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Long Beach, California

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PROGRESS REPORT OF RESEARCH ON WHITE SEABASS, *CYNOSCION NOBILIS*

by

William D. Maxwell

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ABSTRACT

A report is made on the feasibility studies of discriminating possible sub-populations, migratory patterns, and maturity of white seabass, *Cynoscion nobilis*. Biochemical investigations were encouraging and may prove useful in future studies of population structure. The low catch rate of white seabass in southern California precluded tagging substantial numbers of fish and studies of their migratory habits have been terminated until fishing improves.

Insufficient numbers of fish also made successful completion of maturity studies impossible and this project is being held in abeyance at the present time.

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2/ Operations Research Branch. Now with Marine Resources Branch, 1416 Ninth Street, Sacramento, CA 95814.

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INTRODUCTION

The white seabass, *Cynoscion nobilis*, is considered one of the most desirable game fish in California waters by sport and commercial fishermen alike; sport fishermen for its prestige and fighting ability, and commercial fishermen for the high market price which it commands.

Although the catch of both commercial and sport fisheries have fluctuated widely in the past, recent downward trends in total catch and in availability of white seabass on local fishing grounds have given rise to concern over status of the stock. There has been a steady decline in number of fish in the partyboat catch, from a high of 65,000 in 1949 to a low of 3,158 in 1975. The catch during the last 10 years (1966-1975) was the poorest on record, averaging only 4,331 fish, although total effort remained high.

During this same 10-year period the commercial catch per unit of effort has remained relatively stable while overall catch, with the exception of the warm water years (1958, 1959), has declined regularly. However, this was due in part to reduced fishing effort.

Historically, a significant but variable portion of total California landings of white seabass has come from Mexico. This portion of the catch has become more important in recent years. For example, from 1962 through 1975 more than 58% of all white seabass landed in California came from

Mexican waters. A record high was reached in 1975 when 83% came from Mexico.

To successfully manage white seabass, it is important to know if those fish caught off California and Baja California are part of one panmictic or intramixing population. Other important information needed for management includes age at maturity, fecundity, and migration patterns.

In an attempt to obtain this information, a study was begun in July 1975 to: (i) assess the feasibility of discriminating possible subpopulations, (ii) determine age at maturity and fecundity, and (iii) determine migratory patterns.

SUBPOPULATION STUDY

White seabass inhabit coastal waters from Juneau, Alaska, to Magdalena Bay, Baja California. Some also exist in the northern portion of the Gulf of California. However, the center of abundance usually lies between Point Conception, California, and Ballenas Bay, Baja California, shifting from year to year in response to environmental conditions.

The fish harvested off California and off Baja California have, in the absence of other information, been considered part of the same breeding population. However, if they are not, and form separate breeding units, management regulations may have to be broadened in order to be effective.

The differentiation of intra-specific breeding stocks has classically been defined mainly on the basis of phenotypic characters (morphometrics and meristics) which reflect interaction between the genotype of the stock and the environment. However, results have rarely been conclusive because relatively little effort has gone into separating these sets of factors or determining their interactions. By contrast, biochemical and serological identification of fish stocks is concerned with genotype alone, and intra-specific differences caused by environmental forces lie outside

its scope and do not complicate the issue (Moller 1971).

Biochemical identification of fish stocks is an identification of existing gene pools within a species. In practice, this is an identification of individual genetic differences and determination of the frequencies of genes responsible for these differences in diverse localities. Therefore, a biochemical study utilizing electrophoresis was chosen as the technique for use in distinguishing between possible separate breeding stocks of white seabass.

Electrophoresis is one of the most powerful analytic techniques in biochemical research. It is relatively simple and inexpensive, and has proven useful in fisheries research (Parrish 1964). The theory underlying electrophoresis is as follows. Most proteins are negatively charged and migrate a characteristic distance across some type of medium (e.g. starch gel) to which a direct current has been applied. The distance a specific protein migrates depends upon its degree of electrical charge, its size, and its conformation. Histochemical stains for specific proteins are then applied to the gel and the resultant patterns displayed analyzed for number and type of alleles at a particular locus.

Individual differences or characters must be shown to have a genetic basis in order for research to be successful. This can be done either by breeding or by comparing the phenotype distribution of each sample against the Hardy-Weinberg equilibrium expectations using the chi-square test. Further, characters representing more than one genetic system should be used. The number of genetic systems required is dependent on differences between the gene frequencies and the complexity of the systems themselves. A multiple allelic system will have a greater discriminatory power than a simple two-allelic system.

The work was carried out by Dr. M. Soule of the University of California San Diego, and was done in two stages: the first stage was a survey of potentially useful (polymorphic) proteins; the second was determination of gene frequencies for those proteins exhibiting polymorphism. Samples for this technique must be obtained fresh and preserved quickly in order to be useful.

White seabass are cleaned at sea prior to the catch being delivered to market and tissues most useful in this study are discarded. Therefore, a biologist had to accompany the boats to fishing grounds or rendezvous with them utilizing department research vessels. This proved very time consuming and presented numerous logistical problems, even with cooperation and help of the commercial fleet.

Despite these problems samples were collected from commercial boats operating off Baja California during August of 1975. We have not been successful in obtaining samples from southern California where the fishery has been severely depressed and erratic.

Methods and Materials

Samples of blood serum, liver tissue, and muscle tissue were collected from each fish immediately after it was removed from the gill nets. These tissues were chosen as the most likely to have polymorphic proteins.

Blood was taken from the heart cavity with a hypodermic needle and a Peel-A-Way heparinized blood sampler containing 2 cc of glycerol citrate solution to prevent coagulation. Approximately 20-25 gm of liver and muscle tissue were removed and stored in plastic vials. All samples were quickly frozen and taken to the University of California, San Diego where they were kept at -60 C until processed.

Processing involved tissue homogenization, centrifugation at 16,000 rpm for 30 min, and freezing of the supernatant. For blood, these steps were omitted. Electrophoresis was carried out in horizontal trays using starch gel made with "Electrostarch" as a medium (Somero and Soule 1974). The buffers used were Tris-Maleate, pH 7.4 (TM 7.4); Tris-Versene-Borate, pH 8.0 (TVB); Lithium Hydroxide, pH 8.6 (LIOH); Poulik; Tris-Citrate, pH 8.0 (TC 8.0); and Tris-Citrate, pH 6.7 (TC 6.7). Standard staining procedures were used to identify proteins.

Results

Two enzymes exhibited polymorphism (Table 1), alcohol dehydrogenase (ADH) and phosphoglucomutase (PGM). Other systems (isocitrate dehydrogenase and glutamate oxaloacetate transaminase) appeared to show genetic variation but this was most likely due to a breakdown of the proteins prior to freezing.

Genetic data for ADH (Table 2) showed a multiple allelic system (3 alleles), with the fast (f) allele being extremely rare, while PGM data (Table 3) exhibited a simple two-allelic system.

A chi-square test of ADH and PGM observed frequencies compared with expected frequencies showed both loci did not depart significantly from the Hardy-Weinberg equilibrium.

Conclusions

Both loci (ADH and PGM) may be useful in future studies on the population structure of white seabass. Rather large samples, however, will be necessary to distinguish populations. If, for example, California fish were to have parametric gene frequencies 10% different from Baja California fish, samples from approximately 500 fish in each locality

TABLE 1. Electrophoretic Results of Proteins Tested from 20 White Seabass.

Protein	Best buffer	Best tissue	Monomorphic (M) or Polymorphic (P)
α-glycerol-phosphate dehydrogenase	TM 7.4	muscle	M
alcohol "	TVB	liver	P
octanol "	-	-	-
isocitrate "	TC 8.0	liver	M
lactate "	TM 7.4	liver	M
malate "	TC 8.0	liver	M
xanthine "	TM 7.4	liver	M
sorbitol "	Poulik	liver	M
glucose-6-phosphate "	Poulik	liver	M
6-phosphogluconate "	TM 7.4	muscle	M
acid phosphatase	LiOH	liver	M
esterase	TVB	liver	M
fumarase	LiOH	liver	M
glutamate oxaloacetic transaminase	Poulik	liver	M
leucine aminopeptidase	Poulik	liver	M
phosphoglucose isomerase	LiOH	liver	M
phosphoglucose mutase	TC 8.0	liver	P
tetrazolium oxidase	TVB	liver	M
general proteins	LiOH	blood	M

TABLE 2. Phenotype Frequency Distribution of ADH from White Seabass Specimens.

Phenotype	Frequency
ss	27
mm	21
ms	44
ff	0
fs	1
fm	1

TABLE 3. Phenotype Frequency Distribution of PGM from White Seabass Specimens.

Phenotype	Frequency
mm	10
ms	56
ss	41

would be required to establish significance at the 0.05 level. This applies to the most common alleles of both loci. With respect to the rare f allele at the ADH locus, only about 100 individuals would be necessary to establish a significant difference of 10% at the 0.05 level (Sokal and Rohlf 1969).

Liver is the best source of both polymorphic enzymes (Table 1). Hence, in the future it will be unnecessary to collect blood and muscle samples.

When samples from southern California become available, it may be possible to determine if these fish are significantly different from those in Mexican waters. It would be preferable if both samples were collected at about the same time and that the survey be repeated one year after the first comparison.

MIGRATION AND MOVEMENTS

Migratory habits of white seabass are not well understood. Catch records indicate a northward migration along the coast in spring and a southward migration in the fall. Northward migration is thought to be associated with spawning (Young 1973).

While a general migratory pattern has been observed for adults, little is known about normal movements of juveniles. Generally, juvenile white seabass are taken in bays, such as Newport Bay. Intermediate sized fish are found in mainland kelp beds or sandy areas along the open coast, while large fish are generally captured near rocky headlands or offshore islands, especially where there are kelp beds.

Several studies have been made on various aspects of the white seabass fishery since the decline of landings in the 1920's and 1930's (Starks 1919, Skogsberg 1925, Clark 1930, and Croker 1932). However, a

tagging program has not been conducted in conjunction with these studies. Consequently, a tag and recapture experiment was designed and implemented in the summer of 1975. It was directed primarily toward smaller, younger fish which make up the bulk of the sport catch. Tagging was to be done by departmental personnel aboard sportboats while engaged in the party-boat sampling project. Due to the widely fluctuating and sporadic nature of the fishery, however, tagging was strictly opportunistic. Obtaining adequate numbers of fish to tag was extremely difficult because of the white seabass's desirability as a food fish. Few anglers were willing to give up their small fish for tagging purposes.

Some tagging effort also was directed towards fish caught by pier and rental-skiff fishermen within Newport Bay. The added incentive of prizes, offered by the Balboa Angling Club to those donating their fish to our study, failed to produce fish for tagging.

The low catch rate of white seabass throughout the fishery during this period precluded tagging substantial numbers of fish. The fishery, in its present condition, is not amenable to a limited biological investigation (time, money, and manpower).

Results

A total of 58 juvenile white seabass was tagged and released during fiscal year 1975-76. All were tagged and released from partyboats between Newport Beach and Carlsbad (Figure 1). The fish ranged in size from 27.9 cm (11 inches) to 45.8 cm (18 inches) and were from I to III years of age. No tags have been returned to date.

Field observations indicate juvenile white seabass are unable to withstand much handling or to be out of water for any length of time, and it is probable tagging mortality is quite high for these fish.

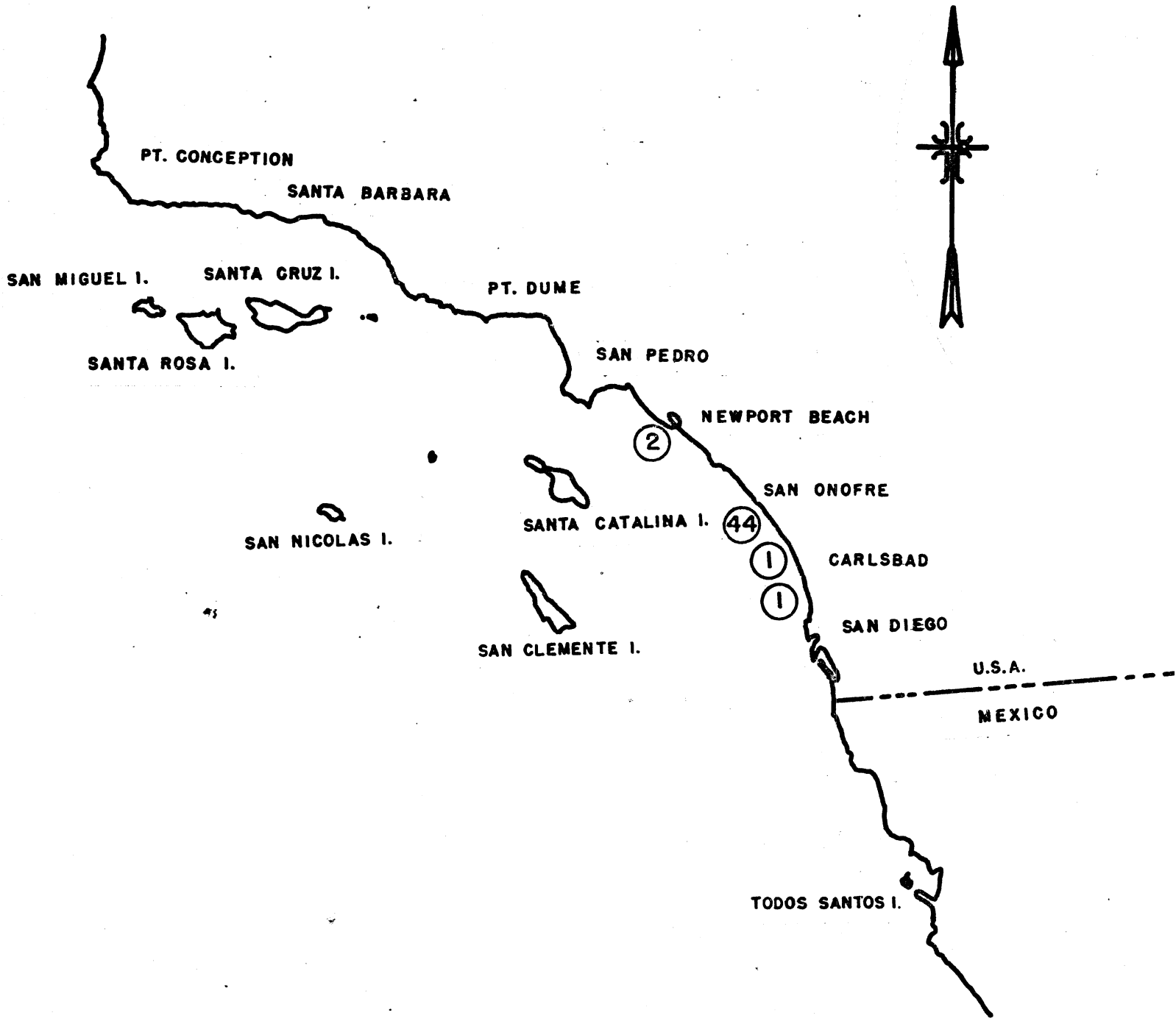

FIGURE 1. Number and location of white seabass tagged and released.

Faced with an erratic fishery and insufficient numbers of fish for tagging, the study has been terminated until fishing improves.

MATURITY AND FECUNDITY

Precise information on maturity and fecundity has not been determined, but existing data imply spawning occurs in southern California from April through August, peaking in May and June.

A preliminary study of white seabass maturity (Clark 1930) conducted in the late 1920's with an extremely small number of samples, determined males start maturing when they are about 50.8 cm (20 inches) long, while females begin maturing at 60.9 cm (24 inches), about a year later than males. However, subsequent determinations of age and growth of white seabass (Thomas 1968) indicated these maturing fish were older than Clark had presumed. As a result, a new, more extensive study was initiated to clarify the differences.

As previously discussed, investigators encountered difficulties obtaining adequate samples. The commercial fishery presented the only choice for obtaining a relatively large and, hopefully, consistent source of specimens and fishery data.

Methods and Materials

Project personnel attempted to collect 10 males and 10 females each month from ten different categories based on total length of the fish. The categories corresponded to age groups found by Thomas. Length of the sampling period was to be one year.

Gonads, length, weight, scales and otoliths were obtained from each individual sampled. All gonads were preserved in Gilson's fluid until processed.

Results

Our inability to obtain sufficient numbers of fish has proved a formidable obstacle to successful completion of this project. At present, only 184 fish have been sampled.

Data collected were to be given to a graduate student for analysis as part of a Masters' thesis, with close supervision provided by project personnel. It's unlikely that enough material can be collected for proper analysis; therefore, the project is being held in abeyance at the present time.

Completion of maturity work would provide information with which to evaluate potential size regulations. We will continue to collect further information as the opportunity presents itself. We can, however, apply Thomas's age and growth information to results of Clark's maturity study and develop a preliminary guide for establishment of protective regulations.

Clark examined 32 female white seabass ranging in length from 60 cm to over 100 cm TL. Two of these (6%) were found to be maturing at under 79 cm TL. No immature fish were found above 73 cm TL. She used this data to conclude that all fish over 80 cm were 3 years old and mature. However, Thomas found fish of this size to be about 6 years old, and that it took about 2 years for them to grow from 60-64 cm (Clark's smallest maturing females) to 80 cm.

In light of these results, the contention that 50% of white seabass females are capable of reproduction at under the present 71 cm (28 inch) size limit is questionable, and allowing fish to be taken at under 80 cm TL can only result in impairment of the species' reproductive capacity.

SUMMARY

Results obtained from these feasibility studies, with exception of electrophoretic work, were not encouraging. The current depressed state of the fishery, particularly in southern California, is not amenable to

a limited biological investigation.

Existence of polymorphic proteins from Baja California white seabass have been demonstrated and can be used to identify possible subpopulations should sufficient material become available from southern California for comparison. More conclusive results would be obtained if samples from both regions were collected during a relatively short period of time to avoid sampling the same stocks should they migrate from one area to another.

Tagging and fecundity projects have not proven successful and future efforts towards these programs has been terminated.

Maturity work will continue as specimens become available, primarily due to its importance with regards to potential regulations.

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