of the 14 (7%) caught sea turtles was released with terminal tackle attached.

Discussion

Chris Boggs led off the discussion with some comments on circle hooks. He noted that the circle hook has an effect on leatherbacks as well as on loggerhead turtles. But the effect was not to reduce deep hooking per-se, which is the normally described effect of the large circle hook on loggerheads. Circle hooks reduced all kinds of capture of leatherback, basically across the board and this cuts back leatherback captures. This was very important since some critics of circle hooks criticize the idea that circle hooks reduce turtle capture and suggest all that is happening is a change in how the turtle gets caught. The European Union (EU) continues to

claim that circle hooks only change turtle catches from deep to shallow hooking, and have no effect on reducing sea turtle bycatch. Further, the EU claim that the reduction in bycatch of hard-shelled turtles is due to the hooks' increased size and not its shape. However, the reduction in leatherback captures, which are usually not deep-ingesting the hook, has a beneficial effect in reducing bycatch, and is a strong indication of the efficacy of the circle hook.

Chris Yates asked if the suite of circle hook experiments that have been conducted showed any changes in the size of the turtles that have been captured with the different size circle hooks. Eric Gilman responded that this had been investigated for the Hawaii fishery, and no significant difference was found in the size of turtles captured. There was a small difference in the average size but this was not statistically significant. It was noted that the success of mitigation programs like the circle hooks also had a negative impact on the ability to conduct statistically meaningful experiments since the numbers caught were now very small.

Selina Heppell asked about the fishermen's perceptions of the changes since circle hooks were introduced. Gilman responded that most of the fishermen he had interviewed did not have any perception of the observed changes from the analysis of the observer data. They did not notice that they had a slight increase in swordfish catch rate and a decrease in the other species. As such, they would not have an inference of what is causing it. Gilman noted in this study they were very careful to state that the results inferred the effects of the change in hook and bait, because there were other differences confounding factors between the two periods. Gilman noted that measures to reduce seabird interactions came into effect in 2001, and as such there were differences in fishing methods and gear that have occurred that could affect turtle interaction rates.

Chris Boggs added that this caution is based on being rigorously scientific as opposed to there being any specific hypothesis why those other changes would have contributed to the differences. The differences that were seen are exactly the qualitative changes that would be expected of beforehand from the use of those gears, because they were tested in other places and had exactly those effects. The use of fish bait and the use of large circle hooks have been tested in several other swordfish fisheries around the world and each time it's tested it qualitatively has the same effect. Consequently, being cautious as why these changes occurred in Hawaii is rigorous and appropriate, but there is no outstanding alternative hypothesis for why things changed the way they did, and other research has shown the same result that it's due to the effect of the circle hook and the fish bait.

Paul Dalzell commented that the whole issue of turtle versus fish catch was on of gear selectivity. All fishing gears are selective to some degree, and the virtue of the circle hook experiments was showing that hook selection continues to be a worthwhile area of study. There have been differing views, for example, on the impacts of circle hooks on shark capture. Further, the use of large hooks may have another spin-off benefit in reducing seabird takes in the swordfish fishery.

There was further discussion on the use of circle hooks and how predominant they were in the tuna deep-set fishery in Hawaii. It was noted that the albacore targeting tuna longline fishery in American Samoa is a circle hook fishery, although on which used smaller (14/0 and 16/0) hooks as opposed to the 18/0 hooks used in the Hawaii swordfish fishery.

C. Bayesian hazard regression modeling of factors affecting post-release mortality of loggerhead sea turtles caught in pelagic longline fisheries. Yonat Swimmer, Milani Chaloupka, Lianne McNaughton, Michael Musyl and Richard Brill

Pop-up satellite archival tag (PSAT) telemetry deployed by 2 observer programs was used to estimate post-release mortality of loggerheads caught between 2002 and 2006 in a North Pacific US-based pelagic longline fishery. A PSAT that detaches and reports prior to its scheduled date (premature report) is considered indicative of an apparent turtle mortality. The premature report rate for 29 PSATs was 50% within 53 days post-deployment, which suggests a high apparent mortality rate. Time-to-report for the PSATs was modeled using an extended Cox-type semi-parametric hazard regression approach to identify any covariates affecting apparent post-release mortality. Covariates or risk factors included observers and program deploying the PSATs, date and geo-location of PSAT deployment or detachment, turtle size and hooking severity (shallow, deep). Nonlinear and time-varying covariate effects were modeled using Bayesian P-splines and varying-coefficient techniques. Spatial effects were treated as correlated random effects estimated using a 2-dimensional P-spline surface smoother. Individual heterogeneity associated with each PSAT (or loggerhead) was treated as a random effect. The time-to-report data were subject to censoring mechanisms including right censoring and left truncation (or staggered entry) that was accounted for explicitly. Models of increasing complexity were fitted using mixed-model estimation (empirical Bayes) and AIC-based model selection. The best-fit model included a monotone increasing log-baseline hazard rate (PSAT "aging" effect) reflecting increasing probability of apparent post-release mortality, a declining hazard rate over the 4-year study (perhaps reflecting improving PSAT technology or turtle handling procedures), a hazard rate that was a time-varying function of hooking severity (a non-proportional hazard) and a spatially dependent hazard reflecting westward movement for longer surviving PSATs. However, time-depth-temperature profiles from PSATs with recoverable data showed that only 2 of 21 loggerheads might have died subsequently from any gear-induced injuries — an inferred post-release mortality rate ca. 9.5% (95% CI: 1-30%). The significant discrepancy between apparent and inferred post-release mortality reflects PSAT equipment and/or attachment failures.

Discussion

Chris Yates asked at what point Swimmer and her collaborators would think that the current post-hooking mortality guidelines should be re-evaluated. Swimmer responded that there will be additional information in about a 18 months time. The NMFS Southeast Fisheries Science Center was planning to better assess deeply-hooked animals in comparison to controls, and that work is scheduled for next summer (2009).

Selina Heppell asked if there was any indication if post-release mortality death may be attributed to increased predation risk as opposed to just simply dying from injuries received from hooking. Swimmer responded that but there was a study showing increased predation risk for animals that have satellite devices hanging off their bodies, and that this was related to some shark work. However, this was still speculative. Heppell also noted that the dive profiles for turtles which were judged to have died following release made shallower dives. Was this potentially an indicator of a sick animal? Swimmer responded that this was a difficult issue. The turtles were all tagged in the same area so there should not be any bathymetry difference. But she indicated that the profiles would be given more scrutiny. The raw data would be filtered by

incorporating the sea surface temperatures, to obtain a much better idea of turtle movements and a better refinement and resolution of the data.

Heppell asked why there was this ongoing concern about deep versus shallow hooks if there was a general movement to transition to circle hooks. Swimmer reported on contacts with Spanish colleagues which indicated that hooks swallowed by loggerhead turtles were expelled with reduced injury. However, she still believed that this was a valid distinction.

Heppell suggested that given the limited funding support for work of this kind whether research should be focused on other questions. Chris Boggs noted, however, that much of the world's longline fisheries still do not use circle hooks. One of the chief objections in the international arena, stemming primarily from the EU, was the argument that it was size that has been reducing turtle hook capture, and not circularity, thus not accepting the case for using circle hooks. The response from US scientists was that it was apparent from every single experiment comparing circle hooks to other types that they change where they're hooked and that alone has value.

Peter Dutton noted that the comments made here at this meeting seemed to confirm anecdotal accounts that deeply hooked turtles could handle and pass fish hooks through their digestive tracts. Was there the potential to conduct more work on holding animals in captivity and observing what happens after they've been hooked? Swimmer noted that she and her collaborators had long been interested in this type of work, but that US funds could not be associated with this type of investigation, due to restrictions on how the money might be spent. Instead, the approach taken had been to remain abreast of research elsewhere on observations on captive animals, and to encourage other nations to conduct this work.

George Balazs added that this was an ethical dilemma when a captive animal is known to have a hook embedded within it and no efforts are made to remove it, but simply make observations. This issue was one which stemmed not only from the strictures of federal statutes but included state and university funding and even publication in scientific journals of the results of this type of work. Balazs also asked Swimmer about the details of the satellite tag attachments, which Swimmer responded was fiberglass. Balazs made additional comments on future work to be conducted with electronic tagging, which would, include double tagging with tags having alternate duty cycles to increase the duration of tracking. Moreover, if both tags fail at the same time it may be a clearer indication of mortality.

Chris Boggs referred back to the issues of keeping hooked turtles in captivity. He noted that a Spanish veterinarian, Mary Louise Parga has the opportunity to look at captive turtles that have been caught and seeing what happens to them. According to Boggs, this researcher is considering the issue of whether the negative impacts of jaw hooking are worse than hooking deeper in the esophagus. This works would feed into the debate about hook retrieval from hooked turtles. There was additional discussion of examples of objects being passed through turtles and of research presented at the WCPFC Science Committee by the Japanese that deeply hooked turtles kept in captivity would shed the hooks

D. Pelagic habitat characterization of North Pacific loggerhead turtles. Donald Kobayashi

Satellite track data for 186 loggerhead sea turtles in the North Pacific Ocean was analyzed using remotely-sensed environmental data to characterize pelagic habitat. A large number of candidate habitat variables were merged to the satellite track data and statistically compared to background values over a large spatiotemporal grid which bounded overall occupancy. Five statistically significant variables were identified out of the 16 environmental variables examined. Two of these variables have strong seasonal, interannual, and spatial patterns (sea surface temperature and chlorophyll a concentration), while three others were primarily spatial (earth magnetic force, earth magnetic declination, and earth magnetic inclination). Habitat selectivity for these variables was quantified using preference curve methodology established in the foraging literature. The output from the selectivity curves was used to predict a multivariate loggerhead sea turtle habitat index across the pelagic North Pacific. T 47 his predicted habitat was ground-truthed with newly available satellite track data.

Discussion

Eric Gilman asked how much of an overlap was there between some the different oceanographic parameters, like sea surface temperature and chlorophyll? Kobayashi responded that there was a very strong overlap; with some so tightly correlated it would be virtually impossible to tease them apart. Experimental work in the field may possibly start to address this but Kobayashi noted that its not possible to do this just from the observational data collected to date.

Tomo Eguchi sought more clarification on magnetic field as a habitat variable. Kobayashi explained that the magnetic field data changes slightly over time and was not a static field. It is a potential descriptor of navigational quality for the habitat. If a certain region has a enhanced properties for an animal to navigate through it, then some evolutionary response may key in on that area as preferred habitat because it is feasible to navigate through that habitat based upon knowledge of declination, inclination or total force. This was a very speculative line of investigation and more work was needed on this. Kobayashi emphasized that it was an index of navigational quality for the habitat.

Irene Kinan asked if the tagged turtles in this work were also included in other data sets such as those presented earlier by Yonat Swimmer. George Balazs responded that different types of tags were deployed in the two studies and that PSATs do not provide very detailed locational information and movements. Kobayashi added that the quality of the position data from the ARGOS tag goes through a very exhaustive process of screening. Only the best position data was used and the positions are based on double tag work. It very different to data from fish with electronic tags, where positions were not really understood until the data is filtered through some complex algorithm. Turtles were more straightforward since they spend most of their time at the surface. Swimmer added that part of the work with PSATs, the use of the common filter by incorporating the sea surface temperature greatly improves the accuracy of the light-based geo-location raw data. As such, the ARGOS data were the highest quality, but there are also additional ways to improve on this accuracy to conduct similar analysis of oceanographic associates even with animals tagged with a PAT tag. Jeff Polovina noted that work with whale sharks using ARGOS and PAT tags on the same fish showed that once sea surface temperature was corrected for the PAT tags gave remarkably similar results.

Elizabeth Petras asked if similar work had been conducted on Pacific leatherbacks. Was there the same quality of tracks for leatherbacks across the North Pacific? Peter Dutton answered this question stating that as more leatherback turtles have been tagged it was clear that the variability of the tracks was presenting all kinds of problems. However, developing predictive

models for leatherbacks that are useful for fishery management is clearly a high priority for the NMFS turtle program. As such, work was being conducted trying to quantify some of the errors associated with ARGOS locations and also errors that are instrument-related, i.e. that arise from tags being made by different manufacturers. Dutton noted that there were a whole new generation of GPS tags are being produced but that finer-scale GPS locations were more costly to battery life.

Chris Boggs asked if some of the tags were indicative of turtles being on fishing vessels, and this generated discussion among participants about this issue, but they was not any firm conclusion either way.

Jeff Polovina noted that one of the main findings out of all of this pelagic work, was a reassessment of the original loggerhead paradigm, which was that turtles left Japan and traveled across the Pacific and all piled up on Baja. However, it is apparent that there are large numbers of animals on the coastal habitat in Baja, but there are a lot more loggerheads that just remain in the pelagic environment for years if not decades.

Hoyt Peckham added that there was no clear idea where the turtles in Baja come from. Some of the turtles that leave Baja, and make a beeline west and go right through the Hawaiian Islands. There were about 30 tracks for these turtles which were not yet in the dataset and may yield some more information.

Chris Boggs asked if there were now clear habitat definitions for loggerheads and not for other turtles. Peter Dutton agreed with this characterization. He added that data from Chile Interestingly, we're looking at data off Chile with a comparable temperate area was showing a very similar story analogous to the North Pacific, where there are associations with temperatures of a much more defined habitat. However, leatherback distributions were much more varied and it was more difficult to tease out a fishery-independent component. Boggs continued that this had led to investigation of the potential for time/area options for fishery management with loggerheads that were likely to possible for leatherbacks. However, the limiting factor in the management of the present fishery is loggerhead bycatch and there is an opportunity to use the habitat and time/area information to make a difference in this fishery.

E. An update on TurtleWatch. Evan Howell

Operational longline fishery characteristics, bycatch information, and loggerhead turtle satellite tracks were used in conjunction with remotely-sensed sea surface temperature data to identify the environmental area where the majority of historical loggerhead turtle bycatch occurred during 1994 -2006. The majority of shallow longline sets and associated loggerhead turtle bycatch were in the first quarter of the year above 28ºN, which corresponds to the area near the North Pacific Subtropical Frontal Zone. Based on the thermal ranges of bycatch, sets, and the satellite tagged turtles, it was recommended that the deployment of shallow sets be in waters warmer than 18.5ºC (~65.5ºF) isotherm to decrease loggerhead turtle bycatch. This recommendation was the basis for the TurtleWatch product, which was released to fishers and managers in electronic and paper format on December 26, 2006 to assist in decision making during the first quarter of 2007. Fishery information from 2007 was later compared with data in the years 2005-2006 to assess the response of the fishery to TurtleWatch. The observed fleet response during the first quarter of 2007 was to the north of the 18.5ºC (65.5ºF) isotherm, (in

bycatch rates. Possible reasons for this decrease in turtle bycatch north of the frontal zone are discussed along with future research directions leading to possible refinement of the TurtleWatch product.

Discussion

Hoyt Peckham expressed admiration for the TurtleWatch product. He asked Evan Howell if the fishermen had opted to go south rather than north based on this product. Howell noted that fishermen had opted to go north and explained the possible reasons for this decision. Howell suggested that the larger vessels could make the northern voyage into the rougher waters of the North Pacific where they could stay out longer and stockpile swordfish. Peckham asked if a similar product could be developed for leatherbacks. Howell responded that such a product would be dependant on finding some form of similar relationship.

Howell commented further on the potential for TurtleWatch for fishery management and to possibly conduct some form of dynamic time/area closure measures. There was also discussions about swordfish habitat, and that there was a strong association with the frontal features in the swordfish fishery. Swordfish were following squid as prey and in the first quarter of the year moving south to spawn which is why there was such a tight association with the sub-tropical frontal system. Fishery independent data such as tagging swordfish suggests that fish are moving to west-east from California and a north-south seasonal movement associated with the frontal system in the first quarter that breaks up in the second quarter. There was discussion about whether separations of swordfish and turtles could be found that might improve fishery management. However, in the first quarter of the year it still appeared that turtles and swordfish were pretty much on top of each other within the convergence zone. However, the fishery independent data shows that there are plenty of swordfish north of the convergence zone. Vessels that can fish that far north catch very large swordfish and catch rates are very high.

Jeff Polovina noted that the fleet dynamics suggested that the fleet pretty much ignored the TurtleWatch product early on, But as the numbers of turtles started to rise, the fishermen may well have started to pay more attention and shift further south.

Paul Dalzell asked if this product was going be produced in Vietnamese. Howell reported that this was planned and indeed it is now being produced in two languages.

There was also some discussion about sea surface temperature measurements being made by observers band how this was being improved for accuracy. It was also noted by Lewis VanFossen that captains and fishermen monitored temperatures rather than latitude and longitude. Finally, there was discussion about additional management measures to modify fishermen behavior if the fleet was approaching turtle caps. Eric Kingma stated that these types of additional measures were being considered in an Environmental Impact Statement and a draft amendment being drafted for consideration by the Council and the Fisheries Service.

F. Fishing Opportunities under the Sea Turtle Bycatch Caps. Shichao Li

This study constructs a spatial bio-economic model to support decision making process for the Hawaii-based longline swordfish fishery management. We apply Generalized Additive Models (GAMs) to the Hawaii longline logbook data to examine and predict sea turtle interactions in response to changes in spatial and temporal distributions of fishing effort and oceanographic conditions. A cost function is built into the model for economic analysis to estimate net revenue returns. Through simulation analysis of time and area closures, this research provides a tool to assess the tradeoffs between sea turtle interaction reductions and economic returns under different policy options including the current federally mandated caps on sea turtle interactions. The model can be extended to explore potential modifications to the existing regulations for the Hawaii-based longline swordfish fishery.

Discussion

Chris Boggs sought clarification that fishing further to the east is more costly, while Eric Gilman asked about the data that was used to validate the model. Li responded that the model showed that fishing to the east was more costly and that a regression model was used to see which variable contributed to the costs, which included fishing days, the distance, set type and the vessel size. Eric Kingma asked if increases in CPUE from the use of circle hooks had been taken in to consideration since theoretically there maybe an increase in revenue over historical levels based on the number of sets. Li responded that this was why the whole time period for economic returns from 1994 to 2006, because there's no similar research.

Chris Boggs suggested a note of caution in interpreting increases in CPUE being due to circle hooks and mackerel bait and not to other factors such as lower fishing effort or temporal differences between the current fishery and the fishery in the 1990s.

Jeff Polovina asked if fuel costs were a major component of the operating costs, and if there was likely to be a change in the spatial dynamics of the fleet in response to these higher fuel costs? Minling Pan answered that fuel costs amount to about 60-70% of the trip costs.

Peter Dutton noted that in the South American longline fishery area closures in the north of Chile are acceptable to the fishermen because fishing in a different area, even though the catch is lower, results in larger and better quality fish that offsets economic loss. I don't know if that is a nuance that you've noticed. Li responded that they were investigating how the auction piece value varied from which location and season. Currently the model only uses a monthly different species value from auction monitoring. But in fact in the future research, we will do the piece value from different locations, different vessels and different seasons, making these three elements combined will much more accurately reflect the economic returns.

Chris Boggs sought clarification on whether the model included both segments of the longline fishery, i.e. both tuna and swordfish. Li responded that the observer data included both deepset and also shallow set, but the GAMS model was used only the prediction for shallow-set was used for this kind of research.

Boggs noted that there had been a lot of speculation that that low CPUE area straight north of Hawaii, where the swordfish catch in the old years was better to the east and to the west, was localized depletion, in the closest fishing ground. The reason that this may not be observed in more recent years was because fishery has thinned out. However the interesting reult from the model was that if a closure was implemented, it predicted a higher economic yield because it pushed people to the east and west, where the assumptions was this might not be something

that would persist over time. So that prediction that the closure would increase economic yield is probably not a very reliable one.

Li replied that he and colleagues had noticed this result and that this seemed to that movement east and west resulted in higher CPUE, possibly because the effort in these areas was not usually very intensive.

Jeff Leppo sought clarification on what the model purported to show, admitting that he was unclear about the conclusions. Li responded that the model allows the testing of any kind of fishing pattern and how this influenced economic returns versus sea turtle interactions. Secondly, the model allows testing the economic returns of a time/area closure and seasonal variations in fishing intensity.

Minling Pan added that she and Li had a discussion about the conclusions, and how to present them. She stated that this model is just a simulation model, but it could be used to give more insight for the decision-makers if they want to choose one option or the other, concerning the estimated economic return and the sea turtle interactions. I

Jeff Leppo stated that it was unclear to him this study was looking at how small changes in economics could radically affect participation in the fishery. Secondly he thought that there was merit in the comments about mixing data from 1994-2000 with that from the current fishery. Lastly, it was unclear to him how much turtle conservation was being achieved?

Minling Pan responded that the economics margin being considered in the model was just net revenue. If the fixed costs were considered, the fishery has a very narrow profit margin, But so far the fixed costs were not included in the model, and adding these would improve the model. The second point, you consider about the historical pattern. Pan also clarified the use of historical data to determine the effort distribution by month and the risk of sea turtle interactions by historical average. Lastly, the model is a way to add some more realistic economic information to the previous time/area closure that helps evaluate the impact of different time/area closure scenarios that might be required in the future.

G. NOAA's ESA loggerhead sea turtle 5 year review: Summary. Brandee Gerke

Preliminary information indicates that an analysis and review of the loggerhead should be conducted to determine the application of the DPS policy to this species. Since the original date of listing the species, a substantial amount of new information has become available on population structure, nesting and foraging distribution, movements, and demography. These data appear to indicate a possible separation of populations by ocean basins; however, more in depth analysis is needed. The current US Government recovery plan was completed in 1998.

Discussion

George Balazs noted the delay in getting the 5-year review completed, and that it had actually taken 12 years since the recovery plans had been drafted for the review to be conducted. Balazs also noted the conundrum arising from the completion of the review and a

recommendation of 'no change' with the NMFS finding that a recent petition[1] to reclassify loggerheads from threatened to endangered was warranted.

Brandee Gerke responded that it may not be as inconsistent as it first appeared. The status review was taking place on the species as listed as a global entity, and the status review made recommendations in the status review on the issue of discreet population segment (DPS) policy be evaluated for all of the species. As such, NMFS was planning to make an evaluation of the DPS policy for all sea turtle species, and the petition accelerated that process significantly.

Jeff Leppo gave a legal perspective on the status review and on the recent petition and suggested that there was low threshold for the petitioned action to be warranted. He reiterated that there are two discreet element of the petition, one being the DPS and the designation of a separate North Pacific population, the other being the reclassification of North Pacific loggerheads from threatened to endangered. Chris Yates added that since the status review indicated a need to consider DPS, it was difficult for NMFS to deny that the petition be evaluated. Yates added that the a petition is either accepted or denied in whole, so NMFS could not simply going to look at the DPS part and not at the listing status part.

H. Genetic Stock Composition of Loggerheads (Caretta caretta) encountered in the Hawaii-based Longline Fishery using MtDNA analysis. Peter Dutton

A total of 158 tissue samples have been collected by fishery observers in for the Hawaii-based longline (HLL) fishery between 1996-2007; of these samples, 158 have been analyzed to date at the Marine Turtle Molecular Genetics Laboratory at the Southwest Fisheries Science Center in La Jolla, California.

The results show that loggerheads encountered in the HLL fishery are from the North Pacific genetic stock comprised of nesting populations in Japan. Three haplotypes have been identified based on ~380 bp sequence data from the mtDNA control region (Bowen et al. 1995). One of the mtDNA haplotypes found in eight of the HLL animals that was previously thought to be from Australia is now known to occur in low frequency in Japan (Hatase et al. 2002). Based on frequency analysis and also based on preliminary data from microsatellite (nuclear) markers (Dutton et al. 1999), we now conclude that these animals are from Japan. All samples are being re-sequenced with new primers that amplify ca. 900 bp of the mtDNA control region to detect additional variation. Hatase et al. (2002) reported evidence for population sub-structuring among four key nesting populations in Japan, which shows a significant haplotype frequency shift between Miiyazaki (in the north) and the southern locations. We explored using the data from Hatase et al (2002) as a baseline for analysis to estimate stock contributions of the three potentially different stocks within Japan identified in Hatase et al. (2002) as potential source stocks (Pella and Masuda 2001). We combined the data for the two nesting sites that were not differentiated in the Hatase et al study (Minabe and Fukiagehama), however we raised concerns

[1] On July 16, 2007, NMFS received a petition from the Center for Biological Diversity and the Turtle Island Restoration Network requesting that loggerhead turtles in the North Pacific Ocean be reclassified as a DPS (see Petition Finding for discussion on Distinct Population Segments) with endangered status and that critical habitat be designated (see Federal Register, Vol. 72, No. 221, Friday, November 16, 2007, 64585-64587

with regard to the evidence for population sub-structuring based on these published data (Hatase et al. 2002).

Results of the mixed stock analysis indicate the putative southern stock at Yakushima as the primary source of loggerheads encountered by the HLL fishery, with a mean estimate of 85.7% (51-99.9% confidence limits). The northern stock of Miyazaki was estimated to contribute 5.2%, with confidence interval ranging from 0-27.9%. These results should be treated as exploratory in nature and not over-interpreted, since the baseline data available for the structure of the Japanese nesting stock is inadequate. Further analysis with longer sequences, additional nuclear markers and additional samples from all the nesting beaches in Japan should enable more precise analyses to be carried out.

Discussion

Jeff Polovina asked if he and his colleagues had looked at the Baja population for genetic structure?

Dutton responded that such investigations were underway. At present there was nothing outstanding to report in terms of the North Pacific, with the presence of the A haplotype (also known as CCP.1). NMFS had a time series from historic collections made by Brian Bowen (Hawaii Institute of Marine Biology) with larger sample sizes.

Polovina asked if the Baja population segment resembled the Hawaii population. Dutton responded that there were strandings along the US West Coast, and that there was some bycatch in the California/Oregon drift gill net fishery. Then there were pelagic samples from the Hawaii longline and California-based longline fishery, and finally the Baja strandings and bycatch. The gene frequencies are slightly different, but the general pattern appeared to be the same.

Milani Chaloupka noted that the published genetics data for Japan by Nobetsu et al, 2004, were the true northern population, at places like Omaezaki, much further north than Minabe, and they're all exactly the same as Yakushima. He suggested that Dutton should include this in his analysis.

Dutton concurred stating that this was the first time to see this paper at the workshop. He asked Chaloupka about the sample sizes used in the study, and that there was no difference between Omaezaki in the north and the whole latitudinal colony. He also noted that it was necessary to control for family-wise error rate. However, even without conducting this procedure, the true northern populations are no different to Minabe, Miyazaki, Yakushima in latitudinal structure. Chaloupka agreed with the points made by Dutton about the small samples sizes not being as spatially extensive as required. Recent discussion in the Council's SSC had indicated the need for an archipelago-wide genetic analysis for this area using the extra methods suggested by Dutton in his presentation.

Selina Heppell asked If any of the analysis of the nesting beaches suggested movement, particularly from those beaches that seem to have a lot of construction and development. The development and landscaping of a beach did not automatically mean the death of the turtles nesting there. Presumably, those turtles would go elsewhere to nest. Heppell asked if declines and increases at the various beaches with some of these beaches was a reflection of movement.

Chaloupka replied that from the limited analysis of satellite telemetry and tagging throughout the archipelago, there appeared to be very little inter-rookery exchange. However, as with the genetics analyses, this data was very limited. It required a far more authoritative analysis to be conducted. So far, there appeared to be very little inter-rookery movement.

Dutton responded that it was important to synthesize the genetic data and telemetry and tagging data together. The genetics data were providing a snapshot that may go back many generations. There may be indications of movements between nesting beaches but his would take several generations to show up in the genetic data.

Paul Dalzell asked if all loggerheads hatched in Japan migrated to California. Peter Dutton responded that this was the original paradigm that all loggerheads migrated to Baja to forage. However, it is likely that not all loggerheads from Japan end up in Baja. However, it is clear that all loggerheads in Baja originated from Japan.

I. *Nesting Beach Management in Japan for the Conservation of Loggerhead Turtles in the North Pacific. Yoshimasa Matsuzawa, presented to the workshop in absentia by Irene Kinan-Kelly*

North Pacific loggerhead sea turtles nest only in Japan. As a result of the dedication and hard work of an extensive network involving many independent field teams in Japan, annual census data are available from most nesting beaches, some leading back to the 1950s, such as at Kamoda Beach. These data suggest that there has been a substantial decline (50-90%) in the size of the annual loggerhead nesting population in Japan (Kamezaki et al., 2003). Information is presented that highlights the serious and continuing nesting beach impacts in Japan, the efforts to mitigate these impacts, and current population nesting information between 1998 and 2007.

Current nesting beach impacts in Japan include beach erosion due to coastal development and beach armaments designed to protect beaches from Typhoons, high beach temperatures that reach lethal incubation temperatures for eggs and pre-emergent hatchlings, high beach use (or foot traffic) that compacts sand thereby crushing nests, and potentially unethical ecotourism practices that disrupts hatchlings natural developmental processes. In general, beach erosion has lead to serious and obvious changes to many nesting beach profiles over the past 30 years. This has altered available nesting habitat as well as increased beach vulnerability to seasonal Typhoons. Additionally, cement barriers or armaments prevent females from reaching adequate nesting habitat and inhibit hatchlings from reaching the water.

The Sea Turtle Association of Japan (STAJ) is working to reduce nesting beach impacts at five locations, including Miyazaki, Minabe, and Atsumi beaches on the mainland and Maehama and Inakahama beaches of Yakuhsima Island—which accounts for 30 percent (Kamezaki et al, 2003) to 60 percent of overall nesting activity in Japan (Kamezaki et al., in review). Activities include relocating nests laid in inundation and/or erosion prone areas, restricting the public from high density areas, utilizing predator cages to keep feral dogs and cats away from nests, sprinkling nests with water that have exceeded the extreme temperature threshold, and identifying hatch success rates in relocated and in-situ nests to quantify mitigation success. Since 2004, over 1,700 nests have been relocated and approximately 110,000 hatchlings have been released that would have otherwise been lost.

Current nesting information for the North Pacific loggerhead indicates an increasing trend in the number of nests laid at Yakushima Island (Kamezaki et al., in review). The number of nests laid at all locations throughout Japan between 1998 and 2007 suggest that nesting activity is stable with a slight increasing trend (Figure 2), however, a ten year time series is not sufficient to conclude a trend. Future activities for the STAJ includes estimating the benefits of fences (i.e., restricting beach use), predator cages, and nest watering on hatching success rates, developing ecotourism guidelines, encouraging the government to remove beach armaments, and working with local communities to reduce coastal fishery bycatch.

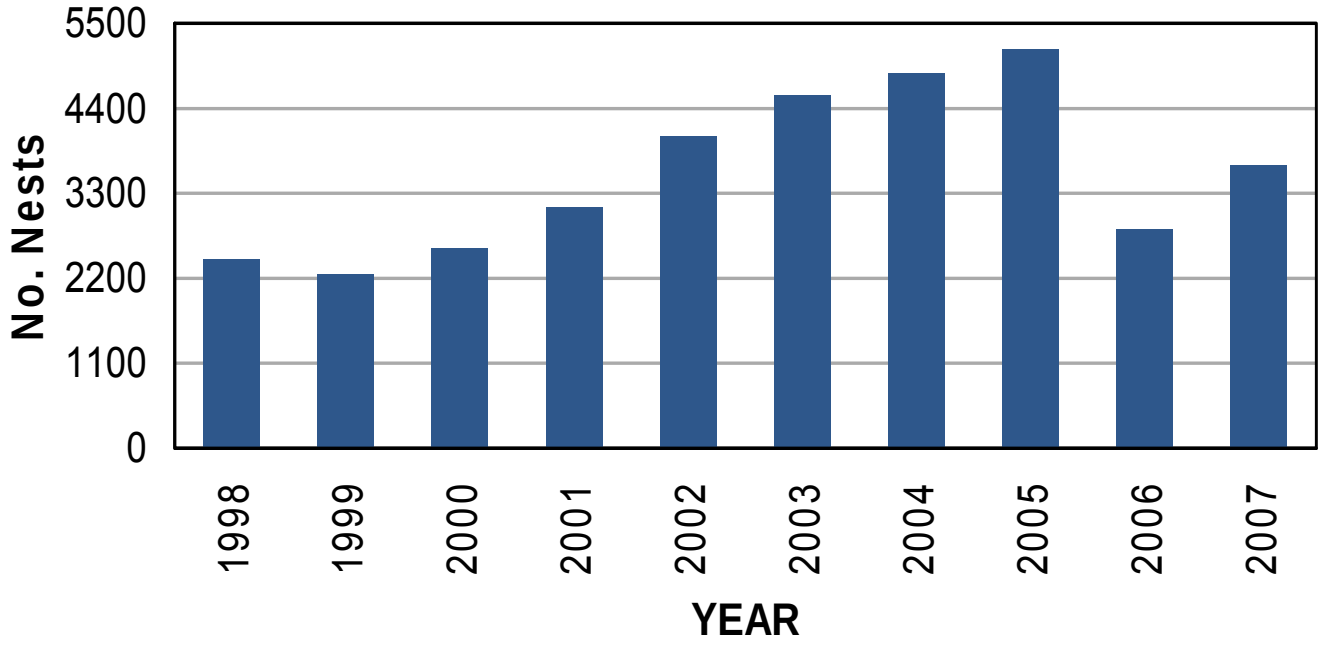

Figure 1. Loggerhead turtle nests in Japan, 1998-2007 (source: Sea Turtle Association of Japan)

Discussion

Milani Chaloupka commented on the data presented by Kinan. He noted that the old data for Kamoda from the 1950s were emergences of turtles on beaches, not nests. As such the measurement metric had changed. He cautioned that care was needed in interpreting these data because of the mixing of different metrics and it could be very confusing. Kinan commented that she would check the data to ensure what the numbers referred to.

Kinan commented on the most recent nesting beach trends in Japan and the ongoing work of the STAJ. These included estimating the benefits of fences and predator cages, watering the nests to maintain optimum temperatures, and developing guidelines for ecotourism. Kinan stated that STAJ had stressed that the need for collaboration with the government, local people and tour guides. STAJ also wanted to encourage the government to remove or modify the beach armament structures and deal with coastal bycatch. Kinan also briefly summarized the

results of the Tri-National Fishermen's Exchange, which included fishers from Japan, Hawaii and Mexico.

George Balazs stated that the beach armament was very important for protecting beaches from typhoon driven erosion Balazs noted that the problems between nesting beach access by turtles and the need for beach armament needed to be addressed by some imaginative engineering.

Brandee Gerke asked if STAJ was relocating nests before it received Council support? Kinan noted that the nest relocation was only undertaken after receiving Council support.

Melissa Snover asked if there was any information on sex ratios, given the high incubation temperatures. Kinan was not aware of any information of this kind. Hoyt Peckham commented on the beach armament noting that at a recent Groupo Tortuguero meeting a figure of 70 % of beaches around Japan were now reinforced by beach armament. This was going to exacerbated by sea level rise during the coming decades through climate change.

Stacy Kubis commented on the nesting beach trends and the rapid increases and declines in Japan, which was similar to loggerhead trends in the Atlantic Ocean. She noted how dynamic the trends were and if there was any information on the connection between these trends and oceanography.

Milani Chaloupka stated that there was a paper in press that looked at this topic. He also agreed with Peckam's comment on beach armament and drew the meetings attention to another issue which had recently surfaced. All of the rivers, or the bulk of the rivers in Japan are dammed with hydroelectric schemes resulting in very little beach sand replenishment coming down from river discharge.

Selina Heppell asked about the effort for counting nests in Japan, i.e. how mean people were working on the beaches to conduct the counts.

Kinan responded that nesting beach counts were conducted at 25 beaches in Japan and that these were all covered by volunteer workers but no numbers were given. Chaloupka added that the 25 beaches were monitored well in terms of good standardized beach techniques and coordinated by the Sea Turtle Association of Japan. He added that quality data exists for the last 16-17 years. Moreover, the metric of measurement changed dramatically but good data

Paul Dalzell asked if there was any sense of the historical scale of loggerhead nesting in Japan? Chaloupka suggested that Peter Dutton's genetic work would probably answer this question. Dutton noted that the genetics research may highlight whether there had been any bottlenecks in the population. If there was a bottleneck then the population may have been low for many years. George Balazs drew attention to the immediate post-WWII period in Japan that there was widespread famine. Interviews that Balazs had conducted with one student revealed that there was evidence of extensive harvesting of loggerhead turtle eggs during this period, and possibly the turtles as well.

J. Japan coastal bycatch investigations. Takashi Ishihara

The Sea Turtle Association of Japan (STAJ) has started bycatch research of sea turtles in the coastal waters of Japan. From October 2006 since September 2007, 121 turtle bycatch were

recorded from Japanese fishermen. Of them, 72% were from pound net fisheries. Furthermore, STAJ established each research base for pound net bycatch in Miyama (Mie), Muroto (Kochi), and Nomaike (Kagoshima), where 194, 1201 and 429 turtles were examined, respectively. Of these 18.4% were dead. Since almost 13,000 pound nets were set around Japanese coast, STAJ suggests that many more turtles are caught by pound nets. Pound nets are classified into 2 types (open type and roofed type, Figure 2). The open type is not covered but roofed type is covered by a cover or net roof. Roofed nets prevent turtles being able to reach the sea surface and breath. The Nomaike net is of the open type, and Miyama net is a roofed type. In Muroto, both types are deployed there. The mortality rate of Nomaike, Muroto and Miyama were 0.0, 12.4, and 96.6%, respectively. Therefore, the roofed type pound nets are assumed to have an associated high mortality rate for sea turtles. Changing the net from roofed to open type has considerable beneficial effects on the conservation of sea turtles, though it costs a great deal to change whilst maintaining the amount of fish catches.

STAJ hopes to clarify current status of bycatch volume and mortality rates for all pound nets in Japan, and reduce the mortality to conserve the north Pacific population of loggerhead turtles. To achieve this goal, STAJ will to establish observations on other pound nets around Japan, to record bycatch and associated mortality in each net. In addition, it is clear that ascertaining the distribution of roofed type pound nets and open pound nest around the Japan coast is essential.

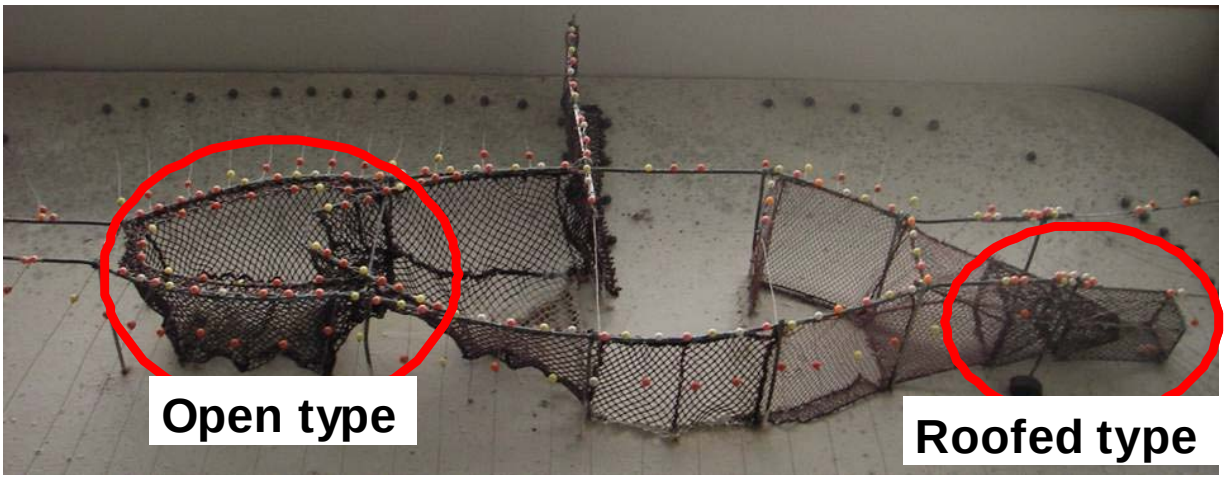

Figure 2. Japanese pound net design showing both the open and roofed capture chambers

Discussion

Hoyt Peckham asked Ishihara if there was any information on the proportion of closed to open pound nets. Ishihara stated that this was unknown. Further, there is no requirement for fishers to report the turtle bycatch so the Japanese Government has no information on the pound net bycatch. Paul Dalzell added that he had contacted the National Institute of Far Seas Fisheries Laboratory in Shimizu. They confirmed that NIFSRL conducts research on turtle bycatch but not on Japanese domestic coastal fisheries. Paul Dalzell asked if Ishihara had any sense of the total pound net mortalities of turtles in Japan. Ishihara stated that this was very difficult to ascertain but may exceed 1000 turtles killed annually by pound nets. It was also noted that the high catch of turtles in the pound nets may be a factor of proximity to nesting foraging grounds for loggerhead and green turtles, as is the case for Nomaike. However, large pound nets are

often at some distance from land, while small pound nets are closer to land and may have higher green turtle catches.

Schichao Li asked if there was any economic incentive for fishers to keep turtles caught in the pound nets. Ishihara commented that turtles were not widely consumed and that some turtles may be used by older people. George Balazs stated that people will not eat turtles if the carcass has been dead for more than a couple of hours. Balazs also wondered whether the fishery cooperatives had records of their bycatch since the national government does not have any records. Also he noted that these type of gears are commonly used in Fujian province in China and Taiwan and that loggerhead turtles may be taken in these nets also.

K. Loggerhead turtle density and abundance along the Pacific coast of the Baja California Peninsula, Mexico determined through aerial surveys[2]: A preliminary assessment. Jeffrey A. Seminoff[a], Tomoharu Eguchi[a], Hoyt Peckham[b,c], Adriana Laura Sarti-Martinez[d,e], Rodrigo Rangel[f], Jim Gilpatrick[a], and Karin Forney[a]

Loggerhead turtles, *Caretta caretta*, are highly migratory and use a wide range of broadly separated localities and habitats during their lifetime. In the North Pacific, loggerheads carry out an extensive developmental migration, often traveling from nesting areas in Japan to distant foraging habitats in the eastern Pacific Ocean. Loggerhead turtles in the Pacific are adversely impacted by a variety of activities including incidental capture in commercial fisheries, boat strikes, debris ingestion, and intentional harvest. These impacts have prompted calls for increased research and protection of loggerheads in this region. Management efforts will include the development of population models to monitor changes as various conservation measures are implemented.

To address the growing need for empirical data on loggerhead population status in the Northern Pacific Ocean, we carried out aerial line-transect surveys for loggerhead turtles along the Pacific Coast of the Baja California Peninsula, Mexico – an area long thought to be critical habitat for juveniles. This presentation builds off of three years of survey data, part of which was reported in Seminoff et al. (2006). The project was a US- Mexico bi-national effort with cooperating institutions from government, academic, and nongovernmental sectors. Surveys were carried out from 2005 to 2007 during September and October. Each annual survey encompassed nearly 4,000 km of track-line with offshore extents to 170 km. During the three-year survey, 604 logger head turtles were sighted (74% of turtle sightings), whereas 132 olive ridleys (16%) and

[2]. **Affiliations**

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11 green turtles (1%) were also sighted. Approximately 9% (70 sightings) of turtles were unidentified. More than 5000 marine mammals were sighted during the three-year survey. Marine mammal sightings included Baird's beaked whales (*Berardius bairdii*), blue whales (*Balaenopera musculus*), sperm whales (*Physeter macrocephalus*), and thousands of Delphinids, including common dolphins (*Delphinus* spp.), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*), and Risso's dolphins (*Grampus griseus*). Other sightings included rays, sharks, and fishes as well as various types of fishing vessels.

Using the line-transect analysis for the first two-year's data, we estimated 10's of thousands of loggerhead turtles in the study area. Combined with our ongoing water-based demographic studies and satellite telemetry efforts, this project has further demonstrated the value of Baja California's Pacific Coast for loggerhead turtles.

Project Goals

- Determine the distribution, density, and abundance of loggerhead turtles along the Pacific Coast of the Baja California Peninsula
- Collect information on additional sea turtle species when encountered.

Survey Methods

- We used a NOAA Twin Otter fixed-wing aircraft (Figure 3)
- Survey altitude 500 ft; velocity = 90 to 100 knots
- Flight crew consisted of 7 people: 2 pilots, 2 bubble window observers, 1 belly window observer, 1 data recorder, 1 person on rest
- Data collected for each sighting: species, no. animals, angle of observation, size, tail
  Track lines modeled prior to study based on 3 datasets:
  a. IATTC fisheries observations,
  b. NOAA ETP cruise data,
  c. Satellite tracks of 8 loggerheads released in study area (Peckham et al. unpubl. data).
- Prior to on-effort data collection during the 2005 season, survey team spent 4 days practicing in study area (110 loggerheads seen off-effort prior to start of study)
- To maintain consistency from year to year, we attempted to maintain as many of the same aerial observers for the entire duration of the study.

Results

- Total track distance: 3,456 km; Survey area: 45,075 km^{-2}
- Very good detection of loggerhead turtles due to 1) contrast of 'yellow' turtles in blue water, and 2) slow speed and low altitude of the survey platform
- On-effort turtle sightings: 604 loggerheads, 132 olive ridleys, 11 green turtles, 2 leatherbacks, 70 unidentified hard-shell turtles
- Three sighting models generated (Table 1, Figure 4); Highest confidence in Model 3 (Data truncated beyond 35ºN, Beaufort ≤2, overcast ≤25%)
- Density range (2005) = 0.17 – 0.24 loggerheads km^{-2}
- Abundance range (2005) = 5,632 – 15,551 detectable loggerheads

Conclusions

- The presence of sighting density 'tails' at north and south extremes suggests the core latitudes of loggerhead presence was encompassed in survey area (Figure 5)
- Density and abundance estimates are for the number of turtles within approximately 2 m of sea surface (maximum visible depth) during survey period

- Dive data (H. Peckham et al., unpubl. data) indicate loggerhead turtles in the area spend approximately 50% of their time submerged, hence undetectable from the air. Consequently, the abundance estimate from the aerial line-transect surveys should be multiplied by a factor of ~2, resulting estimates of up to ~30,000 total loggerheads in the study area during the survey period
- The presence of loggerheads at the offshore extremities of the study area indicate that additional turtles are present in areas farther offshore from the transect range
- We anticipate to finalize the data analysis using all three years by December 2008, which would provide the first estimate of the abundance of loggerhead turtles in the area
- Budget depending, we strive to continue the survey to provide long-term trend data in the future, which is essential for successful stock assessment of the species in the north Pacific

Table 1. A comparison of three sighting probability models that were fitted to the histogram of sighting distances for loggerhead line-transect surveys along the Pacific coast of the Baja peninsula during 2005.

Analysis	No. Sighted	Total distance (km)	Effective strip width (m)	Density Turtles / km^2	Loggerhead abundance	CV	95% CI
All data	231	3,456	201	0.17	7,678	0.15	5,632 – 10,468
Truncated beyond 35º, Beaufort 0–2	151	2,132	174	0.21	9,576	0.14	7,301 – 12,561
Truncated beyond 35º, Beaufort ≤2, overcast ≤25%	120	1,468	174	0.24	10,923	0.18	7,672 – 15,551

Figure 3. A photograph of a Twin Otter aircraft. The same model was used for the aerial surveys of loggerhead turtles along the Pacific coast of Baja Peninsula

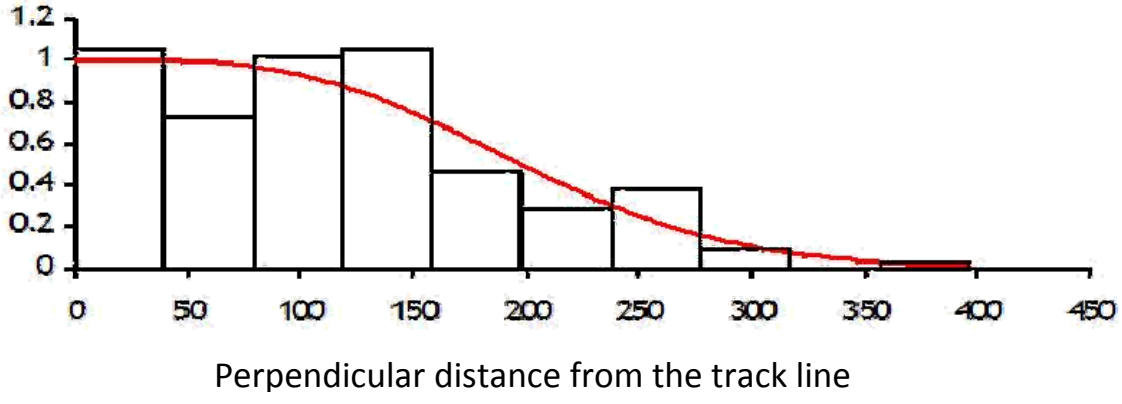

Figure 4. A histogram of the probability of sightings as a function of distance from the track line. The best fit sighting function is shown as a smooth line

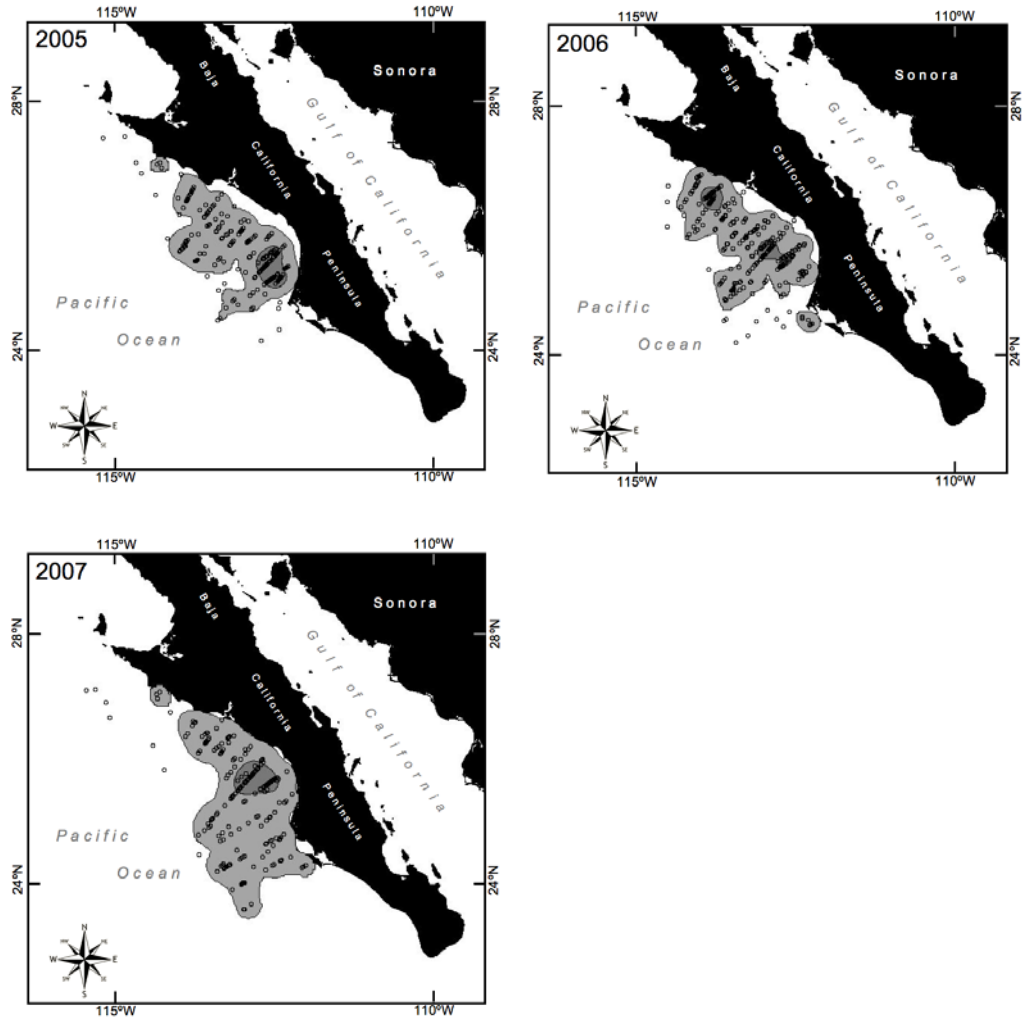

Figure 5. Kernel density estimates for sightings of loggerhead turtles along the Pacific coast of the Baja peninsula between 2005 and 2007.

Discussion

Jeff Polovina asked Iguchi had ever thought of merging aerial survey data with satellite remotely-sensed oceanographic data to explain the hotspots? Eguchi responded that the area was pretty constant in terms of temperature.

George Balazs asked if the over-flights by planes affected the turtles diving behavior. Eguchi responded some of them do dive when the plane passes overhead, but they could be seen diving and the visibility is very good.

Stacey Kubis asked if Eguchi had any plans to add video recording, or to use camera-still images in conjunction with computer algorithms to coincide with detection ability? Eguchi responded that this was additional work and had not been contemplated, however, unless super high definition cameras were used, eyesight was still considered to be accurate.

Elizabeth Petras asked if the turtles were present throughout the year in Baja. Hoyt Peckham responded that loggerheads seem to use the area throughout the year. Data from telemetry suggested that there seemed to be some inshore/offshore and also north/south movement of that hotspot between seasons. This seemed to be related to upwelling intensity and prey distribution which was related to upwelling and productivity.

Peter Dutton noted that the Southwest Fishery Science Center marine mammal group has used high resolution photogrammetry for their aerial survey data, where they take photographs and analyze it for cetaceans at sea. The Center conducted a pilot study with that group looking at the feasibility of using photogrammetry for obtaining more fine-scaled data, as had been undertaken with leatherbacks in Monterey to examine tail length and size distributions. It might be useful where there are high turtle densities where snapshots can be taken and then the images analyzed later.

Hoyt Peckham stated that from his own observations at sea about one third to fifty percent of the turtles were olive ridleys out to about 50 miles. He was unsure about how this proportion changed further offshore.

L. Baja, Mexico foraging demographics & bycatch analysis. S. Hoyt Peckham

Although bycatch of industrial-scale fisheries can cause declines in migratory megafauna including seabirds, marine mammals, and sea turtles, the impacts of small-scale fisheries have been largely overlooked. Small-scale fisheries occur in coastal waters worldwide, employing over 99% of the world's 51 million fishers. New telemetry data reveal that migratory mega-fauna frequent coastal habitats well within the range of small-scale fisheries, potentially producing high bycatch. These fisheries occur primarily in developing nations, and their documentation and management are limited or non-existent, precluding evaluation of their impacts on non-target mega-fauna. Principal Findings/Methodology. 30 North Pacific loggerhead turtles that we satellite-tracked from 1996–2005 ranged ocean-wide, but juveniles spent 70% of their time at a high use area coincident with small-scale fisheries in Baja California Sur, Mexico (BCS). We assessed loggerhead bycatch mortality in this area by partnering with local fishers to 1) observe two small-scale fleets that operated closest to the high use area and 2) through shoreline surveys for discarded carcasses. Minimum annual bycatch mortality in just these two fleets at the high use area exceeded 1000 loggerheads year21, rivaling that of ocean-wide industrial-scale fisheries, and threatening the persistence of this critically endangered population. As a result of fisher participation in this study and a bycatch awareness campaign, a consortium of local fishers and other citizens are working to eliminate their bycatch and to establish a national loggerhead refuge. Because of the overlap of ubiquitous small-scale fisheries with newly documented high use areas in coastal waters worldwide, our case study suggests that small-scale fisheries may be among the greatest current threats to non-target megafauna. Future research is urgently needed to quantify small-scale fisheries bycatch worldwide. Localizing coastal high use areas and mitigating bycatch in partnership with small-scale fishers may provide a crucial solution toward ensuring the persistence of vulnerable megafauna.

Discussion

Brandee Gerke asked how long this level of fishery impact has probably been taking place on the stock in the hotspot location.

Hoyt Peckham responded that gill nets became available in this area in the early to mid 1980s. But fishermen did not begin fishing offshore until they acquired bigger outboards. At that point in time they were only using 15 horsepower outboards. and it was not 10-12 years ago that they began using larger engines. Currently they use 200 hp engines. The fishers operate some surface pelagic longlines to the south of the hotspot and generally have low interaction rates with turtles. The fishers employ about two hundred hooks a day. They fish year-round either surface-set longlines or they also fish a method called *siminas*, which is a string of moorings with buoys at the surface with hooks that are set that and are left out all season. The fishers run along the moorings and re-bait every day. Fishers have been fishing this way for about ten years. The Santa Rosa fleet started fishing between 1999 and 2000.

Jeff Polovina noted that the size frequency for the strandings data presented by Peckham indicated that the 1995 and 1997 data sets had the majority of the smaller turtles. Polovina asked if there have been any gear selectivity changes or changes of gear in those early years that would produce this result. Peckham responded that they had not yet concluded why this happened. Gill nets were generally not selective. Peckham added that he thought that the larger turtles would be more likely to be caught on sets with larger hooks. Peckham also added that Martin Hall from the IATTC had sent a few thousand circle hooks in 2005, which were left with the fishermen. Peckham reported that in 2006, about 220 alternating J and circle hooks were set which caught 21 loggerheads, with about half the turtles caught on circle hooks. Peckham noted that the fishermen had stated that it did not matter which kind of hook caught turtles since they would invariably drown.

Chris Boggs stated that hook size was critical and that size 16 hooks would probably be worthless but that size 18 hooks would likely work, although given the size of the turtles being caught it might take hooks up to size 20 to be effective.

Irene Kinan asked if double counting occurred in his study from the strandings and the reported bycatch. Peckham responded that these had been separated and not added together.

M. Baja, Mexico conservation efforts - status of Fisherman's Turtle Reserve. S. Hoyt Peckham and David Maldonado Diaz

Assessing mortality of long-lived organisms is fundamental for understanding population trends and for implementing conservation strategies, but doing so for marine megafauna is challenging. Here we assessed minimum anthropogenic mortality of endangered North Pacific loggerhead turtles in the coastal waters of Baja California Sur through the synthesis of three data sources. Based on 1) our intensive surveys of an index shoreline from 2003-2007, 2) bimonthly surveys of additional shorelines and towns for stranded and consumed carcasses from 2006-7, and 3) bycatch observations of two small-scale fishing fleets, we estimate that a *minimum* of 1100-1800 loggerhead turtles died yr^{-1} at Baja California Sur from 2005-6 due to bycatch. Actual mortality may be considerably higher due to additional bycatch, directed hunting for black market trade, and natural factors including predation and disease. From 2003-7 we encountered 2,715 loggerhead carcasses on shorelines and in towns of Baja California Sur, Mexico. Survivorship in BCS waters may have a profound impact on the trajectory of the North Pacific loggerhead population. Along the 43km Playa San Lázaro, 0.25 loggerheads stranded km^{-1} day^{-1} during summer fishing months over five years, which is among the highest reported strandings rate worldwide. This stranding rate corroborates similarly high observed bycatch

rates for local small-scale longline (29 loggerheads/1000 hooks) and gillnet fisheries (1.13 loggerheads/km of net). A significant increase in mean length of 2,636 carcasses measured in the area from 1995-2007 may reflect sharp declines in Japanese nesting in the 1990s and suggests that a decline in neophytes nesting in Japan that originated from BCS should be expected over the next two decades. Given the endangered remnant status of the North Pacific loggerhead population, conservation action to reduce bycatch and poaching is urgently needed.

Discussion

Eric kingma asked Peckham to explain about the markets for these fish; in particular, were fish kept on ice and how were fish sent to market? Peckham stated that fish were caught and left un-iced in the vessel bilge until they were brought to shore, where they were iced down and trucked to markets in Cabo, La Paz and Mexico City. There was a great deal of difference between gill net caught fish and those caught by handlines which were handled better and resulted in a higher quality product.

Chris Boggs asked what the surface fishery was catching. Peckham responded they were targeting makos and blue sharks, and hammerhead shark for the value of the fins. All of the shark meat is sold and consumed, but it's not very lucrative. The fishers also catch marlin and swordfish and tuna in significant quantities. But because of the isolation of the fishing camps some of this incidental catch was used for bait.

N. Assessment of the population-level impacts of potential increases in marine turtle interactions resulting from a Hawaii Longline Association proposal to expand the Hawaii-based shallow-set fishery. Melissa Snover

Snover and Heppell (in review) present a quasi-extinction risk index called susceptibility to quasi-extinction (SQE) that can be used to classify populations based on relative risks. While they showed that the method is robust in assessing actual risk (in terms of a binary assessment of at risk or not at risk) using population simulations, they clarify that SQE values are not indicative of a true probability of quasi-extinction because they use long time frames of three generations. Rather, the index is a useful tool for comparing populations and assessing the impacts of increased mortalities by comparing SQE values between perturbed and non-perturbed populations. Here I apply this technique to nest census data for Pacific loggerheads and leatherbacks to assess the impacts of increased mortality resulting from the Hawaii Longline Association's (HLA) proposed expansion of the Hawaii-based shallow-set longline fishery. The SQE values calculated for a nesting beach are strongly and negatively correlated with current population size and population trend (Snover and Heppell, in review) and these parameters obviously change over time. If the populations assessed here continue to decline, detectable changes in SQE may be found with fewer adult female losses, and the reverse of this is true as well. Hence it is advisable to periodically assess the status of the populations interacting with the longline fisheries. The population growth rates and SQE values considered here apply only to the nesting female segment of the population. For most populations, this is the only portion censused for trends and we cannot assume that what is happening on the nesting beach parallels the rest of the population is not appropriate and caution needs to be applied in interpreting these results.

Discussion

Chris Yates sought clarification about the 0.25 reproductive value used in the study. Melissa Snover confirmed that this figure represented how many adult females are being taken out of that population under two different assumptions. Yates also asked if a 50 percent male/female ratio was assumed in the analysis. Snover confirmed that it was.

Don Kobayashi commented on the statistical properties of the analysis and whether there was a potential to dilute the effect of recent trends when using a long time series. Snover replied that it looked possible that there was a new recovery trajectory in the data, possibly resulting from protecting the beaches 20 or 30 years ago. As such Snover stated that she did not want to use all of the data as it would indeed result in such a dilution. Snover referred to the data presented by Irene Kinan for STAJ which suggested that it might be moving into another cycle. One of the recommendations made in the paper for the meeting was identifying trends and the reasons for these trends so that the dat could be used with confidence from this point onwards.

Jeff Polovina noted that the trend of the nesting population might have some autocorrelation or some cyclicity. There was additional discussion on the statistical properties of the model which Snover addressed.

Jeff Leppo sought clarification on the analysis presented by Snover and the percentage of the population attributed to northern Japanese beaches. Snover responded that she used a range of 1% to 24% for turtle takes coming from the northern beaches. Snover explained that in her analysis she preferred to deal with a range rather than a mean point value estimate. There was further discussion from workshop participants seeking further clarification on the statistical properties and the arithmetical procedures used in the modeling exercise conducted by Snover.

O. Long-term temporal and spatial trends in loggerhead turtles Milani Chaloupka

The loggerhead turtle is considered endangered, especially in the Pacific where declines in some populations have raised concerns for the long-term prospects for the Japanese and Australia stocks. Despite such concerns there has been no assessment of the conservation status of the Japanese stock. So we report on long-term temporal and spatial trends in nesting abundance of the Japanese stock. We compiled nesting data series for 25 rookeries derived from a geographically extensive long-term monitoring program covering all nesting regions in the Japanese Archipelago. Some series spanned > 50 years but most were of shorter duration. So we used varying coefficient generalized additive mixed modeling to evaluate trends in nesting abundance over a 16-yr period (1989-2004) at the 25 rookeries spanning > 1500 km. Archipelago-wide synchrony in regional nesting fluctuations was apparent, irrespective of whether there were long-term rookery-specific increases (Yakushima, southern region), decreases (Kamouda, central region) or otherwise (Omaezaki, northern region). This synchrony is presumably due to large-scale environmental forcing by sea surface temperature in the foraging habitat. Overall, Archipelago-wide nesting abundance showed a quasi-cyclic trend over the past 2 decades with no secular trend apparent. We estimated that the 2004 nesting season in the Archipelago comprised > 3245 nests or > 800 nesting females with Yakushima rookeries

accounting for 62% of the nests. We conclude that the Japanese loggerhead nesting stock is one of the largest remaining in the world. So protection of the Japanese loggerhead stock is of paramount importance for the global conservation of this endangered species.

Discussion

Stacey Kubis asked about Australian loggerheads nesting at Mon Repos beach and if there would be a time lag between the increase in juvenile abundance. Chaloupka acknowledged that this could the case based on the data presented.

Hoyt Peckham asked about the foraging grounds used in the analysis of sea surface temperature and nesting beach abundance and which foraging grounds were used in the analysis. Chaloupka stated that that for Kamouda and Yakushima, he and his co-authors had used a very large area, as explained in the paper, that goes around Southern Japan, and that includes most of the Kyushu area. Both of these two stocks are believed to have extensive foraging areas. This was also why the analysis had not included all 25 loggerhead rookeries because all the associated foraging grounds were not known. The same was true for Australia where the analysis had used a very large area north of Mon Repos to Moreton Bay. The data was averaged over this area by month for the last 50 years. Chaloupka noted that the greater spatial resolution of the foraging grounds would improve the analysis. Nevertheless, the importance of this work was that it showed irrespective of genetic stock, hemisphere, time period or rookery, all four examples cited in the presentation and associated paper showed exactly the same pattern.

Jeff Polovina sought clarification on the sea surface temperatures and whether this indicated a general warming of the ocean? In particular, if there were examples of foraging habitats that were warming in some parts and cooling others, would this give the analysis more resolution? Chaloupka acknowledged it would, but that there was no example of large foraging ground with sea surface temperatures which were declining. Chaloupka repeated that irrespective of the trend, increasing or decreasing, the same impacts on nesting abundance were observed.

Chaloupka commented on the long term implications for rising sea surface temperatures geographically, since some loggerheads may have earlier nesting seasons or move pole-wards as temperatures increase. Chaloupka cited some limited information from the Carolinas which indicated earlier nesting seasons and that in Australia, loggerheads had nested further south than the current nesting range. Chaloupka concluded that temperature change and climate change will clearly have a considerable effect on loggerheads

Don Kobayashi asked is the sea surface temperature (SST) terms used in the analyses are linear, as he thought the influence would tend to ne non-linear. Was this user-forced or did the model actually choose this? Secondly, Kobayashi asked about the model fits using the new Dennis model, and if SST entered into that? Chaloupka responded to the second question first by stating that that the state-space trend model is just density-dependent trend analysis. There was no SST data in it at all, although this could be incorporated into it. Kobayashi noted that this would not likely have a great impact on the fit of the model since there was such a strong correlation. Chaloupka agreed, adding that the longer 50 year time series were significantly non-linear, while the shorter data sets tended towards linearity. Chaloupka then commented on the General Additive Models (GAMs) used and the model outputs and how the model internally generated the degrees of freedoms for the smoothing splines.

Tomo Eguchi asked about density-dependent effects in the data sets. Chaloupka responded that these were compensated for in the Dennis model when they were linearized, and were expressed as the parameter 'C' in the equations. The algorithms used to fit the model to the data were a non-linearized mixed analysis, which produced a measure of variability for all of the parameter estimates. Some of these were very tight, while others were very broad, depending on the population.

Chris Yates asked about the difference in the oscillation and the apparent rebound in the southern beaches in Yakushima compared to some of the central beaches. In particular, had anyone developed a metric or any sort of investigation or perhaps the percent of armoring of the beaches? Was there a big difference between the armoring of those locations and was that something that can be correlated into some explanation of success of rebound on those beaches?

Chaloupka responded that in the paper there was a recommendation for a thorough assessment of the hazards associated with beach armament. The paper contained only speculation about the beach armament effects. A figure had been given during the workshop of about 70 percent of the Japan coastline being armored. In addition there needed to be an assessment of the coastal fishery hazards and a proper risk map made for Japan to identify and then to relate it to the types of trend analyses presented at this workshop. Further it was also important to connect the trend analyses with better genetic studies and to improve their spatial resolution. Chaloupka concluded that there was a need for more spatially-resolved genetic analysis and much better identification spatially of the hazards so that particular regional areas can be identified The point of this analysis was to look at regional-specific problems in order to design regional-specific conservation initiatives, as it was incorrect to make generalizations across the Japanese archipelago.

Chris Yates asked if it was possible to determine the Japan rookery origins of turtles that ended up in Baja. Peter Dutton responded that there was currently no information on this. Dutton noted that the resolution of the genetic analyses conducted to date indicated that the turtles across the North Pacific were one stock. The next step would be to characterize those nesting populations with multiple markers. Without this there was no information of the type to answer Yates' question.

Hoyt Peckham asked if there was some capacity to increase the resolution in the near future of the genetic investigations. Dutton responded that many years had been spent on developing the tools to answer these types of questions, one of which were micro-satellites. With these kinds of tools it was possible to look at relationships, look at evolution, and test theories on demographic models, in terms of past history or bottlenecks.

Chris Boggs asked about how density dependant factors could be operating when the North Pacific loggerhead population was markedly reduced and the system was far below carrying capacity. Boggs asked Chaloupka if there had been an environmentally related change in the carrying capacity and how this functioned. Chaloupka noted that this was a good question and one that as yet he was unable to answer, as the data were not available. Boggs addressed a question to Jeff Polovina if there was any evidence from his ecosystem work that the primary productivity of the oceans has been reduced. Boggs commented from his ECOSIM investigations that he could posit some sort of cascade effect with the larger predators being removed and intermediate predators becoming more abundant, and the smaller predators becoming less abundant. Then the zooplankton that the smaller predators feed on becoming

more abundant and, therefore, the primary productivity could make the forage for the turtles much reduced than it was 50 years ago.

Jeff Polovina responded that he had co-authored a paper that looks at the expansion of the least productive areas of the ocean. In other words, the oligotrophic gyres in the world's oceans had all increased. Every year they were expanding by 800,000 square kilometers. So as the ocean gets warmer and more stratified, the very least productive parts of the oceans are the ones that were changing the most rapidly. However, those were not necessarily the areas where the loggerheads were foraging.

Chaloupka added that is was interesting that one of the areas in the Pacific that has undergone the most dramatic climate change effect for sea surface temperature is in fact the Pacific Northwest in Japan. The current climate data show that is where the biggest sea surface temperature changes have occurred. Also, there were publications which showed that the saury (*Cololabis saira*) fluctuations follow the loggerhead fluctuations very closely in Japan. The saury studies were very long-term studies, as well. Chaloupka also stated that loggerheads do not hang around the coast all of the time. In Japan and Australia, there was increasing evidence that loggerheads are spending time offshore. He added that loggerheads do not come out of the oceanic realm and remain in the neritic zone thereafter. They were actually going backwards and forwards between the two environments, so oceanic habitat is important for adults, not just for juveniles and immature turtles.

George Balazs stated that an adult was rarely encountered in the Hawaii-based longline fishery. I can only think of one, and it wasn't able to be brought back because it was too large to bring on the boat. There may have been another.

Jeff Leppo asked if Chaloupka could provide the relative populations for the five regions. Chaloupka stated that going southward; there was a generally increasing trend in abundance which was to be expected. However in Shikoku, Region 3, the population was slightly depressed below that and this is where the greatest decline has occurred in recent years. Something about Shikoku was different to other places. It has slightly different beach characteristics and Chaloupka suspected that there was an anthropogenic hazard effect in the Shikoku region. Kamouda was in Shikoku, which was the longest-term trend.

Jeff Leppo sought clarification about the relative proportions from the different nesting beaches. Chaloupka replied that Yakushima over the last 20 years will range from 40 to 65 percent, depending on the year. But it averages out at around about 50 percent from Yakushima for the whole archipelago. Leppo commented on the genetic analysis as it related to the nesting beach trends and the contribution of different nesting beaches to the loggerhead population as a whole. He asked if Peter Dutton’s analysis of the genetic data from the Hawaii longline fishery matched that presented by Chaloupka. Dutton stated that he didn’t think there was a conflict. Dutton had criticized the Hatase paper as being inadequate to really do a mixed stock analysis. Nonetheless, when looking at the genetic data, Yakushima comes out as a strong signal.

Leppo commented that one of the results of Dutton’s data is that these genetic differences, which are not fully understood, were not necessarily geographic. Chaloupka added that there was geographic variation, but it was not latitudinal. Dutton suggested that increases in sample sizes and the dynamic nature of the populations might show that these populations may not be in genetic equilibrium. It was important to note that expressions of genetic differences were not particular populations being inherently genetically different from another. The neutral markers

were used to try and see if there's any movement between these populations on different nesting beaches.

P. Development of Alternative Quantitative tools to assist in jeopardy evaluation for sea turtles, Selina Heppell, Oregon State University

A report was prepared for the US NOAA Fisheries Southeast Fisheries Science Center as a framework for development of quantitative risk analysis tools that can be used to evaluate how human activities that result in sea turtle mortality may affect the recovery of stocks, populations or species. Five possible evaluation tools are discussed, with examples of how the models could be used as part of a Section 7 consultation. This report is intended to present issues, options, and recommendations for consideration by NMFS and quantitative ecologists on the pros and cons of various quantitative evaluation alternatives and the associated data/research needs to support them.

Eric Kingma asked how the methods presented by Heppell related to the Susceptibility Quasi-Extinction idea that Dr. Snover presented.

Heppell responded that one of the five alternatives presented one of my five was an approach similar to the SQE shown by Dr Snover, but the overview given by Heppell was much simpler as it was just an idea at the time. Snover had taken this forward to see if the method could work. The approach she had taken was to see how the SQE changed when more animals were taken out of the population, and to see if some form of allowable take threshold could be developed based on an acceptable level of risk.

Jeff Polovina suggested that it was important to note the use of a number of different models to address a question is a good idea.

Heppell agreed adding that there was no reason to be restricted to only one management model. There could be multiple management models to see where the results intersect.

Polovina added that the link between models and data is important, as well as the link between simulations and models that help to understand the performance of models.

Paul Dalzell added that stock assessments for Pacific pelagic fish typically ran up to a dozen different runs of the stock assessment models with varying parameters

Heppel agreed noting that it in all cases one should not expect that there will be an intersection, and it was an interesting exercise to investigate why there was no convergence

Polovina concurred noting that this exercise might lead to the identification of some research issues, parameters that are needed to be better understood or key assumptions of the model.

Lance Smith asked for an example of what was meant by predetermining what precautionary means?

Heppell responded that from a modeling perspective, precautionary means serious consideration about uncertainty and when this was high then erring on the side of caution and

the use of lower confidence intervals. However, from a management perspective, precautionary can mean different things.

Liz Petras added that with respect to developing Biological Opinions (BiOps), uncertainty means to err on the side of the species.

Heppell suggested that one way to consider this was to think which was the lesser of two evils; a Type I or Type II error? Or that exercising the precautionary principle may mean erring on the side of the species to minimize the threat of extinction even if there was a cost to a fishery. Further, having some idea *a priori* of what weight might be put on Type I and Type II 2 error is a useful thing to know ahead of time. Heppell also noted that there was danger from easy to use management models that they were not really predictive, and that simple models which did not require a great deal of data may actually militate against better modeling.

Jeff Polovina agreed suggesting that a good population model that took into account the spatial and life history aspects could be used in combination with a management model to explore impacts from different population scenarios, to get a sense of where the management model is deficient.

4. Discussion & Research recommendations.

Jeff Polovina opened the final session of the Workshop. he reviewed the objectives of the workshop which was to provide the people involved in the management side to be aware of what the most recent research results were for loggerhead turtles, especially those results that had bearing on issues relating to the impact of the Hawaii longline fishery. Irene Kinan had identified a number of themes including pelagic ecology, coastal bycatch in Baja and Japan, post-hooking mortality, population modeling and identified who had results that were new and could be presented to update participants on the status of the latest research.

Polovina continued that there may be other either results that were not presented that are relevant to the information on the impact of the Hawaii longline fishery on sea turtles of which participants were aware, including publications or ongoing work or work in press. He began the discussion with just an open forum asking participants if there were additional pieces of information that people developing the Environmental Impact Statement (EIS) should know about or the Council should know about, Council staff should know about.

Eric Gilman commented that he was developing the FAO's Technical Guidelines for sea turtle avoidance in marine capture fisheries. The meeting had learned about the issue of pound nets in Japan and identified these as a potential large source of mortality and the lack of understanding of how to mitigate it. Gilman continued that there were a large number of other fishing gear types that are similar to pound nets, and where there was little understanding of levels in avoidance methods. It might, therefore be important to document what gear types are potential problems.

Paul Dalzell added that comments made in the meeting suggested that pound nets of the type observed around Japan were also a very common fishing gear in Fujian Province in China and also in Taiwan, and that presumably there are some similar scale of level of interactions between loggerhead turtles and those gears in those locations.

George Balazs referred to small pound nets in Japan and whether or not these had closed or open tops. In any case, small pound nets were not set out in the pelagic zone where loggerhead interactions were more likely. Balazs suggested that the smaller pound nets might take green turtles associated with a more benthic habitat.

Jeff Polovina noted this data gap and then referred to an earlier comment made by Balazs on providing observers with small electronic tags in an effort to estimate post-hooking mortality in the Hawaii longline fishery. The problem was that so few turtles were now caught in the Hawaii

Yonat Swimmer asked whether there was an issue of electrical interference with the double tagging. George Balazs responded that there was no problem unless the antennas were rubbing against one another. Balazs added that double tagging provided an extra bonus by extending the life of the tags by alternating the duty cycles. Observers were being trained to deploy double tags in the shallow set swordfish fishery

Selina Heppell asked if there was any conventional tagging being conducted at present.

George Balazs responded that since the start of the observer program, observers have always put double flipper tags on captured turtles. However, the observers did not deploy PIT tags because of the surgical nature of the instrument.

Heppell noted that with a decent number of recaptures, there would be a potential for growth rate estimation and other parameters.

Balazs noted that the numbers tagged was very low, perhaps 15 tagged turtles at maximum.

Paul Dalzell asked if the only loggerheads being tagged were those from the Hawaii fishery. George Balazs responded that turtles had been tagged for many years in Baja, but there was not much of an effort in tagging turtles captured by Japanese pound nets except for a couple of satellite tags that a couple of Dr. Kamezaki's graduate students had undertaken, which were supplied by NMFS PIFSC.

Dalzell asked if anyone was working on a tagging database for loggerheads? George Balazs responded that tagging was being conducted on nesting beaches in Japan, such as Yakushima, Minabe and Muroto.

Selina Heppell added that conventional tagging would give growth rates for Japanese loggerheads since all that was available at present for loggerheads was Atlantic and Australian growth rates.

However, Takashi Ishihara responded that this was difficult because of so few recapture rates.

Melissa Snover stated that she had some turtle humeri from Baja that she had analyzed for growth rate, although, it was fairly small sample size. This work could be expanded and there was a person in Japan interested in learning the technique and willing to collaborate. Further specimens from Baja could probably be obtained through individuals such as Hoyt Peckham.

Jeff Polovina observed that it would be really interesting to increase the ability to look at trends in juvenile abundance. This had begun in Baja with the aerial surveys, which had produced a

valuable time series. Polovina also wondered if the local cooperative and prefectural authorities in Japan would have any long term records of turtle catches.

Takashi Ishihara note, however, that the prefecture and national government do not keep records of turtles captured in pound nets. He continued that he had recently estimated the population of loggerheads around Japan to be about 10,000-30,000 individuals. In response to questions about small pound nets, Ishihara stated the small pound nets were close to shore and catch small green turtles and the occasional loggerhead. However, the larger pound nets represented a greater threat to loggerhead turtles. Ishihara added that pound nest could be changed from opened to closed (i.e. the terminal chamber open or closed) seasonally and location.

Jeff Polovina asked how much was known about loggerhead interactions with coastal fisheries in the South China Sea since there were many loggerheads present there.

Milani Chaloupka responded that there were documents from a recently convened SEAFDEC (Southeast Asian Fishery Development Center) meeting, but it was poorly documented. Chris Boggs added that there were US officials that conducted trawl certifications around the world, and that they may have some information on trawls in that area.

George Balazs commented that there was a short paper on skeletal chronology of loggerheads from the drift net fishery in the North Pacific co-authored by himself and Jerry Wetherall. Balazs also commented on the unlikelihood of obtaining samples from Japan, and that only two CITES permits had ever been issued and these were for blood samples from captive animals. There is a considerable stranding data collection held by the Sea Turtle Association of Japan, which Dr Naoki Kamezaki would like to see analyzed by Japanese students.

Selina Heppel noted that there had not been much discussion about risk assessment and risk in a spatial context, especially the amount of time the loggerheads are spending in dangerous areas. A possible analytical approach to this would be to use stable isotope techniques to get a better understanding what proportion of the turtles are going to Baja, and what proportion of the turtles are bouncing back and forth between pelagic and neritic habitats. Or is there some proportion of the population that make a single ontogenetic shift.

Jeff Polovina commented that it would be useful to provide additional support for work initiated by Hoyt Peckham on stable isotope research using sea turtles from Baja, and to expand this to include animals from Japan. Milani Chaloupka concurred that this would provide useful information.

George Balazs explained that Jeff Seminoff, who works at the La Jolla National Marine Fisheries Service Science Center, has been conducting loggerhead necropsy work, and recommends collecting biopsies from live animals. Seminoff recommended collecting a skin sample from the dorsal neck area because this provides a recent record, as this area has a high biomass turnover rate. He also stated that it is important to collect a sample of bone. Concerns over the distress to the animal from taking a biopsy from the dorsal neck were raised.

Tomo Eguchi explained that they scrape the skin and do not take a full biopsy with leatherback and green turtles, which is a less invasive procedure.

Jeff Polovina responded that use of the high turnover skin would not provide a record that goes back to when the animal was born.

Selina Heppell commented that, in the Pacific, it appears that there has been ample collection and stockpiling of humeri. However, in the Atlantic this is not occurring.

George Balazs confirmed that, in Hawaii, humeri of green turtles have been routinely collected since the early 1980s, when a stranding program was initiated. It is a labor-intensive and expensive program. Research is now being conducted using these stockpiled humeri, so it has been worth the effort.

Paul Dalzell raised the issue of whether or not the Council should be providing more support for research to assess loggerhead capture in pound net fisheries throughout Southeast Asia.

Takashi Ishihara explained that the Sea Turtle Association of Japan has supported some pound net fishermen to assist in assessing the degree of loggerhead interactions.

George Balazs suggested an appropriate approach would be to provide support to Japanese graduate students, through Dr. Kamezaki at Hokkaido University, to conduct this research. It would also be useful to translate relevant PhD theses such as by Ms. Takauchi and a researcher from Hokkaido University who worked on the pelagic ecology of pound net satellite-tracked turtles.

Jeff Polovina pointed out that there is a need to support research to improve the understanding of the link between the pelagic life stage and the Baja population. In particular, it would be useful to link this to the research results presented by Hoyt Peckham, which showed that there appears to be a reduction in recruitment to the Baja population, where the proportion of animals below, say, 50 centimeters, has declined substantially.

Selina Heppell noted that this has occurred in the Southeast U.S. as well. One hypothesis proposed to explain this observation is that their pelagic habitat is optimal so the turtles are staying out at sea longer before transitioning to nearshore habitat. Alternatively, the turtles may be growing faster, and coming into the nearshore habitat at a larger size but the same age. And, there is of course the possibility that fishery interactions are affecting their recruitment.

Jeff Polovina commented that, the satellite tagged turtles he and George have been tracking are generally not moving from the pelagic environment into the Baja coastal habitat, and wondered if movement to Baja may occur irregularly perhaps in response to decadal pulses, or alternatively, maybe animals that go to Baja are not part of the population of animals that were currently being tagged.

Eric Kingma explained that an additional research priority is to document the proportion of Japan's turtle nesting beach coastline that has been hardened. Jeff Polovina continued that the study could also investigate the possibility of removing obstacles to turtle nesting habitat along some of these stretches of coastline.

Selina Heppell added that it would also be interesting to learn what happens to nesting females who come across hardened nesting beach habitat – do they lay their eggs seaward of the wall, or at sea instead?

George Balazs commented that he has observed turtles laying eggs below the wall.

Irene Kinan explained that, in Japan, at five sites, turtle nests that are laid seaward of seawalls are relocated. Unfortunately, Takahashi explained that they have the capacity only to manage these five sites, and cannot expand to include additional sites. There are 25 loggerhead nesting beaches in Japan.

Chris Yates inquired if the people monitoring these nesting beaches in Japan could provide information on what happens to the nesting females who come upon hardened sections of beach. For instance, if an observer records a tagged female come up on the beach but is unable to nest because of an obstacle from beach armament, and later the same turtle emerges at a different section of coastline and successfully nests, that would provide useful information.

Irene Kinan replied that, in Yakushima, researchers do count the turtles that come up on the beach but do not lay a nest.

Stacy Kubis noted that a disturbance study was conducted in Florida a couple years ago. A fake seawall would be placed in front of a turtle, a radio tag would be attached to the turtle, and they would observe the turtle's movements. The turtle eventually went out to sea, and two weeks later, she would return and attempt to nest again. Unfortunately, the work that they did didn't have any conclusive results because the turtle was not returning to the 26 kilometers of coastline that was being monitored.

Paul Dalzell commented that, while we know that the loggerhead turtles in Baja are from the Japan population, it is curious that there are limited observations of these turtles returning to Japan. Therefore, we do not yet understand their migratory path from Baja to Japan. The loggerhead turtles caught in the Hawaii longline fishery are too small to be from the Baja population. Jeff Polovina and Irene Kinan confirmed the accuracy of these statements.

Paul Dalzell continued that it would be useful to improve our understanding of the population dynamics in Baja, where observations indicate that the turtles are getting bigger. This may be a result of a lack of recruitment, which is discouraging.

George Balazs continued this discussion, pointing out that it is important to know the size of the population of loggerheads in Baja, to then determine if they are a resident population, which does not return to their nesting habitat in Japan, and if the population is small, it might not represent an important portion of the overall population. Perhaps the loggerheads at Baja are a sink for loggerheads – where they have accumulated over time.

Tomo Eguchi replied that, even if there is only a small proportion of the total Japan loggerhead population in Baja, that does not mean that it is not important for the overall population.

George Balazs added that there have been observations of adult-aged loggerheads with satellite tags tracked traveling from Baja towards Japan, in studies by J. Nichols, Scott Eckert and Peter Dutton.

Tomo Eguchi pointed out that there have been few satellite tagged loggerheads from Baja, and, according to Hoyt Peckham, the scutes slough off rapidly because they grow quickly, making the study period for tagged turtles short.

George Balazs clarified that Hoyt Peckham has tagged about 40 loggerheads from Baja. Tomo Eguchi stated that these tagged turtles were observed to remain in the Baja area. George

continued that, the loggerheads from north of Hawaii to Japan migrate over broad area, but not to Baja, while the Baja-tagged loggerheads generally remain in the area.

Selina Heppell raised the hypothesis that, because of a small cohort size that came out of Japan in the late 1990s, and now that the population is increasing, it is possible that the lack of recruitment to Baja is due to the low reproductive success in Japan in the late 1990s, and that now we should expect the recruitment to Baja to begin to increase again. It is a research priority to use the data collected by Hoyt Peckham on the size frequency structure in Baja with the nesting beaches in Japan.

Jeff Polovina concurred, that it would be useful to attempt to link the size frequency structure in Baja with a nesting beach in Japan with some suitable time lags, to obtain an idea of a recruitment indicator for juveniles.

Jeff Polovina noted the different patterns observed on Japanese nesting beaches, i.e. some in decline while others showed an increasing trend. Information on loggerhead populations globally seemed to have a fairly common pattern. Was the overall picture for Japan due to spatial coherence or were there different patterns.

Chaloupka responded that it was a combination of both effects. There was a low frequency oscillation that is consistent across the regions, and it happened in Australia as well. However in different regions loggerheads were exposed to some other hazards. Some of these hazards include coastal fisheries such as pound nets. He added that a high priority was the need to conduct a hazard analysis for all of Japan to examine all of the hazards around Japan, e.g., beach armament, coastal fisheries, pound nets, longline fisheries. Where are the risk areas in Japan?

Eric Kingma added that a parallel study needs to be conducted on the genetic structure of Japan loggerheads so that the animals with which the Hawaii longline fishery interacts can be traced back to their natal origins.

Milani Chaloupka referred to the study conducted by Hatase et al (2002) on Japanese loggerhead turtle genetics, noting it was a good study, but that it was insufficient to answer the type of questions being posed in this discussion.

Irene Kinan asked if Dr Kamezaki would have materials stockpile which could be used for additional genetics studies. George Balazs indicated that Kamezaki may have materials in storage for students to work on. He also added that on the several occasions when he had met with Dr Kamezaki that there was no discussion of sending any archived material overseas for analysis. Further, he noted that the Government of Japan did not support turtle research domestically, so any work on these materials will depend on the financial support that DR Kamezaki receives from institutions such as the Council.

Takashi Ishihara stated that one student of Dr Kamezaki was looking at nuclear DNA. and her work was now complete and her thesis may shortly be available.

Jeff Polovina asked Paul Dalzell and Chris Boggs who both chaired bycatch working groups in the Western and Central Pacific Fisheries Commission, if anything had emerged from these groups that were relevant to loggerheads. Both indicated that the focus of these groups had been primarily longline fishery mitigation, particularly circle hook and fish bait. He added that replicating the success of US fisheries in the regional fishery management organizations was a

slow process with stiff resistance to the imposition of requiring large circle hooks and fish bait for shallow set fishing, although the Japanese were in favor of adopting this for shallow set fisheries.

Chris Boggs added that despite ongoing work by other countries on circle hook and fish bait combinations in trials, there was no data available from these studies. The only available data apart from the US comes from an experiment in Spain. An EU-associated study by a Spanish vessel in the Indian Ocean presented to the WCPFC second Science Committee was poorly conducted. Boggs also noted that the issue of other sources of mortality for turtles appeared not to be serious interest in other sources of mortality for turtles other than as scapegoats, but countries appear not to be interested generating mortality estimates in their other domestic fisheries, stating that this is not in the purview of the regional tuna fishery management organizations

Selina Heppell raised the issue of the need to conduct theoretical work on the issue of off-setting or mitigation or does it really work to trade one dead turtle in the fishery for some number of hatchlings on the beach. Heppell suggested that there was no good answer to this question from a management standpoint. Paul Dalzell referred to some work being conducted by the National Center for Ecological Analysis and Synthesis (NCEAS) of the University of California of which Hoyt Peckham was a member, which was looking at this issue.

Liz Petras noted that one of the questions which is frequently raised in ESA Section 7 Biological Opinions is the question of males, because so many of the models that are done are based on nesting females and assume a 50 percent sex ratio. One of the questions that was now being posed was how climate change may affect long-term trends in sex ratios among turtle populations and how we begin to consider this when conducting risk assessments.

Selina Heppell ctated that most of the populations do not assume a 50/50 sex ratio. Instead the hatchling sex ratio or even in-water sex ratio information was used when it was available. As far as the long-term prospects other researchers such as Jeanette Wynaken and Larry Crowder were investigating sex ratios in loggerheads. The issues was not as simple as beaches just get warmer and producing more females, as the sex determination process was more complicated in nature as opposed to laboratory conditions. Crower and Wynaken had found more males in warm areas than they expected and more females in cool areas than they expected. Humidity within the nests and various other factors have also to be considered. As such it was unrealistic to simply assume that climate change will create a skew towards females. This study was conducted about five years ago and the researchers had produced were technical papers on how they determined the sex of the animals. However, papers on the implications of the sex ratios were still in preparation.

Eric Gilman raised the issue of technology transfer between people that have conducted work on reducing turtle interaction in gill net fisheries through gear modification and indicated that this could be helpful, at least in Baja.

Paul Dalzell noted that the main operator of bottom-set longline gear in the Baja loggerhead hotspot had retired his fishing gear, but this did not mean that this gear may not be used by another individual in the future. He suggested that a properly structured experiment of the type that's been conducted for pelagic longlines might be replicated bottom-set longline fishing

Shichao Li suggested that initiatives such as the TurtleWatch program initiated by Evan Howell and his colleagues may have changed fishermen’s behavior and that this could be investigated.

Selina Heppell added that it would useful to conduct an exercise on developing a temperature-based Marine Protected Area. Eric Kingma responded that there was going to be an analysis of precisely this type of alternative in the Environmental Impact Statement and draft amendment.

Paul Dalzell concurred with Li's suggestion and noted that the TurtleWatch products would now be produced in Vietnamese, which was the primary language of most of the swordfish participants in the Hawaii longline fishery.

Jeff Polovina thanks participants for a successful meeting and closed the workshop.

5. PARTICIPANTS LIST

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George Balazs	National Marine Fisheries Service–Pacific Islands Fisheries Science Center (NMFS-PIFSC)
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Milani Chaloupka	Ecological Modeling Services & Council Turtle Advisory Committee Chair
Paul Dalzell	Council Staff
Peter Dutton	NMFS-Southwest Fisheries Science Center (NMFS-SWFSC)
Tomo Eguchi	NMFS-SWFSC
Brandee Gerke	National Marine Fisheries Service –Pacific Islands Regional Office (NMFS-PIRO)
Eric Gilman	International Union for the Conservation of Nature (IUCN)
Selina Heppell	Oregon State University
Evan Howell	NMFS-PIFSC
Takashi Ishihara	Sea Turtle Association of Japan
Irene Kinan-Kelly	Council Staff
Eric Kingma	Council Staff
Don Kobayashi	NMFS-PIFSC
Shichao Li	Joint Institute for Marine and Atmospheric research & NMFS-PIFSC
Melissa Snover	NMFS-PIFSC
Hoyt Peckham	ProPeninsula & University of California at Santa Cruz Ph.D. candidate
Jeff Polovina (chair)	NMFS-PIFSC
Chris Yates	NMFS-PIRO
Via web-conference	
Elizabeth Petras	NMFS-Southwest Region (NMFS-SWR)
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