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**Reproductive Biology of Yellowfin Tuna (*Thunnus albacares*), in Hawaiian Waters
and the Western Tropical Pacific Ocean**

University of Hawaii
Pelagic Fisheries Research Program - Project # 2060

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The project described here is a large-scale study on the reproductive biology of yellowfin tuna from the central and western Pacific region, sponsored by the University of Hawaii Pelagic Fisheries Research Program. The reproductive biology of yellowfin tuna has been studied in the central and western Pacific using samples harvested by a variety of gear types.

However, the majority of these studies have used macroscopic techniques to estimate maturity and spawning of yellowfin from samples taken from a single fishery (i.e. longline) within limited spatial and temporal strata. The project described here will investigate the reproductive parameters of yellowfin tuna through the analysis of histological sections of ovarian tissue and batch fecundity estimates using the hydrated oocyte method. Samples will be taken from all major fleets and gear types exploiting yellowfin from these regions over a two year time period to address questions of interaction between surface and sub-surface fisheries and possible differences due to inter-annual variability. The main objectives of the project are to:

- (1) define seasonal, areal and size-related patterns in reproductive parameters for yellowfin tuna (length at 50% maturity, spawning frequency, batch fecundity, sex ratio by length (age) and spawning distribution);
- (2) to compare these parameters between fish taken by surface (purse seine, troll) and sub-surface gear types (longline, deep handline) that may play a role in determining cycles of vulnerability, i.e. address certain interaction issues between regional tuna fisheries, and
- (3) to compare and contrast the main region of yellowfin reproduction in the western Pacific along the Equator, where spawning occurs 12 months of the year to a representative area of seasonal spawning, i.e. around the Hawaiian Island chain.

Purse seine, longline, handline and troll fisheries are being sampled through a series of cooperative agreements and collaborations with at-sea observer and port sampling programs of several international and government research organizations. Fishermen, processors and contracted samplers are also collecting data and samples for the project. As fishing strategies, techniques and efficiency vary between fleets, the sampling effort is distributed over US, Japanese, Korean, Taiwanese, mainland Chinese, Pacific Island domestic, Philippine and Indonesian fleets.

The study area encompasses the main region of yellowfin spawning in the western Pacific that is basically coincident with the western Pacific purse seine and tropical longline fisheries. Specifically, the study area lies between 10°N - 10°S latitude from Kiribati in the east to the Philippines and eastern Indonesia in the west as well as Hawaii waters surrounding the Hawaiian islands.

All samples are shipped to Hawaii, histologically processed and interpreted using light microscopy to determine exact reproductive state; noting oocyte development, presence and age in hours of post ovulatory follicles, presence of atretic oocytes, etc. Hydrated whole ovary samples will be used to derive batch fecundity estimates for different areas and length classes of tuna. These data will be correlated to related capture data, such as set type, school behavior, capture depth, water temperature, seasonality, etc. as may be useful to address project objectives.

Slide interpretation and analysis is ongoing, but indications are that yellowfin in the western Pacific region exhibit spawning characteristics similar to studies from other regions conducted by researchers using histological techniques, i.e. yellowfin are serial spawners, releasing millions of eggs per batch during extended periods at nearly daily intervals. Post ovulatory follicles apparently persist for less than 24 hours and are a reliable indicator of recent spawning activity. Observations of post-ovulatory follicle condition related to time of capture indicates that spawning in Hawaii and the western Pacific occurs at night, primarily before midnight.

Analysis of samples collected near the Equator indicate that female yellowfin in the western Pacific spawn almost daily throughout the year after reaching sexual maturity. The smallest sexually mature female yellowfin identified by this study so far was 78 cm in fork length, but most females are not reproductively mature until over 105 cm in length.

Preliminary analysis of samples taken by purse seine sets on surface unassociated schools, log associated schools and sub-surface longline sets produced mean estimates of batch spawning frequency of 1.13, 1.18 and 1.23 (day per spawning) respectively. The slightly less than daily spawning rhythm is due to the inference that sexually mature female yellowfin pass through long phases of active spawning, interspersed with shorter dormant periods when environmental conditions will not support daily spawning. The surface 'unassociated' schools were actually all actively feeding schools classified as foaming or boiling schools. They exhibited the highest spawning frequencies with little or no atresia of fully yolked oocytes. This observation supports the assumption that the high cost of daily spawning of female yellowfin requires a high level of feeding activity. Longline samples showed higher rates of mature but not spawning females that had fully or partially atretic oocytes. However, many longline samples appeared identical to purse seine samples which may be a reflection to the shallow setting strategy and surface nature of some longline fisheries.

It has been observed that yellowfin spawn only during the late spring, summer and early fall seasons in Hawaiian waters. Preliminary results from this project corroborate these observations and indicate that during the spawning season, mature yellowfin spawn almost every evening in Hawaiian waters and release millions of eggs per batch. Batch fecundity estimates for Hawaiian yellowfin range from 1.8 to 10.5 million eggs.

The *ika shibi* handline fishery of the Big Island of Hawaii lands mostly mature, spawning condition fish after soon after the fish have spawned. Apparently, the fish do not take hook and line gear during spawning but do so immediately post-spawning. Spawning condition yellowfin are also taken by the summer troll fisheries, and it is likely that the intense feeding activity necessary to sustain high levels of spawning makes the fish more vulnerable to troll gear. Mature but reproductively inactive yellowfin are taken by longline all winter in Hawaiian waters.

Sampling for the project will continue through April 1996. Ongoing work during 1995 will concentrate on maximizing sampling from all areas, analysis of histological and batch fecundity samples and correlating the large amount of fishery data with analyzed samples for report generation.