# Sea Turtle Bycatch Reduction: Regulation Efficacy of Circle Hooks in the US Hawaii-based Shallow Set Longline Fishery

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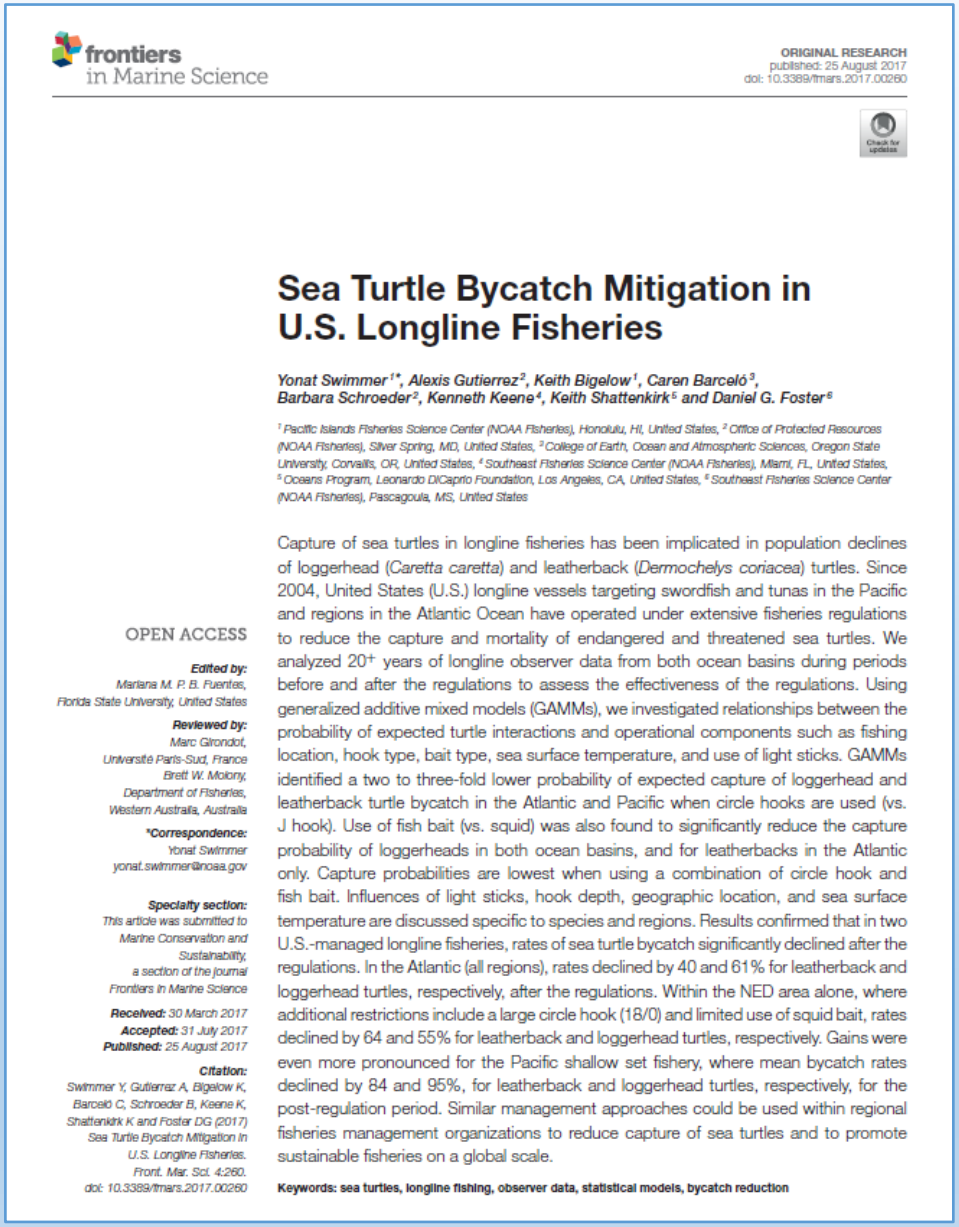

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# Sea Turtle Bycatch Mitigation in U.S. Longline Fisheries

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Capture of sea turtles in longline fisheries has been implicated in population declines of loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*) turtles. Since 2004, United States (U.S.) longline vessels targeting swordfish and tunas in the Pacific and regions in the Atlantic Ocean have operated under extensive fisheries regulations to reduce the capture and mortality of endangered and threatened sea turtles. We analyzed 20+ years of longline observer data from both ocean basins during periods before and after the regulations to assess the effectiveness of the regulations. Using generalized additive mixed models (GAMMs), we investigated relationships between the probability of expected turtle interactions and operational components such as fishing location, hook type, bait type, sea surface temperature, and use of light sticks. GAMMs identified a two to three-fold lower probability of expected capture of loggerhead and leatherback turtle bycatch in the Atlantic and Pacific when circle hooks are used (vs. J hook). Use of fish bait (vs. squid) was also found to significantly reduce the capture probability of loggerheads in both ocean basins, and for leatherbacks in the Atlantic only. Capture probabilities are lowest when using a combination of circle hook and fish bait. Influences of light sticks, hook depth, geographic location, and sea surface temperature are discussed specific to species and regions. Results confirmed that in two U.S.-managed longline fisheries, rates of sea turtle bycatch significantly declined after the regulations. In the Atlantic (all regions), rates declined by 40 and 61% for leatherback and loggerhead turtles, respectively, after the regulations. Within the NED area alone, where additional restrictions include a large circle hook (18/0) and limited use of squid bait, rates declined by 64 and 55% for leatherback and loggerhead turtles, respectively. Gains were even more pronounced for the Pacific shallow set fishery, where mean bycatch rates declined by 84 and 95%, for leatherback and loggerhead turtles, respectively, for the post-regulation period. Similar management approaches could be used within regional fisheries management organizations to reduce capture of sea turtles and to promote sustainable fisheries on a global scale.

**Keywords: sea turtles, longline fishing, observer data, statistical models, bycatch reduction**

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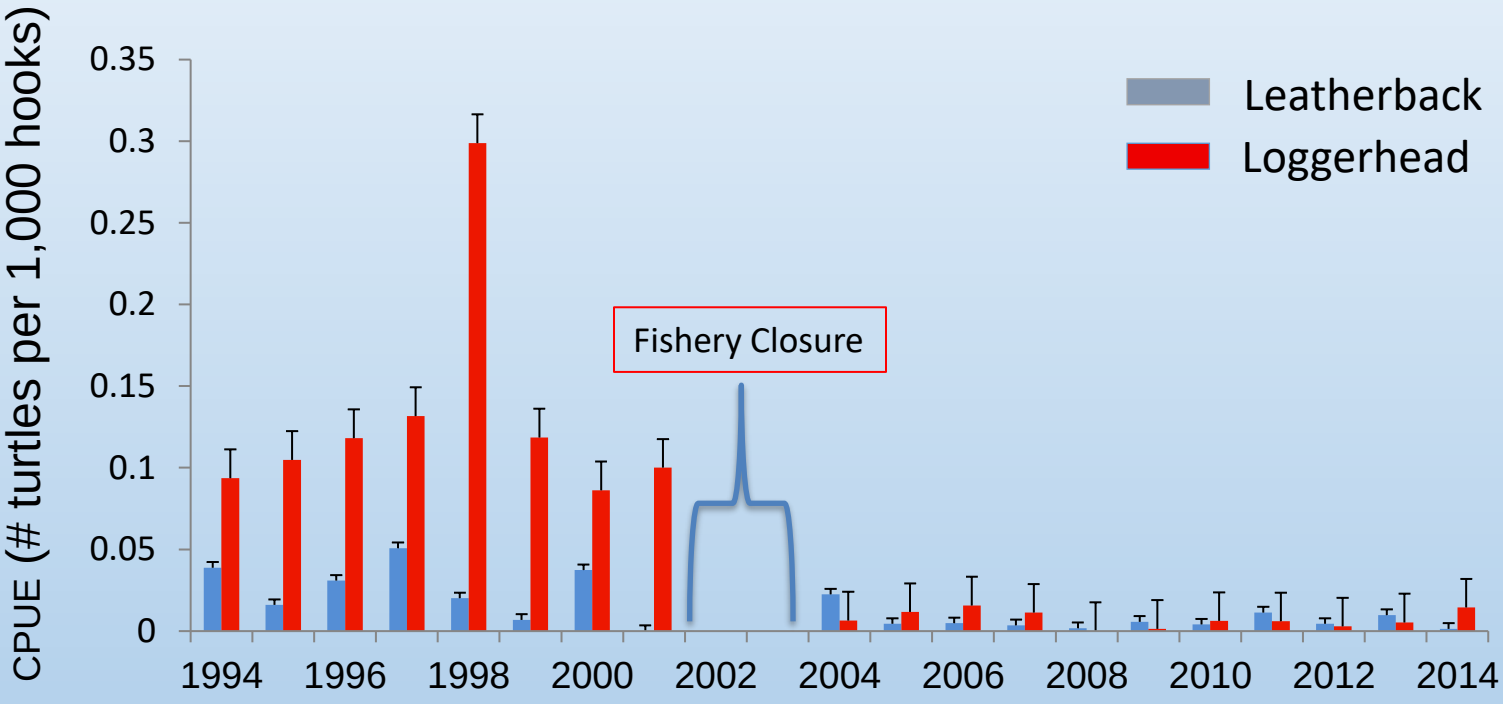
- **Analysis of sea turtle bycatch before and after implementation of regulations to reduce bycatch**

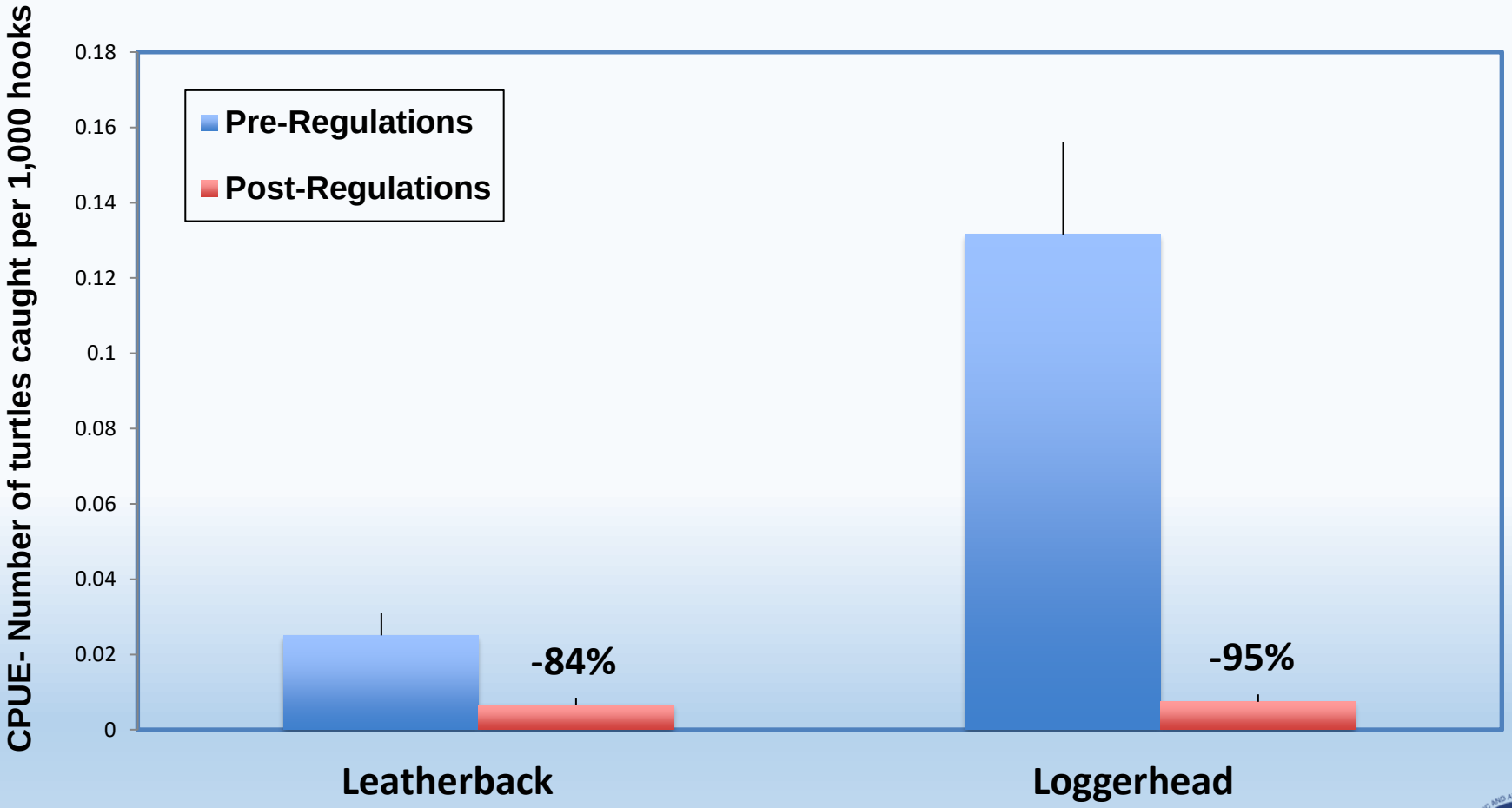
- **Pacific Data (Hawaii-based shallow set fishery)**
  - **1994-2014**
  - **Swordfish-target only**
  - **>15,000 sets**
  - **20-100% observer coverage (100% since 2004)**

- **Regulations since 2004:**
  - **circle hooks sized 18/0 or larger with offset <=10 degrees**
  - **mackerel-type fish bait only (no squid)**
  - **safe handling**

# Sea Turtle Bycatch in Hawaii-based Shallow Set Longline Fishery Before and After Regulations



# CPUE Pre vs. Post Regulation



# Key Points

- The use of 18/0 circle hooks with offset <=10 degrees and mackerel-type fish bait very effectively reduced the probability of catching sea turtles in Pacific Hawaii-based shallow set longline fishery.

- Bycatch rates of leatherbacks were reduced 84% and loggerhead bycatch was reduced 95% before and after the regulations were implemented.