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HYPOTHETICAL SKIPJACK TUNA HABITAT BASED ON PHYSIOLOGICAL LIMITS

By

Richard A. Barkley[1]

SUMMARY

Neill, Gooding and others at the National Marine Fisheries Service Honolulu Laboratory have measured a variety of physiological parameters of skipjack tuna. The factors which most obviously tend to limit the distribution of these fish are: (1) the lower lethal temperature, approximately 14° to 18°C depending upon prior conditioning; (2) the lower lethal dissolved oxygen concentration, 4 to 5 ppm or 2.8 to 3.5 ml/liter; and (3) an upper temperature bound which varies with size and metabolic rate of the fish.

According to Neill, a normally active skipjack tuna, whose metabolic activity requires some 3 mg oxygen/gram/hour, undergoes thermal stress if the ambient water temperature exceeds 35°C for fish smaller than 2 kg, and lesser temperatures for larger fish, such as 20°C for a 12 kg animal. If the water is too warm, skipjack tuna must either reduce their activity, or risk overheating of muscle tissue, because they conserve body heat with marked efficiency.

Skipjack tuna should therefore inhabit waters with oxygen concentration in excess of 3.5 ml/liter, and temperatures between about 18°C and the upper bound appropriate for their size and activity. Throughout the equatorial Pacific Ocean, water in the lower portion

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[1]Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, Hawaii 96812.

of this temperature range is deficient in oxygen, and the maximum habitat depth is set by the oxygen requirement. At higher latitudes, the water at the cold limit has enough oxygen, and low temperature is the limiting factor.

Skipjack tuna can exceed their thermal limits for short periods of time, because the time constant (the e-folding response time for a step change in water temperature) for skipjack tuna muscle temperature ranges between 30 minutes and an hour. That is, skipjack tuna can forage for some time in water which is clearly too warm, provided that cool oxygenated water is available immediately below; similarly, they could move into water which is oxygenated but too cold for long-term comfort, as long as there is water overhead in which to warm up afterward.

Clearly the normal habitat of all but the smallest skipjack tuna is the upper thermocline, for most of the year, throughout most of their range. In much of the eastern tropical Pacific, however, water with at least 3.5 ml/liter of oxygen is warmer than medium and large skipjack tuna can tolerate; some 200 km off Mexico's west coast, the minimum temperature of adequately oxygenated water may exceed 26°C, which would stress fish larger than 4 kg. This warm, low oxygen water is found between 10° and 15°N, 105° to 120°W, approximately. Fish which require water cooler than 24°C (those larger than 6.5 kg) should in addition be excluded from coastal waters between Tehuantepec and Cape Corrientes.

The location and extent of these "forbidden" areas probably varies with season, and from year to year, depending upon mixing and advection--and thus upon winds and currents. These variations should be reflected in the geographic distributions of skipjack tuna of various sizes caught off western Mexico.

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