

TurtleWatch: a tool to aid in the bycatch reduction of loggerhead turtles *Caretta caretta* in the Hawaii-based pelagic longline fishery



Evan A. Howell¹, Donald R. Kobayashi¹, George H. Balazs¹, Denise M. Parker¹, Sei-Ichi Saitoh², and Jeffrey J. Polovina¹

¹Ecosystems and Oceanography Division Pacific Islands Fisheries Science Center, Honolulu, HI

²Faculty of Fisheries Sciences Hokkaido University, Hakodate, Japan



Pacific Islands Fisheries Science Center

Why do we need a TurtleWatch?

- Loggerhead turtles bycatch is a large concern in the Hawaii-based pelagic longline fishery targeting swordfish
- Swordfish fishery was shut down in 2002 (ban on shallow sets)
- Fishery was reopened in 2004 with very strict guidelines
- 17 Loggerhead interactions will shut down shallow set fishery
- Impetus to find area where highest interactions occurred (avoidance)

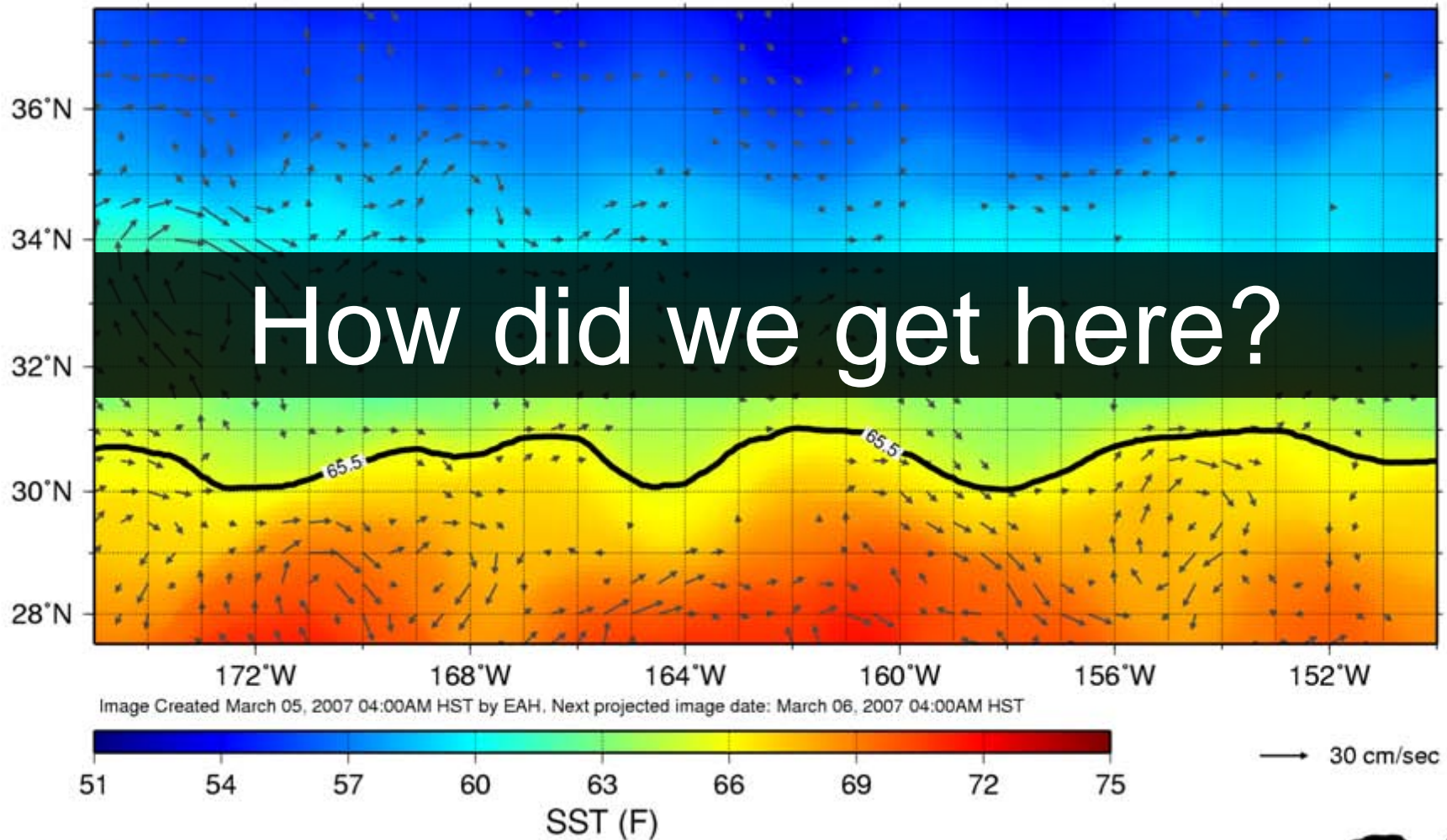


EXPERIMENTAL PRODUCT

avoid fishing north of solid black 65.5°F line to reduce turtle interactions

Sea Surface Temperature: 02Mar2007-04Mar2007

Ocean Currents: 21Feb2007-27Feb2007



PACIFIC ISLANDS FISHERIES SCIENCE CENTER
ECOSYSTEMS AND OCEANOGRAPHY DIVISION
2570 Dole Street, Honolulu, HI 96822

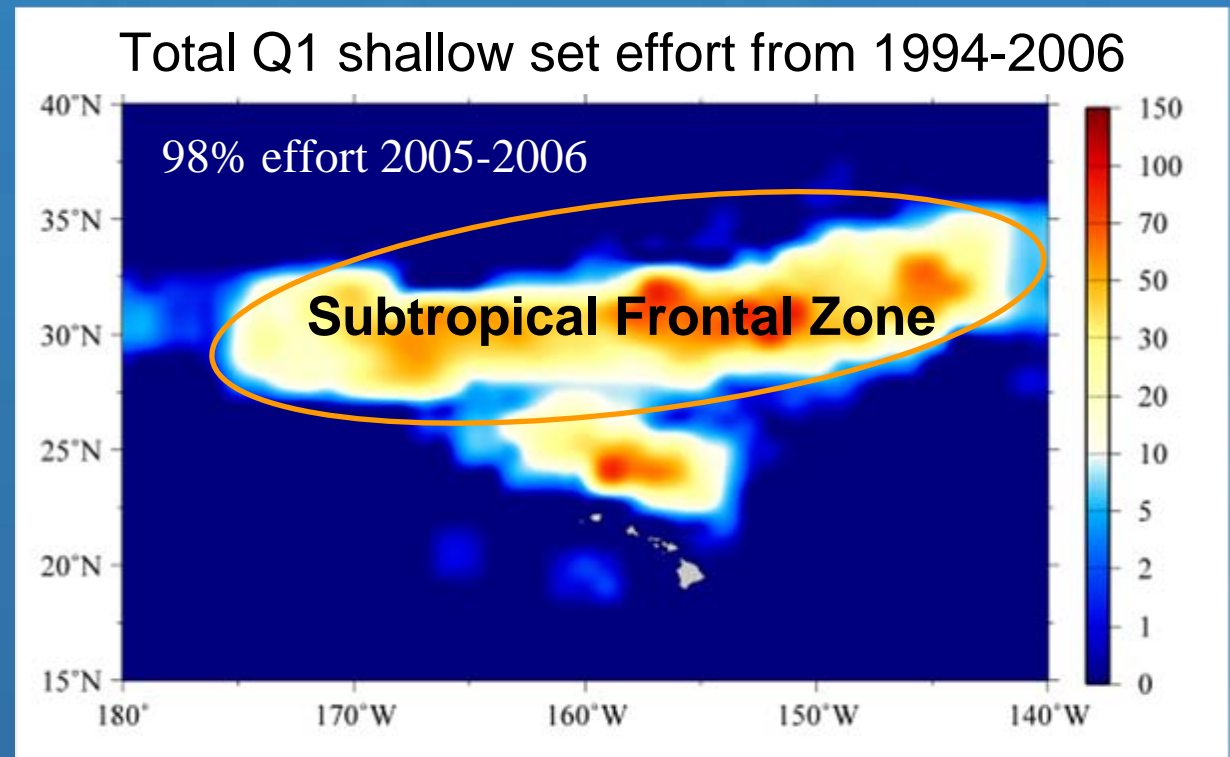
Data provided by Central Pacific CoastWatch Node

TURTLEWATCH



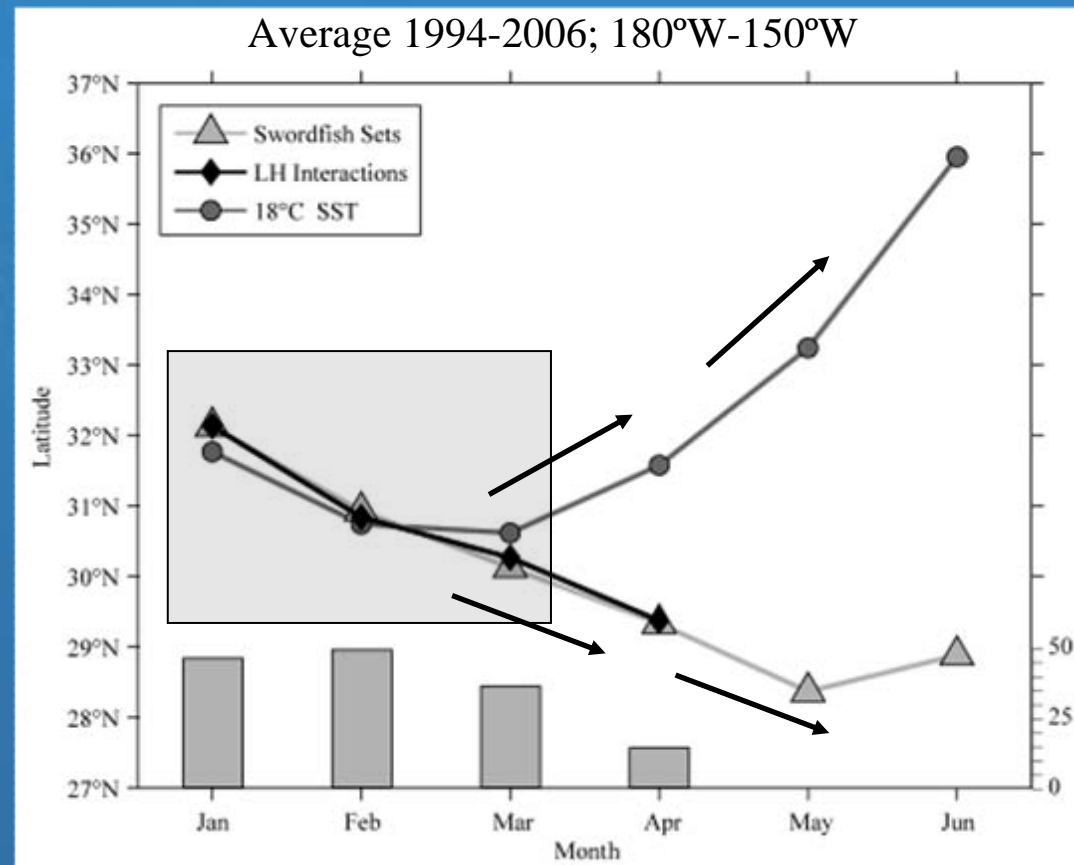
Hawaii-based longline fishery: What we knew

- Swordfish and turtles both within subtropical frontal zone north of Hawaii during January – March
 - This frontal zone is an area where physical and biological properties change rapidly with latitude (TZCF)
 - Place of convergence where prey species aggregate
- Fishery uses environmental data (esp. SST) to locate areas with higher probability of catch
- Fishery since 2004 under strict regulation
 - 100% observer coverage
- Hard cap: 17 loggerhead interactions closes fishery for remainder of year
- In March 2006 17th turtle was landed and fishery was shut down



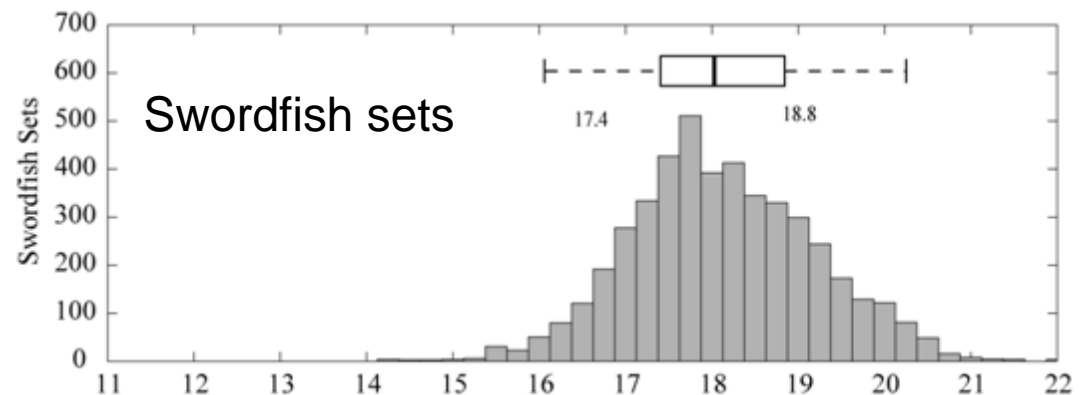
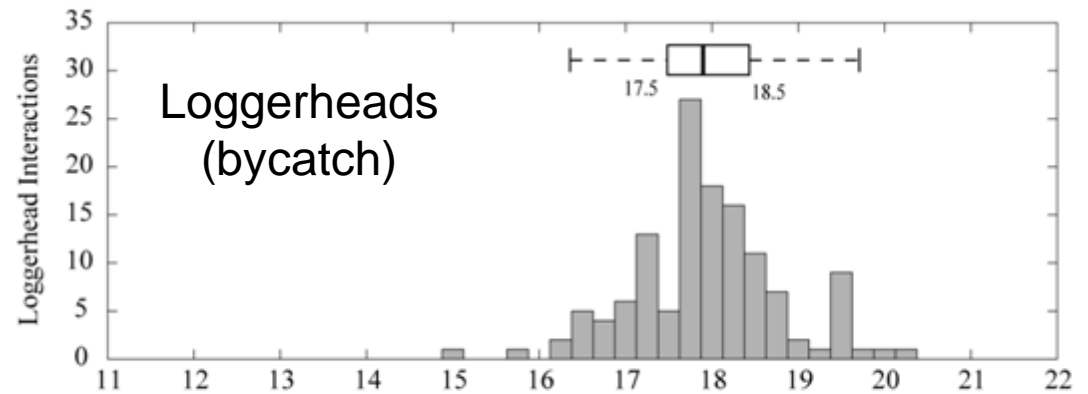
Relationship between SST, sets, and interactions

- During 1Q shallow sets and turtle positions track latitudinal movement of 18°C isotherm (proxy for central location of the NPTZ) with highest interactions
- From April, fishery moves to south, frontal zone to north
 - Large decrease in loggerhead turtle interactions
- This divergence continues through May and June, with no loggerhead turtle interactions above 28°N in these months
- Can compare environmental (SST) signal of sets, interactions



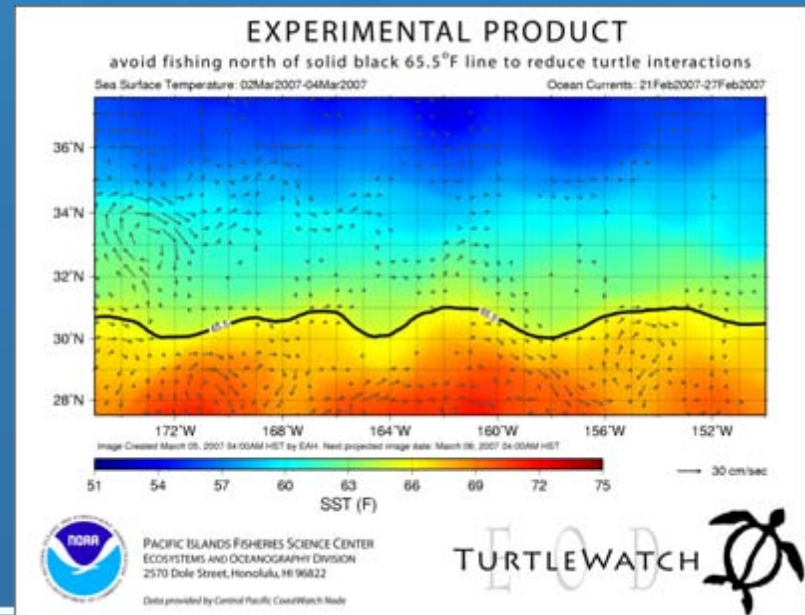
SST distributions

- All SST values from 1994 - 2006
- Inter-quartile range of turtle interactions 1994-2006 between 17.5°C and 18.5°C
- Swordfish within similar range yet skewed to warmer temperatures (17.4°C – 18.8°C)
- These are fishery dependent, what is “real” turtle distribution?
- Have positions from juvenile satellite-tracked turtles: in much colder surface waters
- Due to ARGOS satellite positions, 18.5°C chosen as northern rec. limit of fishing (conservative)



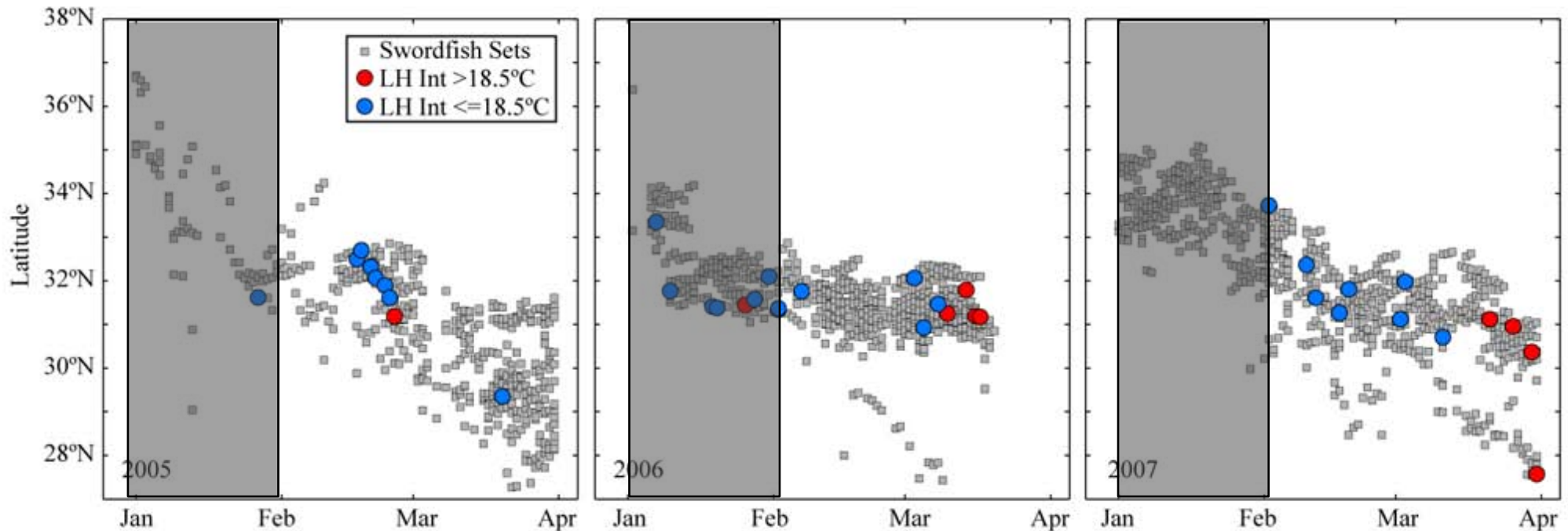
Post-release behavior of fleet (Q1 2007)

- TurtleWatch product released in December 2006 to fishery and managers
 - Idea was to provide information to fishers to attempt to minimize bycatch
 - Also given to managers to attempt to create “dynamic” time-area closures or recommended avoidance areas if necessary (i.e. bycatch too high)
- Main question was: What was the response of the fleet, if anything?
- Basically we were recommending to not fish in a large area of the fishing grounds to avoid bycatch
- So what happened?



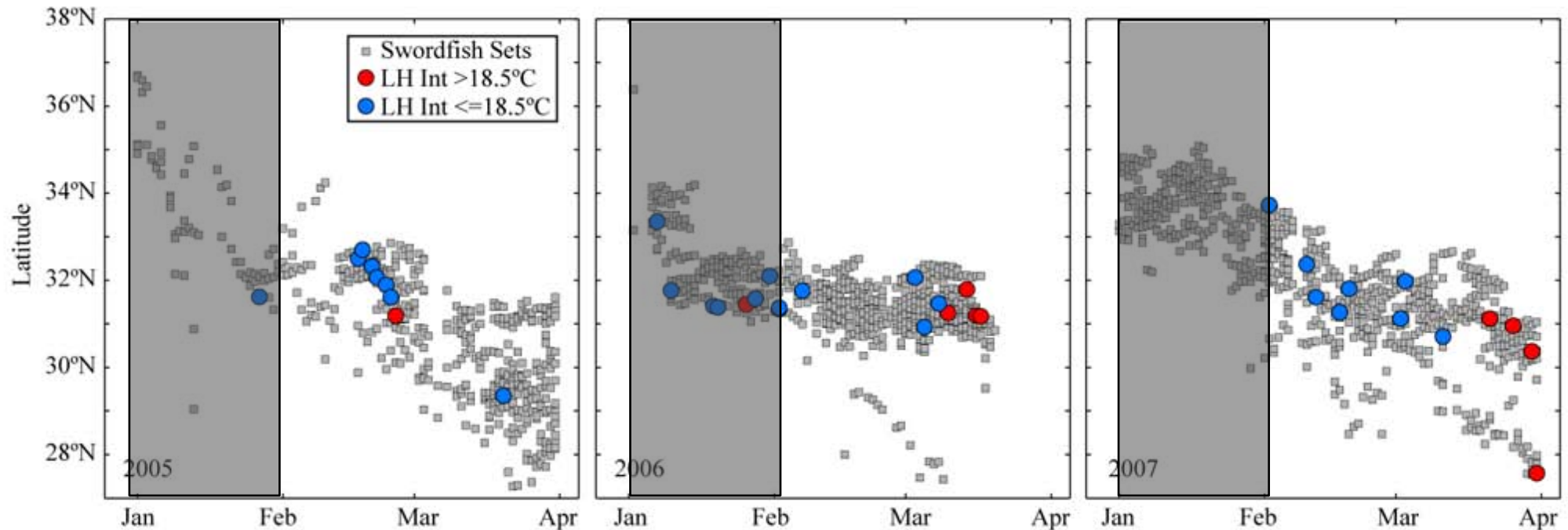
Latitudinal patterns of fishery in 1st quarter 2005-2007

- Fleet behavior: apparent shift in placement of sets in 2007, majority of sets in January north of 33°N
- Similar to set position in 2005, yet much further north than sets in January 2006
- In addition, fishery did not begin its southern movement until late in January (in contrast to 2006)



Latitudinal patterns of fishery in 1st quarter 2005-2007

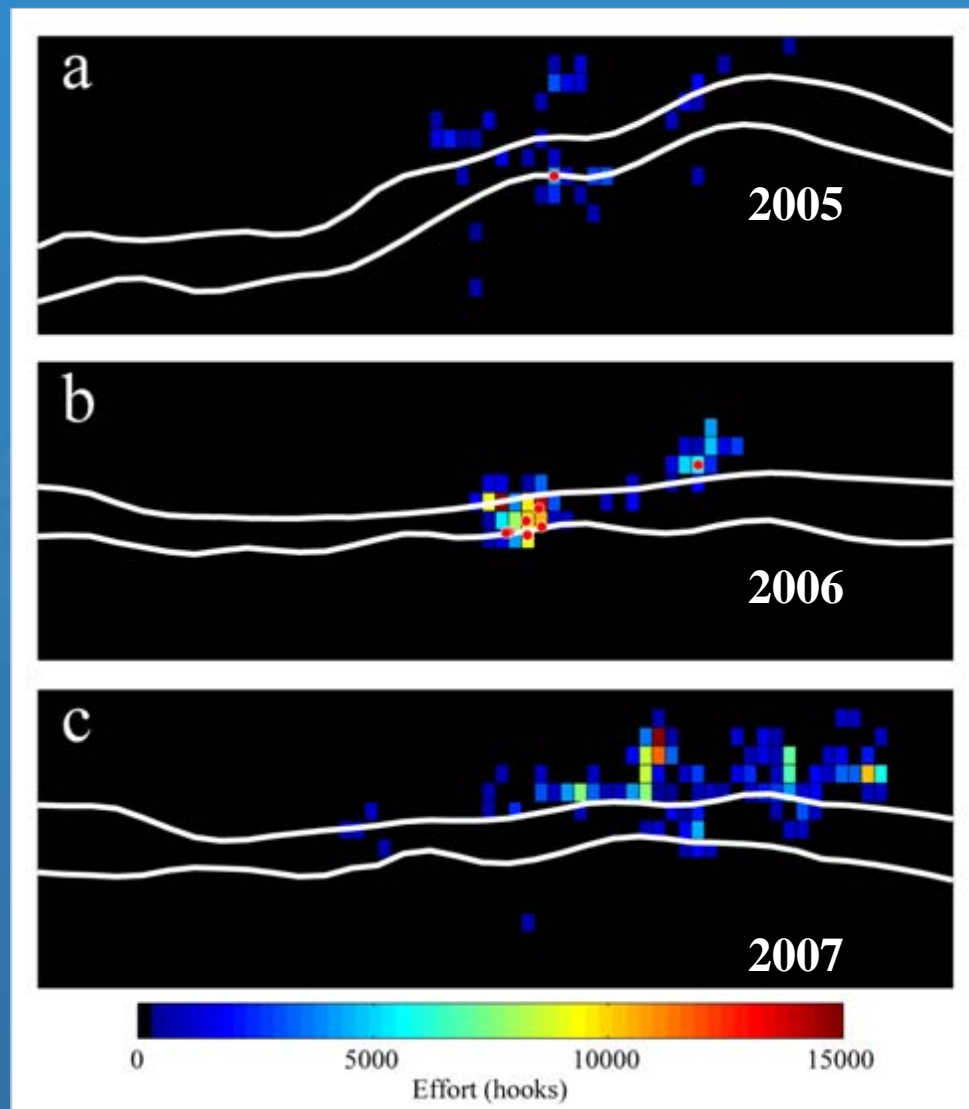
- 8 of the 12 turtle interactions (66.7%) in the first quarter of 2007 occurred in surface waters colder than 18.5°C, in the area where fishing was discouraged by the TurtleWatch product
- Most interactions in waters cooler than 18.5°C (74%) for all 3 years
- January pivotal month to prolong season? Appears that **when** fleet moves south important



Fishery and environmental variability for January 2005-2007

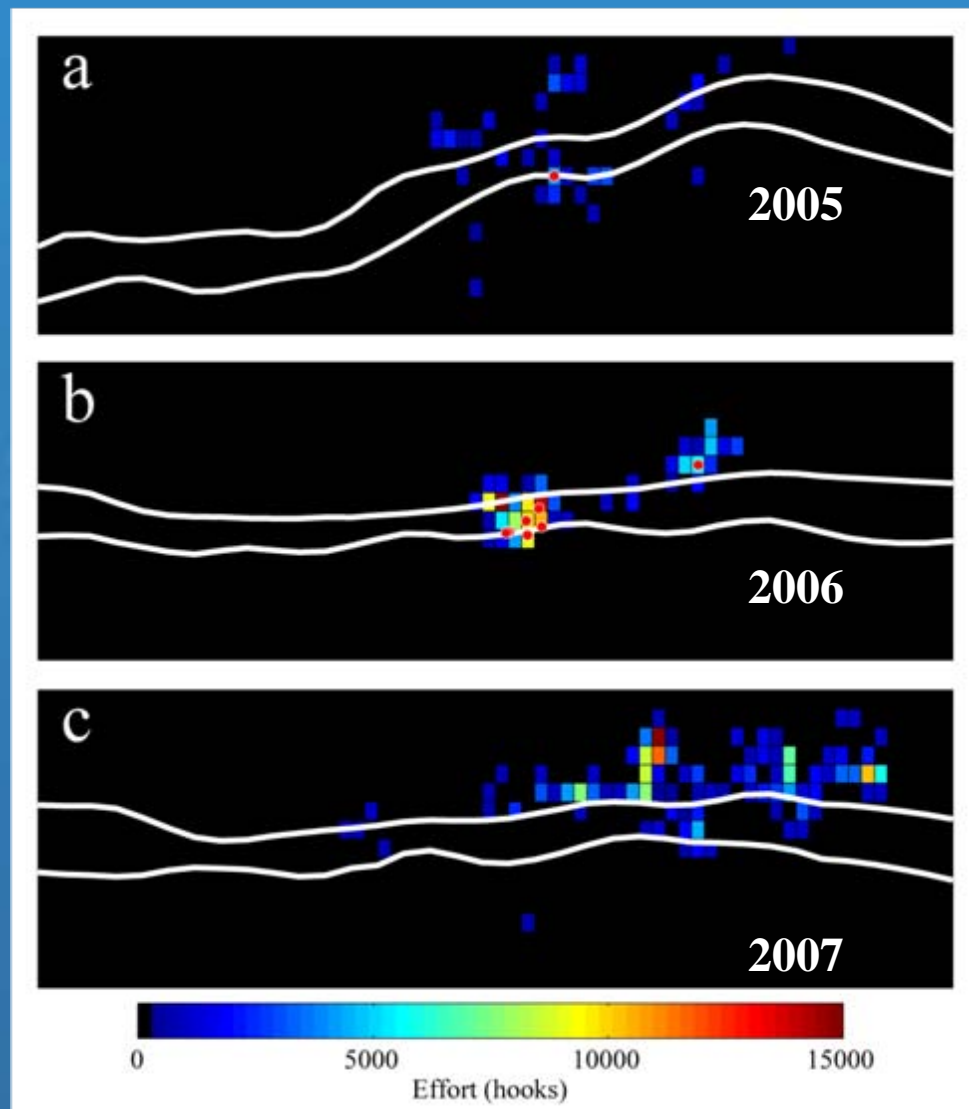
- 2005: There was one turtle interaction during January of 2005 which occurred in surface waters colder than 18.5°C
- 2006: One interaction in northeast, six interactions in frontal zone. 5 of 6 were in 17.5° - 18.5°C

(TurtleWatch released December 2006)



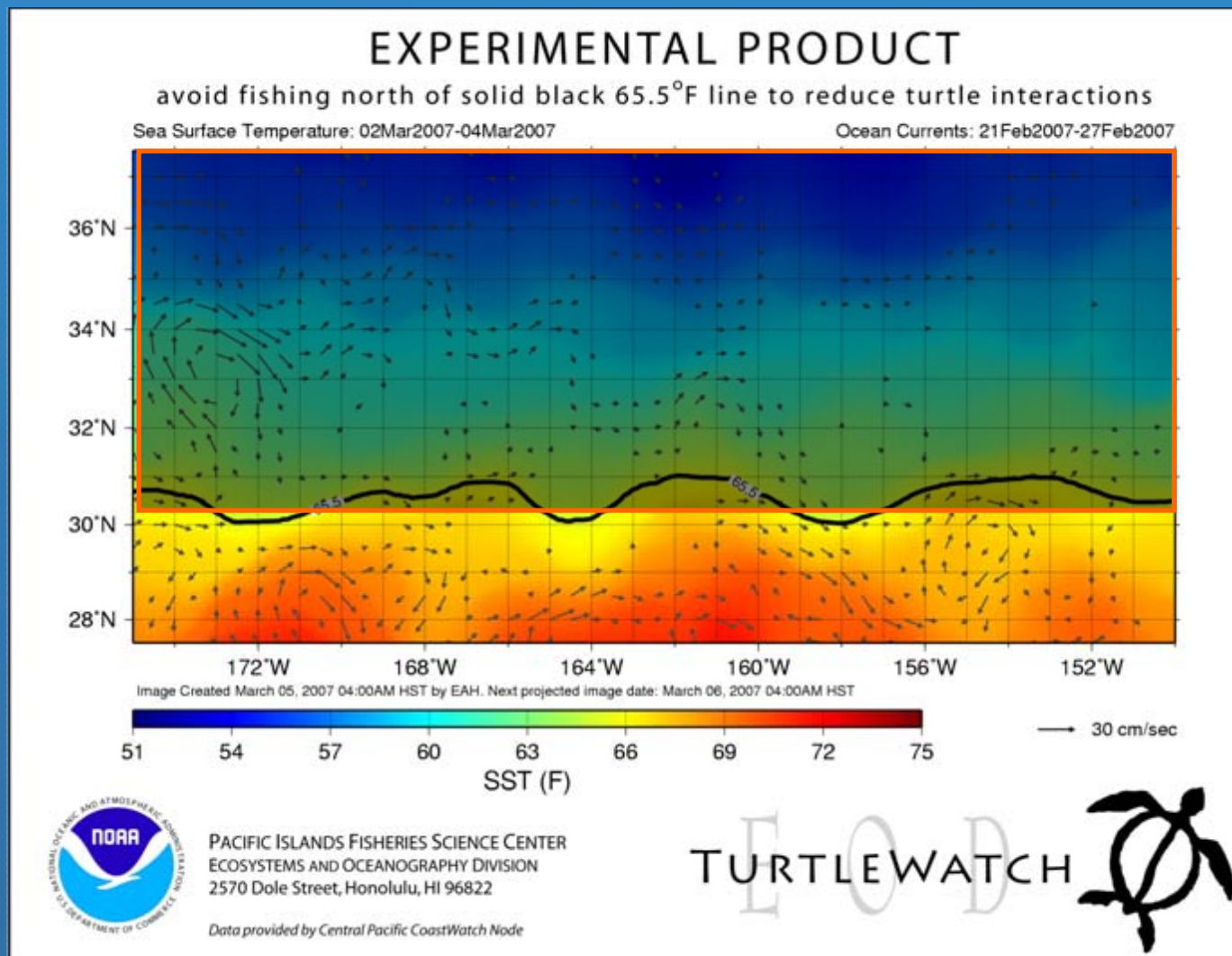
Fishery and environmental variability for January 2005-2007

- 2007: Majority of shallow sets north of 17.5°C isotherm in 2007 with no interactions
- Response of fleet was not to avoid the region of avoidance recommended by TurtleWatch, yet from 2007 more data showing lower bycatch when effort in area to north where more “real” turtles were (from satellite data)
- This allowed for possible refinement of TurtleWatch product



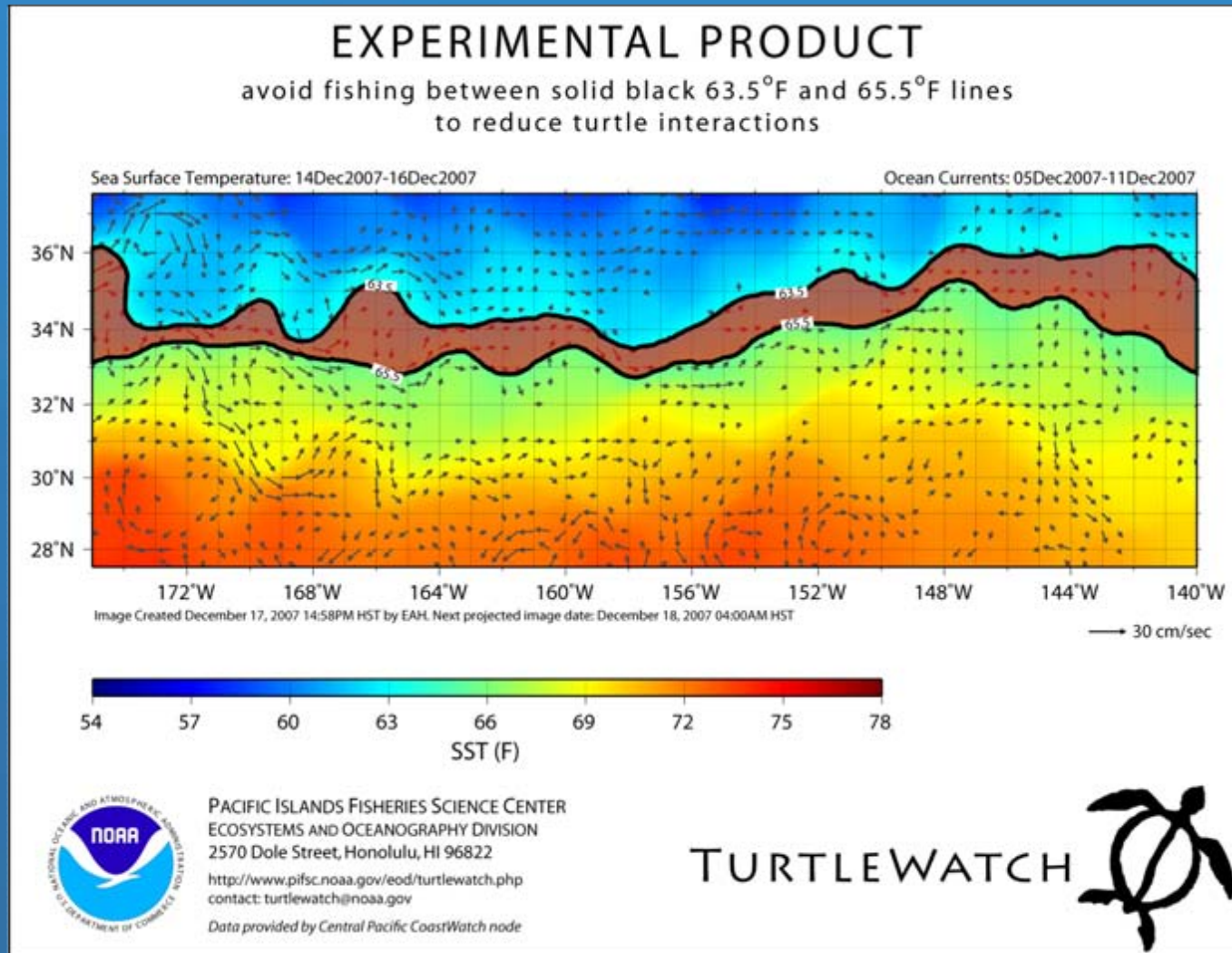
PIFSC TurtleWatch – 2007 season

- Initial product. Released Dec 26, 2006 to managers and industry
- Basically recommended avoiding a very large area



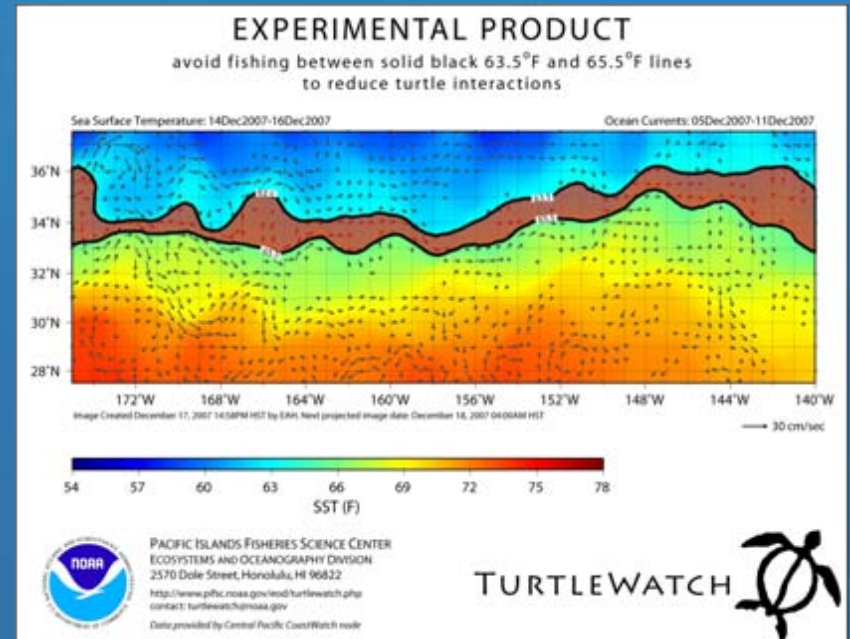
Refinement of TurtleWatch product - 2008

- Based on lack of interactions in colder SST (yet higher observed satellite positions) we can begin to refine TurtleWatch (original inter-quartile range)
- Chose to recommend thermal band (17.5°-18.5°C) as region to avoid



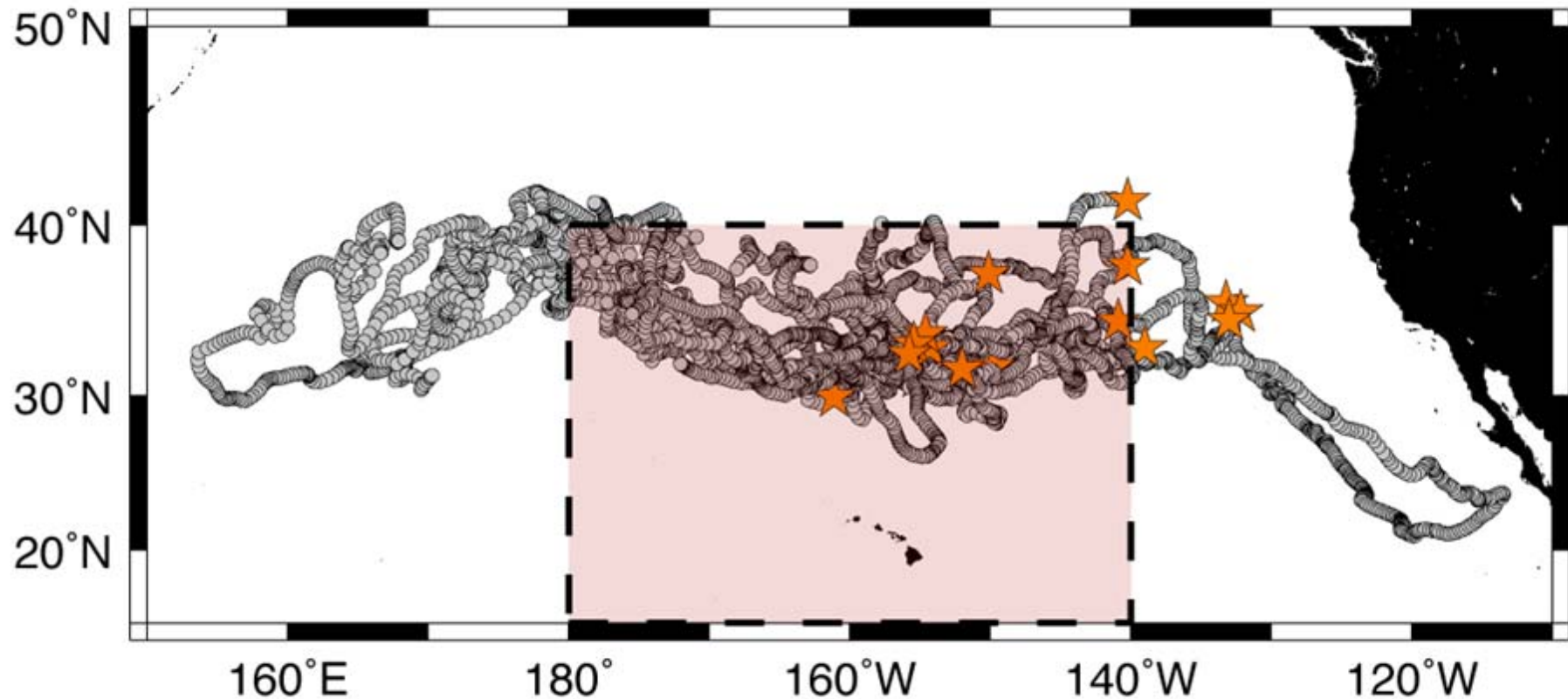
TurtleWatch – 2D

- One goal of this work was to try to get managers to focus more on feature area closures rather than time area closures. Managers (the council) open and responsive to this idea
- TurtleWatch at this point is a 2D region of predicted highest interactions
- Next step – Expand surface work with dive data (3D predictions)



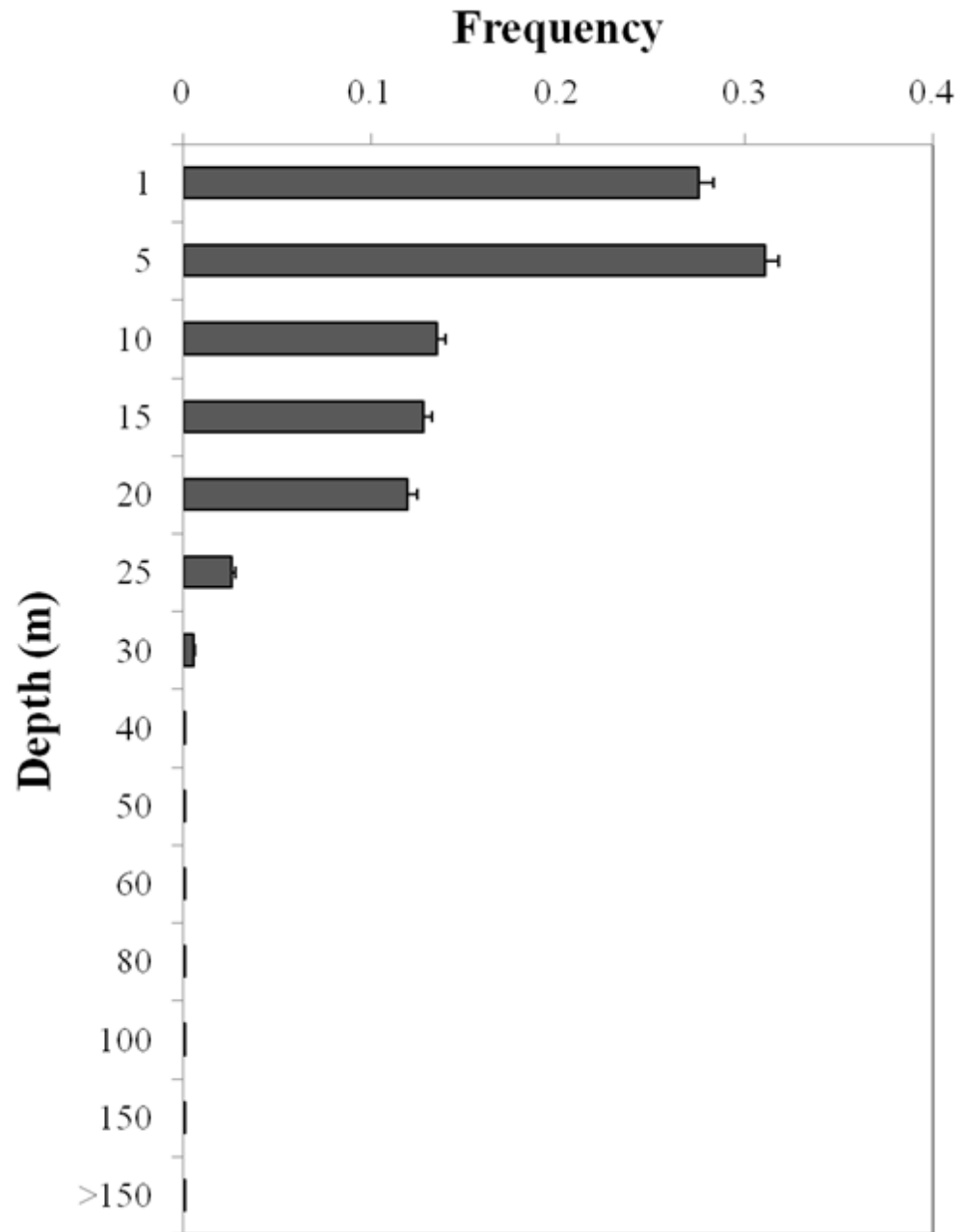
Juvenile loggerhead turtle satellite telemetry dive data

- 17 animals tagged in study (2002-2005)
 - Caught by fishery, tagged and released
- Over 75% of total data within fishing area
- ~20% in fishing area during first quarter



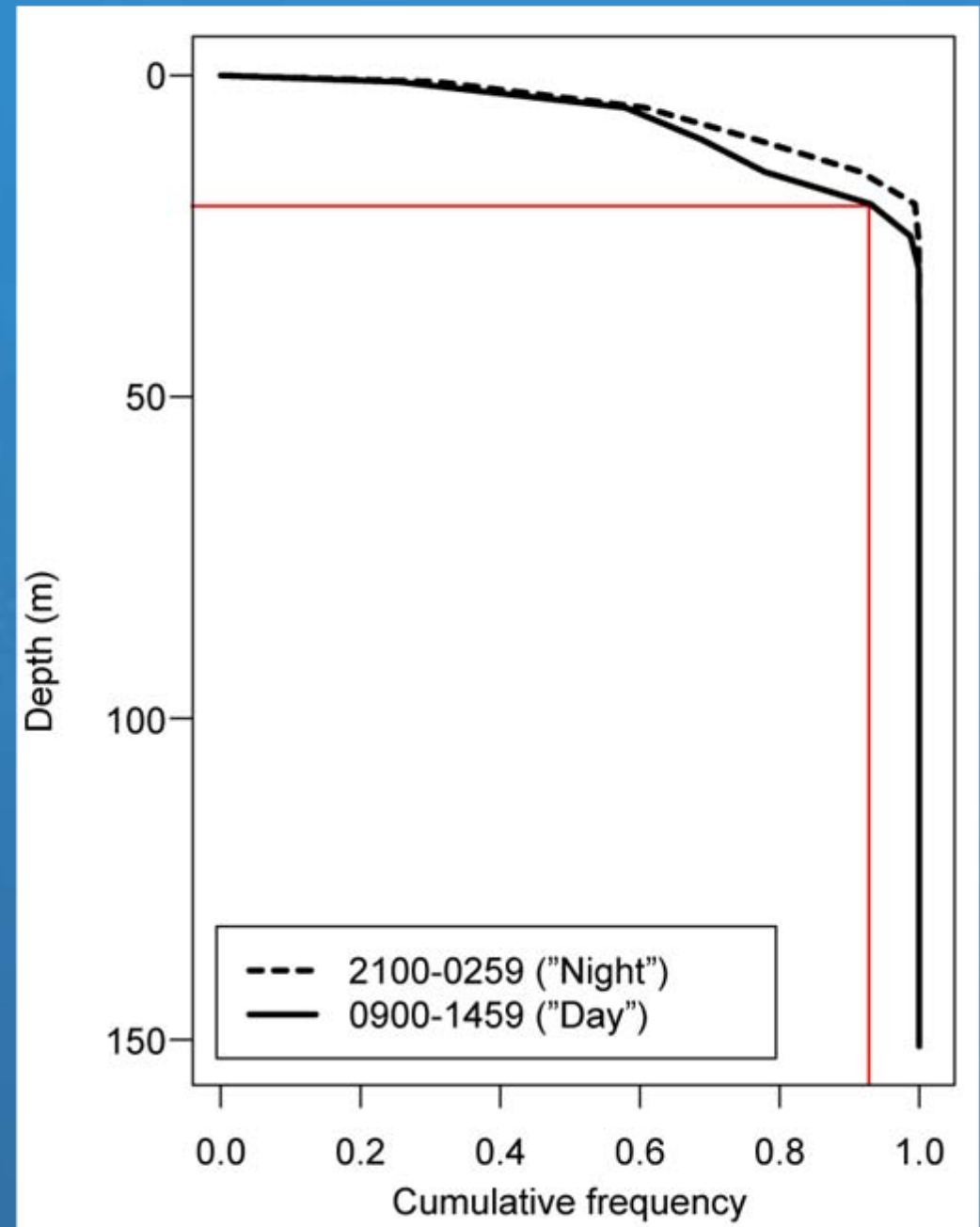
24 hour Dive frequencies in fishing grounds

- Over 50% of time spent in top 5 m (not really “diving”, more like gliding)
- Over 95% of time spent in the top 20 m
- Sporadic dives to >100 m, but most time is shallow



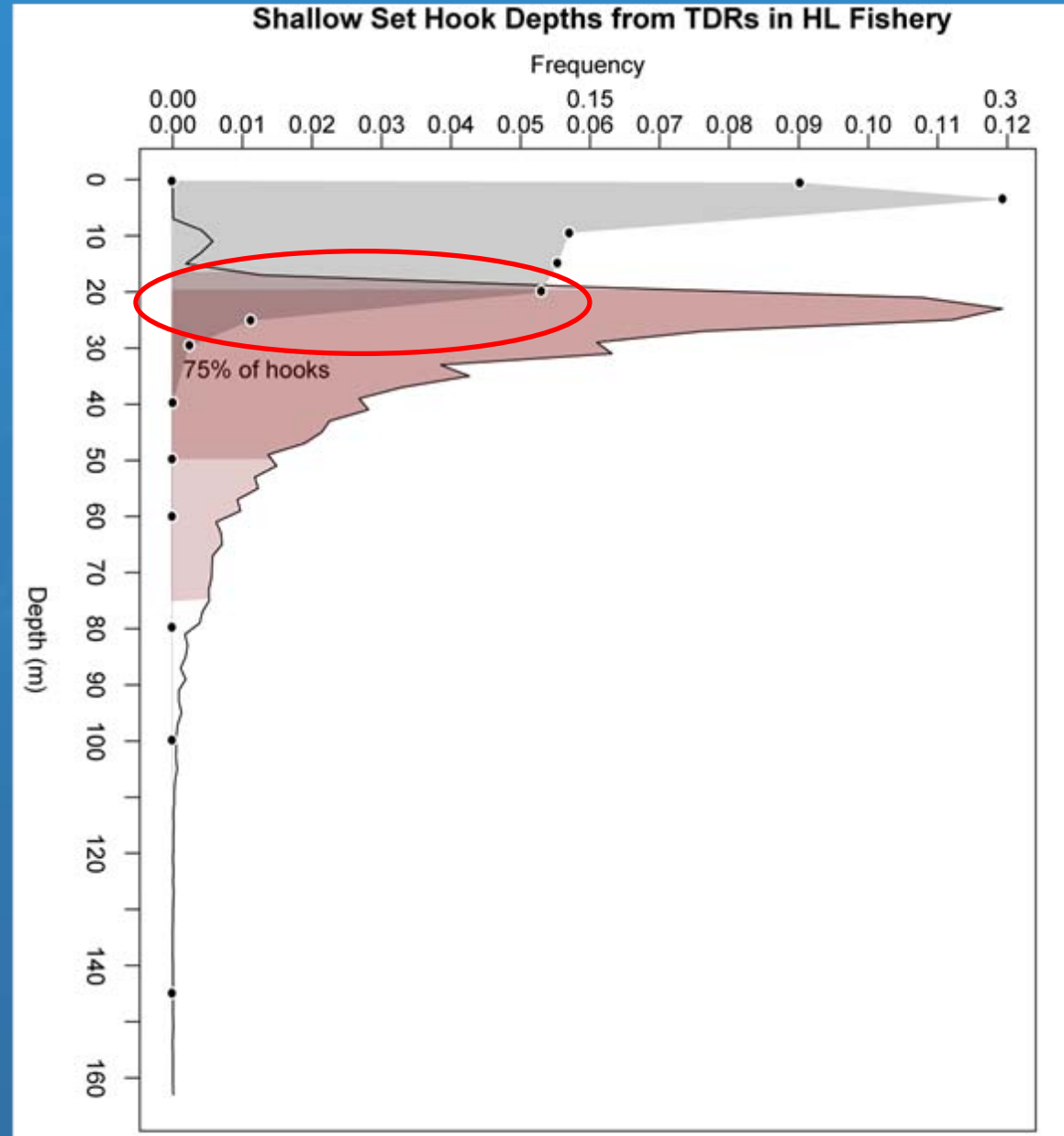
Cumulative dive frequencies in fishing grounds

- Can see day night differences
 - Deeper during day
- For both periods over 90% of time spent in top 20 m
- Interesting in that fishery is now mandated to have floats shallower than 20 m to avoid accidental drowning of bycatch
- This may push gear shallower and increase interactions (assuming that when gear and turtles crossover = interaction)
- We have gear depth from TDRs



TDRs and Fishery Area TAD (Oct-Mar)

- Crossover of turtle dives (from tags) and fishing gear depths (from TDRs set after 2005)
- Very small area of crossover
- This is just looking at time at depth, type of diving (forage) may be more important than just time
- Very preliminary, but begins to set the stage for future research
- Incorporate depth to make interaction predictions from 3D data

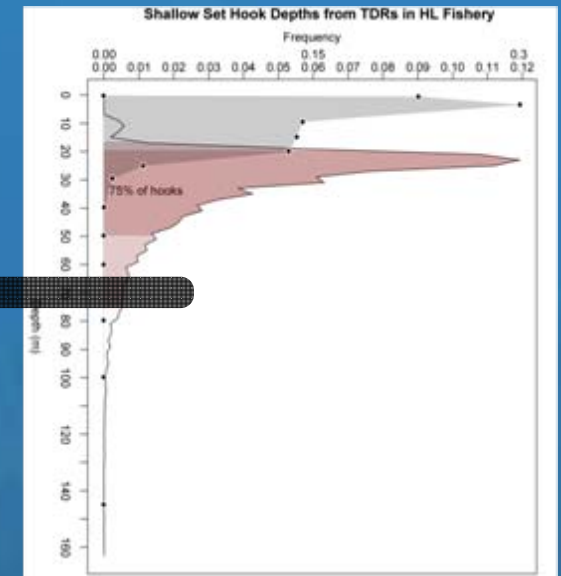
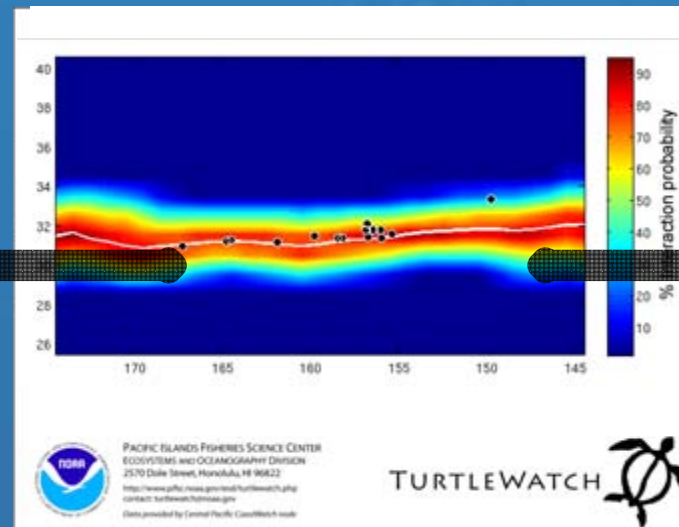
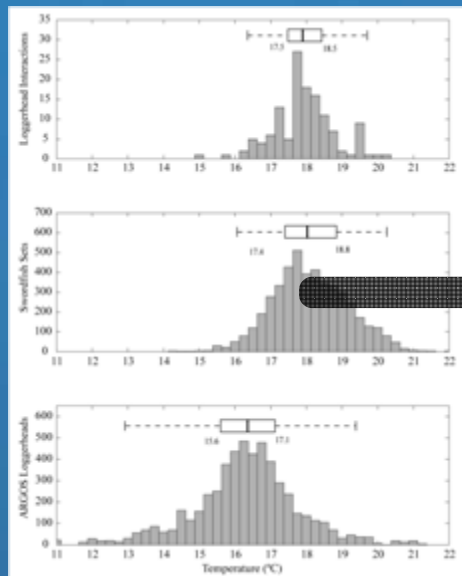


Loggerhead/gear “3D” interaction maps (proof in concept)

Have SST distributions (fish/non-fish)

Can incorporate dive data

- Provides current TurtleWatch product
 - 2D method
 - Mean \pm SD
 - Bayesian probabilities
- Incorporate dive and TDR data
- Provide “3D” based prediction



Summary and Future Work

- Results from tagging studies show that juvenile loggerhead turtles are associated with the frontal zones and hot spots in the North Pacific
- Matching these tagging data with remotely-sensed environmental data allows us to see where the highest loggerhead interactions have occurred, and to recommend an environmental area to avoid setting shallow gear to minimize bycatch (i.e. TurtleWatch)
- Preliminary results from juvenile loggerhead dive data looks promising in allowing us to further predict where bycatch may occur in space and depth
- Future work will concentrate on researching variability in dive behavior and will be incorporated where possible into TurtleWatch





Pacific Islands Fisheries Science Center