REVIEW OF BIOLOGY AND FISHERIES ON ALBACORE IN THE NORTH PACIFIC OCEAN

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ABSTRACT

Biological information on stock identification, growth, reproduction and migration of the north Pacific albacore are reviewed. The north Pacific albacore has been considered as a unique stock, although some scientists consider it a non-homogenous stock unit. Several investigators reported growth curves using hard parts and/or tagging, however, there is no unique solution. The size on maturity, spawning ground and season, migration models, and major albacore fisheries in the north Pacific are also reviewed.

RESUME

L'information biologique sur l'identification du stock, la croissance, la reproduction et la migration du germon du Pacifique Nord est examiné. Le germon nord-pacifique a été considéré constituer un stock unique, bien que quelques scientifiques aient mentionné une unité de stock non homogène. Plusieurs chercheurs ont signalé des courbes de croissance utilisant les pièces dures et/ou le marquage, mais il n'y a pas de solution unique. La taille à la maturité, les lieux et saisons de frai, les modes migratoires et les principales pêcheries de germon du Pacifique Nord sont également examinés.

RESUMEN

Se examina la información biológica sobre identificación del stock, crecimiento, reproducción y migración del atún blanco del Pacífico norte, donde se considera que constituye un único stock, aunque algunos científicos lo consideran como una unidad de stock carente de homogeneidad. Algunos investigadores presentaron curvas de crecimiento usando partes duras y/o marcado. Sin embargo, no existe una solución única. Se estudia también la talla a la madurez, la temporada y la zona de desove, los modelos migratorios y las principales pesquerías de atún blanco en el Pacífico norte.

1. INTRODUCTION

Foreman (1980) summarized albacore biological information and fisheries in the Pacific in a special report published by the IATTC. The present report reviews albacore biology and fisheries, focusing on the north Pacific, based on Foreman (1980) and new information after Foreman (1980).

2. STOCK IDENTIFICATION

The distribution of albacore across the north Pacific is centered around 35°N latitude, and extends from the northern part of Mexico, to the Gulf of Alaska in the east, and from the equator to 45°N in the west (Figure 1), depending on the season and oceanic conditions (Yoshida and Otsu, 1963). There are low *CPUE* areas in the equatorial waters between 10°N and 5°S (Shiohama, 1981). They are highly migratory within the distribution area and are considered to be a unique stock from the data of length frequency, spawning ground, and tag-recapture studies, although some scientists maintain a two stock hypothesis (Otsu, 1960; Clemens, 1961; Suda, 1962; Shiohama, 1980; Bartoo and Kume 1982; Holts and Bartoo 1985; Nishikawa *et al.*, 1985). Several genetic studies have indicated that there are no differences among the north Pacific albacore (Graves and Dizon, 1983; Graves, 1985; Chow *et al.*, 1993).

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3. GROWTH

The age and growth of north Pacific albacore have been estimated by the analysis of hard parts (vertebrae, scales and otoliths), size composition of the catch, and tagging experiments (Clemens, 1961; Yabuta and Yukinawa, 1963; Laurs and Nishimoto, 1979; Laurs and Wetherall, 1979). A summary of age-length relationship values is presented in Table 1. The size mentioned in this report is fork length (FL). There is no unique solution for the growth curve in the north Pacific. Some discrepancies exist among researchers in deciding which mode corresponds to 1-year old fish. Laurs *et al.* (1985) estimated that the size of 1-year old fish was less than 40 cm based on the daily increments in otoliths. After his work, Wetherall *et al.* (1987) reported the growth curve of albacore and showed that the size of 1-year old fish is less than 40 cm. The recent study made by Bigelow *et al.* (1993) showed similar results to those of Laurs *et al.* (1985) and Wetherall *et al.* (1987).

4. REPRODUCTION

Females attain maturity and spawn at about 90 cm in length (Ueyanagi, 1955; Otsu and Uchida, 1959a). Males may be larger than females on maturity. Ueyanagi (1957) postulated that males reached maturity at 97 cm, on the premise that fish with testes containing milt and weighing over 150 grams per pair were mature. Under the same criteria Otsu and Hansen (1962) found males to be mature at 90 cm, but both studies were inconclusive due to the lack of an objective means of determining maturity. Albacore are generally believed to reach maturity at 5 years of age (larger than 90 cm) or older (Suda, 1958; Otsu and Uchida, 1959b).

Albacore spawn during the summer in subtropical oceanic waters where surface water temperature is above 24°C (Figure 2) centered around 20°N (Ueyanagi, 1969). Evidence of multiple spawnings have been described by Otsu and Uchida (1959a), who found two or more modes in the size frequency of egg diameters found in ovaries. Egg remnants and eggs approaching ripeness in the same ovaries also suggest multiple spawnings. Matsumoto (1958) estimated that the incubation period of a fertilized egg was no more than 4 days. The distribution of larvae proved that the albacore spawning ground centered around 20°N and summer was the spawning season (Nishikawa *et al.* 1985).

5. MIGRATION

The migration of albacore in the north Pacific has been described based on length frequency and/or tagging experiments by Clemens (1961), Flittner (1963), Otsu and Uchida (1962), Otsu and Yoshida (1966), Rothschild and Yong (1970), Kikawa *et al.* (1977), Laurs and Lynn (1977), Laurs (1979), and Shiohama (1980). An outline of albacore migration is as follows. Young albacore move northward from the spawning ground centered around 20°N and are caught in the fishing ground of Japanese pole and line, located north of 30°N, from 50 cm (2-years old). They stay in the feeding ground located in the area between north of 30°N and south of the sub-arctic boundary located 40°N until 90 cm (4-years old). Immature albacore move north and south in the feeding ground depending the season. In the feeding ground, they are caught by the Japanese pole and line, and the North American fisheries. Then they move south for spawning and are caught by the Japanese longline fishery. Adult albacore larger than 90 cm stay in the area south of 30°N throughout the year.

6. RECRUITMENT HISTORY

Recruitment to the northeast Pacific surface fishery is believed to take place at 2 years old. Bartoo and Weber (1979), making certain assumptions about mortality and age structure, estimated the recruitment for the age-2 fish of the north Pacific stock by cohort analysis for 1955-1974, and found it may vary by as much as four times. The estimates for the birth years 1953-1972 varied from 3.3 to 14.5 million age-2 fish (Figure 4).

7. FISHERIES

Japan and the United States are two major albacore fishing countries in the north Pacific (Bartoo and Uozumi 1994). Japan has pole and line, large-mesh driftnet and purse seine fisheries for young albacore and longline fishery which target adult albacore. The U.S. has several kinds of fisheries that catch albacore, but a major portion of catch consists of young fish caught by the troll fishery. Other fishing countries include Taiwan, Korea, and Canada some fisheries of which catch albacore, however, the amounts of their catch are small. The fishing grounds of the major fisheries are shown in Figure 5. The total amounts of albacore catch varied from 30,000 to 125,000 metric tons (MT) during 1952-1991 (Table 2). The highest catch was recorded in the mid-1970s after which the catch gradually decreased to around 30,000 MT in 1991.

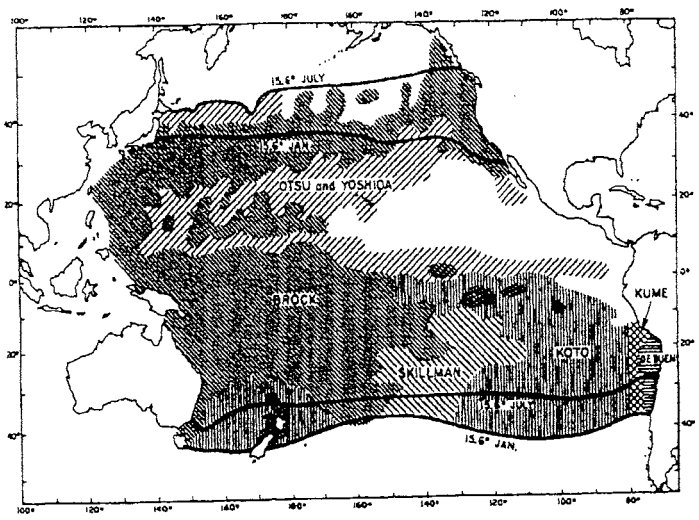

Fig. 1. Distribution of albacore in the Pacific Ocean (from Foreman, 1980).

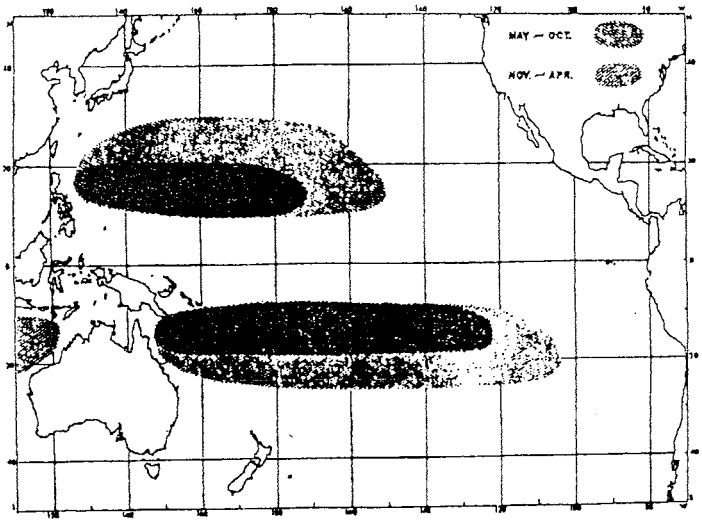

Fig. 2. Distribution of albacore larvae in the Pacific Ocean (from Ueyanagi, 1969). The spawning ground are coincidental with larval distribution.

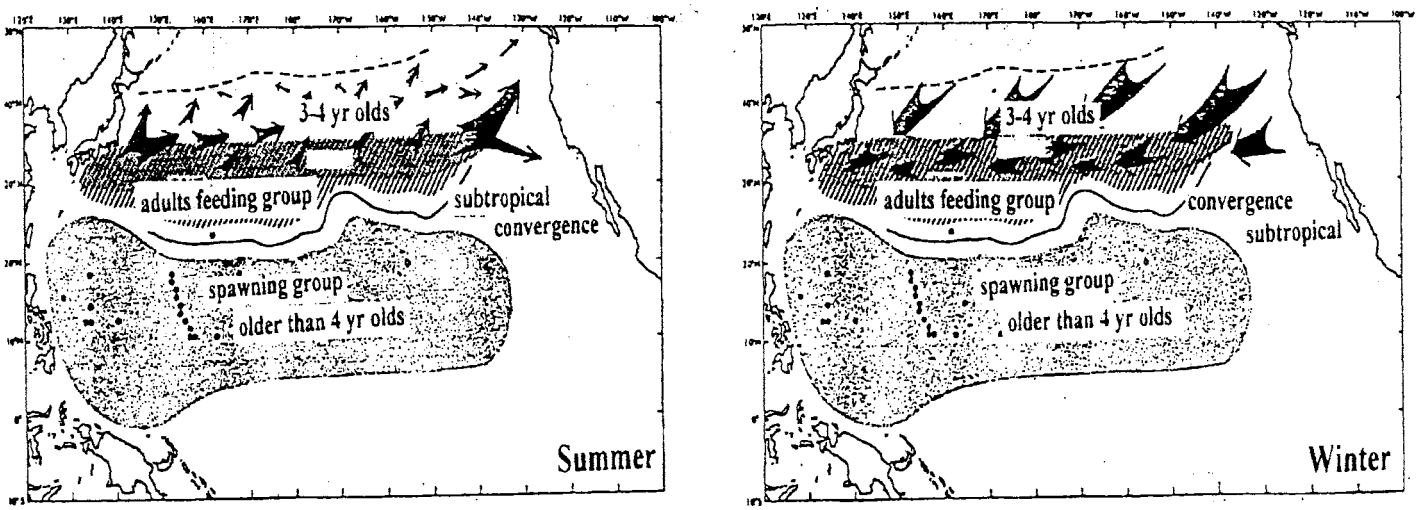

Fig. 3. Model of albacore migration in the north Pacific Ocean (from Shiohama, 1980).

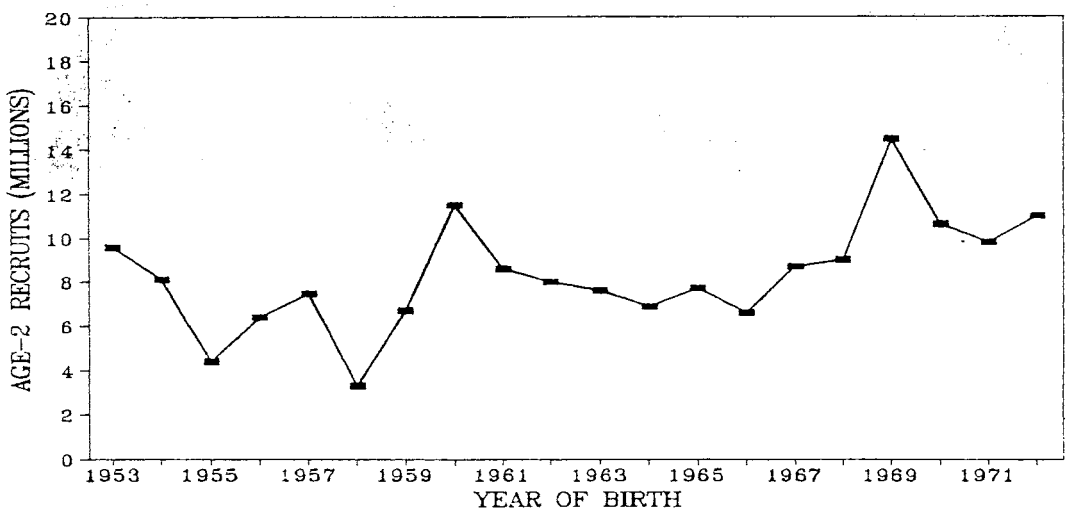

Fig. 4. Recruitment of two years old albacore for 1953-1972, estimated from cohort analysis for the north Pacific (from Bartoo and Weber, 1979).

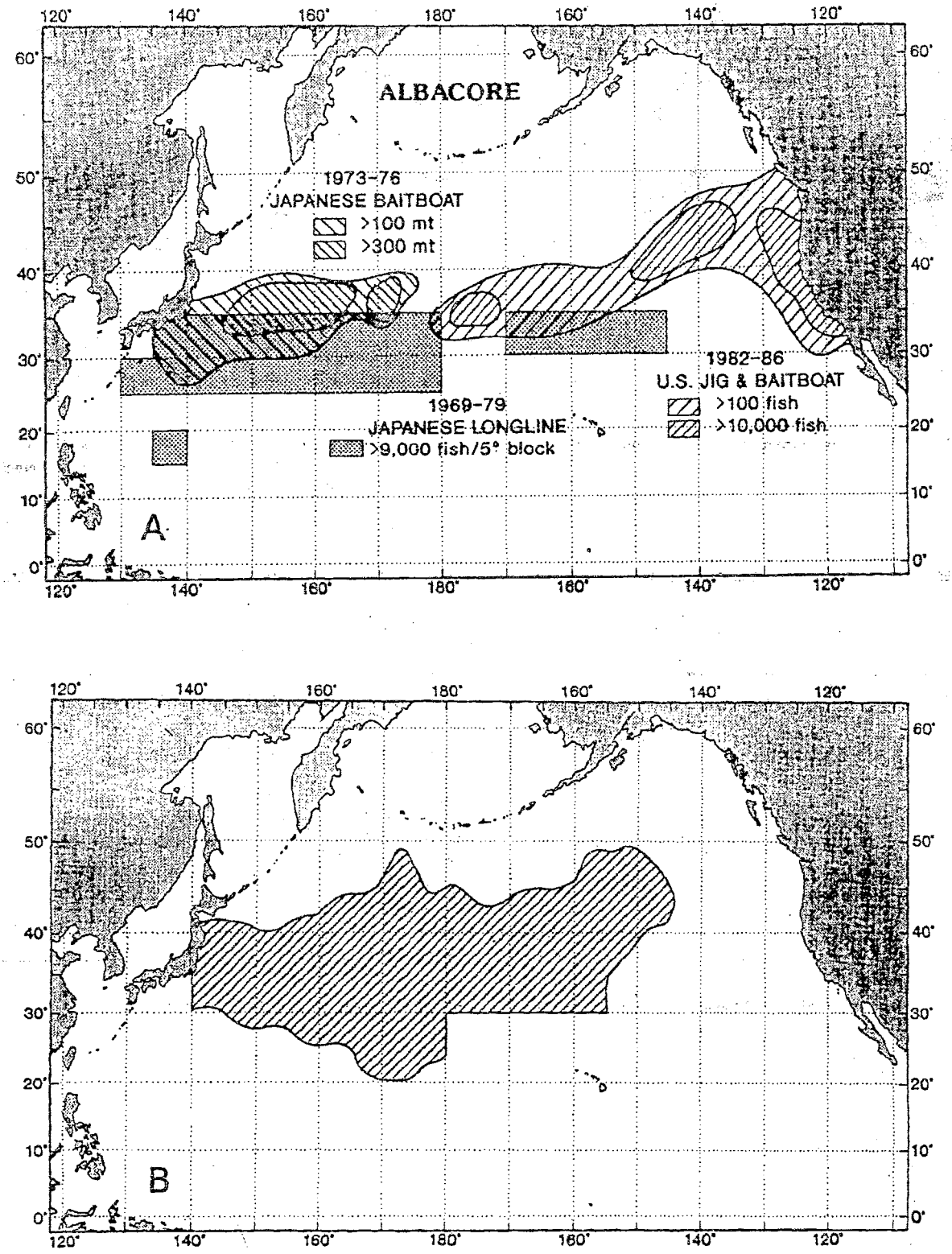

Fig. 5. (A) Major fishing ground for Japanese pole and line, longline, and U.S. jig and baitboat and (B) Japanese drift gill-net fishing ground in 1981 (from Laurs and Lynn, 1991).