PELAGIC FOOD WEB CONNECTIVITY IN THE NORTH PACIFIC SUBTROPICAL GYRE: A COMBINED PERSPECTIVE FROM MULTIPLE BIOCHEMICAL TRACERS AND DIET

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAIʻI AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

OCEANOGRAPHY

DECEMBER 2013

By

C. Anela Choy

Dissertation Committee:
Jeffrey C. Drazen, Chairperson
Brian N. Popp
Jeffrey J. Polovina
Erica Goetze
Gregory E. Ravizza, Outside member

Keywords: micronekton, pelagic fishes, stable isotopes, mercury, amino acid compound specific isotope analysis, mesopelagic, stomach content analysis, Hawaii longline fishery

ABSTRACT

Long-term shifts in the abundances of open ocean fishes have been observed over the period of 1996-2011 in the North Pacific Subtropical Gyre (NPSG). Fishery data indicate that large, high trophic position fishes such as tunas, billfishes, and sharks, have been decreasing in relative abundance, while smaller, mid-trophic position fishes such as alepisaurids and gempylids have been increasing. Some of these species are of great commercial importance, and recent calls for ecosystem-based fishery management require accurate characterization of predator-prey relationships supporting biomass production at the top of the food web. The broad goal of this study was to elucidate pelagic food web structure within the NPSG, focusing on the links formed by understudied mid-trophic level animals (micronekton and their predators), and how energy is transferred through feeding interactions between these animals inhabiting different vertical habitats. Four distinct but complementary approaches were employed: stomach content analysis, bulk stable isotope analysis, compound-specific nitrogen isotope analysis of individual amino acids (AA-CSIA), and total mercury concentrations.

Stomach content analysis revealed that pelagic fish species that have been increasing in abundance have distinct diets relative to adult tuna and billfishes. Unique components of the micronekton community were exploited by alepisaurids, gempylids, and lamprids, including hyperiid amphipods, the little-known cephalopod *Walvisteuthis youngorum*, and mesopelagic fishes (*Anoplogaster cornuta*, *Sternoptyx* spp.), and the polychaete *Vanadis nans*. Despite shared vertical habitat and unique diets, AA-CSIA indicated that both groups of fishes have similar trophic positions. Thus, shifts in

abundances could be the result of predation release since tunas and billfishes feed upon smaller size classes of alepisaurids and gempylids.

Biochemical metrics of trophic position (bulk tissue $\delta^{15}N$ values**,** total mercury concentrations, and AA-CSIA data) were strongly related to animal size for diverse food web components ranging from zooplankton to micronekton to large pelagic fishes. Distinct increases in the $\delta^{15}N$ values of glycine, serine, and phenylalanine were observed with micronekton fish depth of capture, suggesting a separation in food resources across epipelagic, mesopelagic, and upper bathypelagic habitats. Broadly, this study established that the pelagic food web of the NPSG is structured by size-based interactions and the influence of vertical habitat.

TABLE OF CONTENTS