CALIFORNIA FISH AND GAME

"CONSERVATION OF WILDLIFE THROUGH EDUCATION"

VOLUME 57 APRIL 1971 NUMBER 2

California Fish and Game is a journal devoted to the conservation of wildlife. If its contents are reproduced elsewhere, the authors and the California Department of Fish and Game would appreciate being acknowledged.

The free mailing list is limited by budgetary considerations to persons who can make professional use of the material and to libraries, scientific institutions, and conservation agencies. Individuals must state their affiliation and position when submitting their applications. Subscriptions must be renewed annually by returning the postcard enclosed with each October issue. Subscribers are asked to report changes in address without delay.

Please direct correspondence, except regarding paid subscriptions, to:

CAROL M. FERREL, Editor
California Fish and Game
987 Jedsmith Drive
Sacramento, California 95819

Individuals and organizations who do not qualify for the free mailing list may subscribe at a rate of $2 per year or obtain individual issues for $0.75 per copy by placing their orders with the Office of Procurement, Documents Section, P.O. Box 20191, Sacramento, California 95820. Money orders or checks should be made out to Office of Procurement, Documents Section. Inquiries regarding paid subscriptions should be directed to the Office of Procurement.

CALIFORNIA FISH AND GAME

VOLUME 57 APRIL 1971 NUMBER 2

Published Quarterly by
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

CONTENTS

ERRATA

In *California Fish and Game*, Vol. 57, No. 1 in the article by Cordone, Nicola and Baker entitled, "The Kokanee Salmon in Lake Tahoe" there is a misplaced figure. The top graph of Figure 4 should be part of Figure 3 and represented as the lower graph.

On page 30 the first sentence in the first paragraph should read, "In 1964, 1965, and 1966 the Nevada Fish and Game Commission planted 610,120 fry on the Nevada side of the lake."

Calif. Fish and Game, 57(2):90-98, 1971.

SEX RATIOS AND SURVIVAL ESTIMATES AMONG SALMON POPULATIONS[1]

PAUL T. JENSEN
Anadramous Fisheries Branch

JACKSON HYDE
Inland Fisheries Branch

The effects of sex ratios other than one-to-one on survival estimates produced by Murphy's method of estimating third-year survival of silver (coho) salmon (*Oncorhynchus kisutch*) are discussed.

Techniques are described for determining sex of fingerling king (chinook) salmon (*O. tshawytscha*) over 40 mm TL by gross gonad examination. Sex composition of 970 fingerling king salmon at the Coleman National Fish Hatchery was 490 males and 480 females.

Evidence is presented which suggests that fish cultural practices may alter the initial sex ratio among propagated silver salmon stocks.

INTRODUCTION

Sex ratios among spawning populations of salmon common to California usually demonstrate a preponderance of males. Spawning runs of king salmon *(Oncorhynchus tshawytscha)* and silver salmon *(O. kisutch)* contain mature 2-year-old males referred to as grilse or jacks. Very few females of either species spawn as 2-year-olds. King salmon females spawn primarily as 3- and 4-year-olds and spawning silver salmon females are, with few exceptions, 3-year-olds. Males which do not spawn as grilse return to spawn at ages similar to female spawners; that is, mostly 3- and 4-year-old king salmon and 3-year-old silvers.

California's commercial salmon fishery routinely takes well over three-quarters of the State's annual ocean salmon landings (Jensen, 1964 and Jensen and Swartzell, 1967). Size restrictions in this fishery limit the landings to king salmon 26 inches TL or greater and silvers 25 inches TL or greater. Because king and silver salmon during their second year of life rarely reach these sizes prior to the conclusion of fishing, grilse of neither species undergo significant mortality resulting from commercial fishing.

Size limits in the sport fishery allow one fish of either species 20 inches TL or greater and three of either species 22 inches TL or greater in the three-fish daily bag. A portion of the population of each species is recruited to the sport fishery toward the end of their second year. However, most salmon in their second year of life escape the ocean fisheries.

The fisheries are, therefore, operating more efficiently on females than males. If a one-to-one or near one-to-one sex ratio exists in the ocean population prior to the end of year two, females should predominate in fishery landings and males in spawning escapements.

Murphy (1952) has developed a method for estimating survival of silver salmon during their ultimate year of life. Murphy's method re-

[1] Accepted for publication December 1970.

quires only counts of grilse and adult males and females from successive spawning runs. It postulates that the number by which 3-year-old females exceed 3-year-old males represents the number of 2-year-old males which would have returned as threes had they been exposed to an additional year's mortality. Third-year survival is then obtained by subtracting 3-year-old males from 3-year-old females in year n and dividing the difference by grilse escapement in year n-1.

Murphy applied his scheme to 13 years of silver salmon counts at Benbow Dam Counting Station on the South Fork of the Eel River in northern California and arrived at a mean value for third-year survival of 0.356. Yearly values ranged from 0.158 to 0.569.

D. H. Fry, Jr. (pers. comm.) applied Murphy's method to silver salmon spawning counts obtained at the Washington Department of Fisheries' Minter Creek Station (Salo and Bayliff, 1958). Minter Creek data yielded unreasonable results, $s < 0$ or $s > 1$, in 7 of 14 years, even though a basic requirement of the method is probably better met here than at Benbow. That requirement is accurate fish counts. Conditions at the Benbow Station did not always provide accurate counts. This is a technical problem, however, which in no way affects the validity of the method.

Murphy's method, developed to estimate ocean survival of silver salmon, is also applicable to king salmon, although complicated by adult males and females of the same brood appearing in two or three successive spawning escapements. Furthermore, as Murphy points out, it provides a means of separating fishing mortality from total mortality when applied to groups of marked salmon when estimates of fishery contribution of marked fish are available.

In theory, the method requires two basic assumptions. First, that a one-to-one sex ratio exists in the population prior to year three; and second, that total mortality (other than spawning mortality) with respect to sex is equal. The first of these assumptions readily lends itself to testing.

A review of the literature on sex ratios of juvenile salmonids produced little information. Ricker (1958) in a description of Murphy's technique, states that sex ratios other than one-to-one have been observed in juvenile sockeye smolts. In any event, if no differential mortality occurs with regard to sex, the method will work with any sex ratio so long as the ratio is known.

Because of the potential value of Murphy's method in providing information regarding fishing, hooking and natural mortality in ocean salmon populations, we undertook to measure the sex ratio of hatchery-produced juvenile king salmon at Coleman National Fish Hatchery on the upper Sacramento River.

METHODS

The subject of sex determination is fundamental in comparative anatomy texts, yet the literature was almost barren of publications specific to sexing immature salmonids. Wiesel (1943), Robertson (1958), and Robertson and Rinfret (1957) provided information which aided in the development of a technique.

Initial work was accomplished at the Nimbus Salmon and Steelhead Hatchery on the American River near Sacramento to determine the

minimum size at which sex could be readily determined. King salmon fry in the size range from 30 to 40 mm TL were isolated in circular tanks and sampled periodically to determine stage of gonadal dimorphism.

The fish were opened ventrally by an incision started at the gill isthmus and continued posteriorly to the vent. A second incision was made from immediately posterior to the pectoral fin into the dorsal musculature. The flap thus formed was lifted for entry into the body cavity. Care must be used to maintain an intact air bladder, as it is extremely difficult to detect the gonads once the air bladder has been deflated. They are held in contour with the air bladder from its most anterior ventral surface.

Tissue preparation was not required for sex determination once specimens had reached 42 to 44 mm TL. At this size, gonads can be distinguished by shape as well as texture and surface appearance. Ovaries are relatively enlarged in the anterior portion and taper to become undistinguishable from the mesenteries in the area below the origin of the dorsal fin. They are mushy in texture and exhibit a tapioca-like appearance under a dissecting microscope. Testis are smooth, narrow bands of tissue, uniform in cross section and extend to a point well beyond the insertion of the dorsal fin. Testis respond elastically to teasing with forceps and if pulled away will coil upon breaking.

Microscopic examination was necessary to determine sex of the smallest fish (i.e., 40 mm or less). Phase microscopy was employed for squashed preparations and also for frozen cross sections that were manually cut and mounted in glycerol. Developing ova were observed in ovaries of the smallest fish.

During the developmental work at Nimbus Hatchery, histological methods (Figures 1, 2 and 3) were used to confirm results. The final

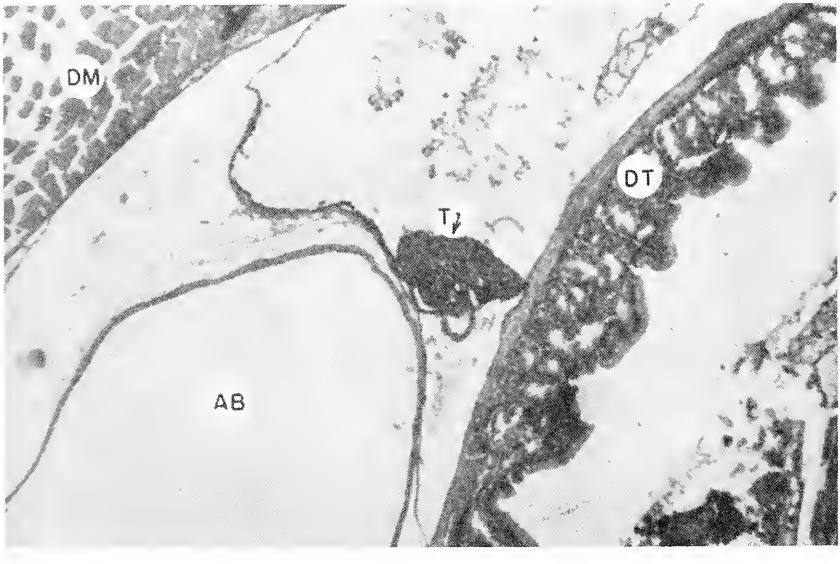

FIGURE 1. A cross section of a male fingerling king salmon, × 100, H. and E. stain. DM = dorsal musculature; AB = air bladder cavity; T = testis; and DT = digestive tract wall.

technique, as used at Coleman Hatchery, employed gross organ detection and a dissecting microscope (x 20 to x 30) for organ discrimination.

In general, the king salmon egg taking season at Coleman National Hatchery extends from October through January. As a result, juvenile

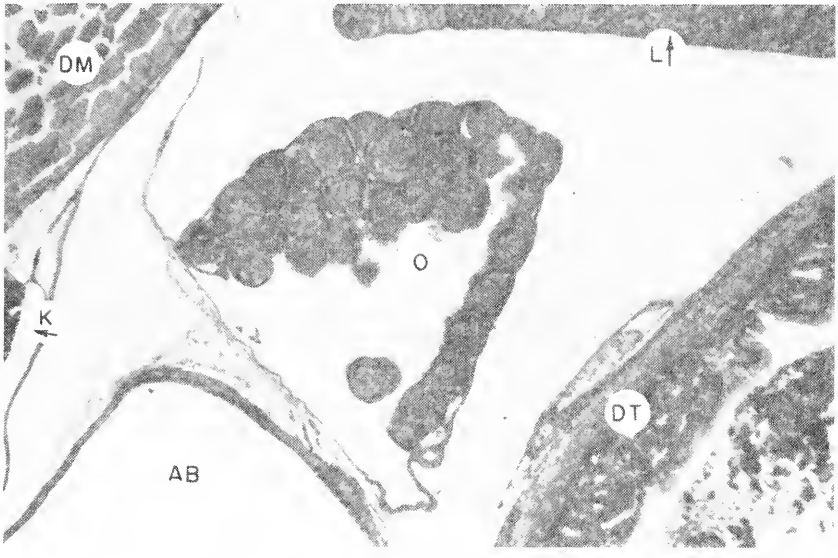

FIGURE 2. A crass section of a female fingerling king salmon, × 100, H. and E. stain. DM = dorsal musculature; AB = air bladder cavity; O = ovary; L = liver; K = kidney; and DT = digestive tract wall.

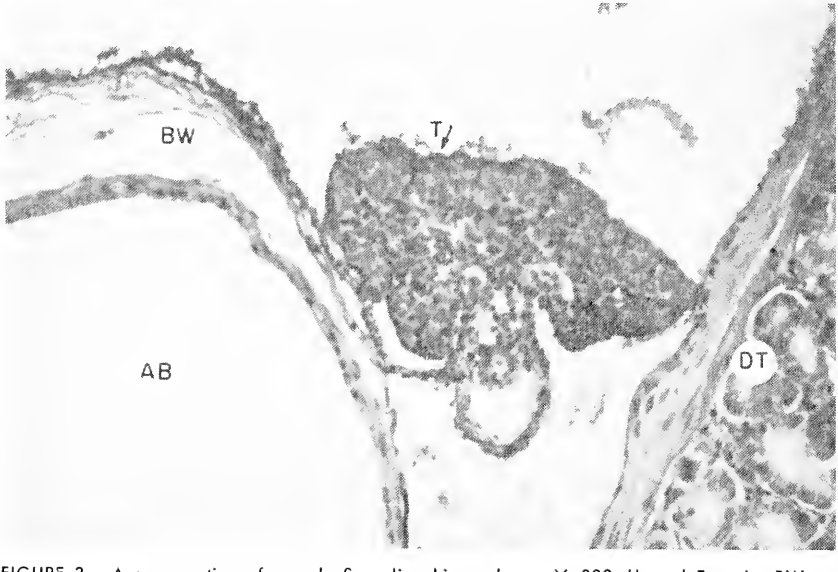

FIGURE 3. A crass section of a male fingerling king salmon, × 300, H. and E. stain. BW = air bladder wall; AB = air bladder cavity; T = testis, and DT = digestive tract wall.

fish are growing into the easily sexable size range (i.e., > 40 mm) throughout the spring and summer months. Sampling for sex determination occurred on three occasions: June 6 and 7, July 9 and 10, and August 8, 1968.

Samples were examined in groups of ten fish each and were obtained by dipnetting. An attempt was made to examine at least one ten-fish sample for every 100,000 fish. At least one sample of ten fish was taken from the head and one from the tail end of each 8 x 80-ft concrete raceway pond, and additional samples of ten fish were taken alternately from pond heads or tails when a pond contained more than 200,000 fish. During June sampling, six ten-fish samples were taken from near the middle of the raceways.

The ten-fish samples were placed in a solution of MS222 (Tricain-Methanesulfonate) and left there until they expired. Total length of each fish was measured prior to dissection.

TABLE 1—**Sex and Mean Length of 970 Fingerling Chinook Salmon from Coleman National Fish Hatchery June, July and August 1968**

Pond area sampled	Month	Male				Female			
			Total length mm				Total length mm		
		Number	Mean	Range	SE	Number	Mean	Range	SE
Head	June	39	75.28	57–101	2.57	31	74.71	56–100	2.61
Middle	June	27	72.67	54–100	3.06	33	72.23	49–106	3.52
Tail	June	29	64.10	45–85	3.26	31	65.87	44–92	3.45
Head	July	81	68.38	52–110	1.61	79	68.77	51–86	1.33
Tail	July	69	64.55	49–80	1.50	81	64.47	46–82	1.43
Head	August	137	67.91	48–99	1.17	93	67.57	45–87	1.28
Tail	August	108	67.81	49–91	1.30	122	67.54	50–90	1.03
Totals		490				480			

RESULTS

Sex composition of 97 ten-fish samples was determined. Examination of mean lengths and standard errors reveals no significant difference with regard to sex within sample groups (Table 1). Of the 970 fish examined, 490 were males and 480 females.

Repeated observation is the only way by which the actual sex ratio can be measured; statistical tests provide little assistance. For example, the instant data certainly provide no basis for rejecting the hypothesis that the actual ratio was one-to-one. Indeed, grounds for rejection at $p = .95$ would have been provided only if the number of males had fallen outside the range 454–516 of 970 fish examined. Based on the evidence at hand, the best estimate of the sex ratio among fingerling king salmon in the Sacramento River is 490 males to 480 females, or 1.02:1.

DISCUSSION

Murphy estimated third-year ocean survival by solving:

$$s = \frac{♀n - ♂n}{♂(n-1)} \qquad (1)$$

where n = year of counting

For estimates where the sex ratio is other than 1:1, his formula can be modified to:

$$s = \frac{\frac{♀n}{p} - (♀n + ♂n)}{♂(n-1)} \qquad (2)$$

where p = the proportion of females in the initial population.

The term "initial population" refers to the population of fish immediately prior to the time that grilse migrate. If sex specific mortality occurs after that time, the rates must be determined so that appropriate corrections can be made to estimates of survival.

Paulik and Robson (1969), in a description of "change in ratio" estimators, develop provisions for cases where the initial sex ratio is other than 1:1. In an example applied to a hypothetical marked silver salmon population, they assume a 1:1 sex ratio and produce estimates of population size and survival prior to grilse migration. A small amount of manipulation to obtain a different parameter produces third-year survival estimates identical to those obtained by Murphy's method and its modification.

Estimates of survival derived by Murphy's method are quite sensitive to minor changes in initial sex ratio. For example, using equation (2) on Murphy's Benbow data, a change in the assumed proportion of females from 0.500 to 0.495 results in an increase in the calculated mean annual third-year survival of from 0.356 to 0.399.

The Benbow data for the 1946–47 spawning year produced an estimate of third-year survival of 33.3%, almost identical to the average estimate for the 12-year period. Acceptable values of s (i.e., $0 < s < 1$) for this year are produced only when the initial proportion of females ranges between 0.435 and 0.540.

Senn and Noble (1968) describe the return rates, to fisheries and to spawning stocks, of three groups of marked coho released as yearlings

TABLE 2—**Release and Recovery Data from Marked 1962 Brood Year Coho Released from Washougal Hatchery** *

	Mark		
	Ad RV	Ad LV	Ad LV LM
Number released	111,588	61,400	50,120
Fishery returns	4,665	2,761	638
Escapement			
Grilse	1,115	134	19
Adult males	1,222	597	151
Adult females	801	351	68

* From Senn and Noble (1968). Estimates of sex composition of escapement obtained from Senn (pers. comm.).

TABLE 3—**Maximum and Minimum Values of *p* and *s* for Marked Washougal Hatchery Coho**

	Mark		
	Ad RV	Ad LV	Ad LV LM
s ($p = 0.495$)	−0.363	−1.783	−4.296
s maximum	0.302	0.259	0.256
s minimum	0.018	0.015	0.004
p maximum	0.392	0.369	0.311
p minimum	0.339	0.357	0.304

in 1963 from the Washougal Hatchery in Washington (Table 2). Values of s obtained with equation (2) using the sex ratio observed among Sacramento River chinook fingerlings (proportion of females, $p_s = 0.495$) are unreasonable ($s < 0$) in all three instances (Table 3).

Maximum possible survival among these marked groups would have been achieved if the only mortality had resulted from fishing. Since catch estimates are available from fisheries operating on the marked populations, maximum possible third-year survival can be estimated by dividing adult spawning escapement of marked groups by fishery landings plus adult spawning escapement. These values are 0.392, 0.259 and 0.256 for the Ad-RV, Ad-LV and Ad-LV-LM groups respectively (Table 3).

The relationship between s and p is inverse; solving equation (2) for p using maximum values of s produces minimum values of p, and maximum values of p can be estimated by taking limits of p as s approaches 0. The actual lower possible limit of s for each group can be approximated because the total number of marked fish released is known.

Values of p, throughout the three marked groups, which produce acceptable values of s, range from 0.304 in the Ad-LV-LM marks to 0.392 in the Ad-RV marked group (Table 3). Assuming that fishery landing and escapement estimates are valid, the proportion of females among coho produced at the Washougal Hatchery is between 0.3 and 0.4.

Evidence substantiates the premise that troll catches of chinook and coho salmon contain more females than males. Mr. Bertal Christiensen, skipper of the troller M/V *Silverside*, has provided sex and species composition of his annual salmon catch for the 7-year period 1961 through 1967 (Table 4). Although Mr. Christiensen's catches were taken off central California and consisted primarily of chinook salmon, females of each species consistently outnumbered males. This situation was the rule among adult spawners at Benbow, and was also the case during the first 7 or 8 years of operation at Minter Creek. However, in 6 of the final 7 years at Minter Creek discussed by Salo and Bayliff, and among the three marked groups of 1962 brood coho at Washougal Hatchery, the situation reversed itself, adult males outnumbering females.

Acceptable ranges of p can be approximated from the Minter Creek data by solving equation (2) for $s = 0.01$ and $s = 0.99$ (Table 5). No single value of p exists which produces values of s between 0.01 and 0.99 in every year. An examination of the ranges indicates that the proportion of females among coho produced at Minter Creek was reduced in the late 1940s and early 1950s from what it was in the early 1940s imme-

TABLE 4—**Sex Composition of the Catch * of the Troller M/V *Silverside* 1961 through 1967**

Year	Chinook			Coho		
	Males	Females	Proportion females	Males	Females	Proportion females
1961	464	620	.572	12	19	.613
1962	396	493	.555	18	35	.660
1963	485	671	.580	52	79	.600
1964	464	551	.543	98	113	.593
1965	507	672	.570	41	49	.544
1966	246	322	.567	75	107	.588
1967	161	203	.558	159	198	.555
Total	2,723	3,532	.565	455	630	.581

* Fish taken off central California coast between Half Moon Bay and Cape Mendocino.

diately after the station was opened. Survival estimates, assuming a 1 : 1 sex ratio ($p = .5$) become generally unreasonable after 1947.

Application of Murphy's method to wild coho populations (e.g., South Fork Eel River) yields acceptable survival estimates, while application to cultured stocks (e.g., Washougal Hatchery) yields unreasonable ones. It would appear that artificial propagation either alters the sex ratio among the propagated stock, or artificially-produced coho females are much more vulnerable to some mortality factor than are the males.

If fish cultural techniques alter sex ratios among juvenile populations, the ratio can be measured prior to release, and Murphy's method can be used to estimate third-year survival. Such estimates obtained by Murphy's method are quite sensitive to subtle changes in the sex ratio. Depending on the size of the population under study, it may prove

TABLE 5—**Coho Salmon Counts at Minter Creek * and Estimates of Survival (*s*) and Proportion Females (*p*)**

Year	♂	♀	Jacks year-1	*s*, when $p = .5$	*p*, when $s = 0.01$	*p*, when $s = 0.35$	*p*, when $s = 0.99$
1939	673	915	679	0.356	0.574	0.501	0.405
1940	1,314	1,574	433	0.600	0.544	0.518	0.474
1941	921	1,160	860	0.278	0.555	0.487	0.396
1942	759	821	502	0.121	0.518	0.468	0.395
1943	978	1,015	662	0.056	0.507	0.456	0.383
1944	1,787	1,959	319	0.493	0.522	0.506	0.479
1945†	--	--	166				
1946	719	1,034	131	2.351	0.589	0.574	0.548
1947†	--	--	179				
1948	357	291	39	−1.692	0.418	0.440	0.424
1949	1,181	1,140	44	−0.932	0.491	0.488	0.482
1950	964	807	178	−0.882	0.455	0.440	0.414
1951	637	598	68	−0.574	0.481	0.475	0.459
1952	1,282	1,536	290	0.876	0.544	0.526	0.495
1953	943	737	55	−3.745	0.439	0.434	0.425
1954	593	441	75	−2.027	0.426	0.416	0.398

* From Salo and Bayliff (1958).
† Counts incomplete.

necessary to actually measure the ratio rather than estimate it by sampling. This would require a very rapid sexing method which did not injure the fish. Techniques for such a procedure have yet to be developed.

REFERENCES

Jensen, Paul T. 1964. Landings estimates of California's marine recreational salmon fishery. Calif. Fish and Game 50: (1): 48-52.

Jensen, Paul T., and Phillip G. Swartzell. 1967. California salmon landings 1953 through 1965. Calif. Dept. Fish and Game, Fish Bull. 135: 57 p.

Murphy, Garth I. 1952. An analysis of silver salmon counts at Benbow Dam, South Fork of Eel River, California. Calif. Fish and Game 38: (1): 105-112.

Paulik, G. J., and D. S. Robson. 1969. Statistical calculations for change-in-ratio estimators of population parameters. J. Wildl. Manage. 33: (1): 1-27.

Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Fish Res. Bd. Can., Bull. 119: 300 p.

Robertson, O. H. 1958. Accelerated development of testis after unilateral (Gonadectomy), with observations on normal testis of rainbow trout. U.S. Fish Wildl. Serv., Fish Bull. 58: 30 p.

Robertson, O. H., and A. P. Rinfret. 1957. Maturation of the infantile testis in rainbow trout (*Salmo gairdneri*) produced by salmon pituitary gonadotrophins administered in cholesterol pellets. Endocrinology 60: 559-562.

Salo, Ernest O., and William H. Bayliff. 1958. Artificial and natural production of silver salmon (*Oncorhynchus kisutch*) at Minter Creek, Washington. Wash. Dept. Fish. Res. Bull. 1: 76 p.

Senn, Harry G., and R. E. Noble. 1968. Contribution of coho salmon (*Oncorhynchus kisutch*) from a Columbia watershed hatchery. Wash. Dept. Fish. Res. Pap. 3 (1): 51-62.

Weisel, G. F. 1943. A histological study of testis of the sockeye salmon (*Oncorhynchus nerka*). J. Morphol. 73: 207-229.

Calif. Fish and Game, 57(2):99–106, 1971.

CALIFORNIA INLAND ANGLING SURVEY FOR 1969, WITH CORRECTIONS FOR THE 1964 SURVEY[1]

JOHN W. EMIG[2]
Inland Fisheries Branch
California Department of Fish and Game

This is the ninth report on California angling trends based on postal card questionnaires. Questionnaires were sent to 0.6% of the resident license purchasers in 1969. The returned cards amounted to a 0.3% systematic sample. Catch and effort by successful anglers were determined for trout, striped bass, sturgeon, black bass, catfish and panfish. Errors in the 1964 survey were corrected. Catch and effort for trout and panfish increased in 1964, and again in 1969. Catches of other fish declined in 1964, but those of black bass and catfish reached record highs in 1969. Striped bass catches remained low.

INTRODUCTION

Angling surveys to determine trends in the California sport fish catch have been made since 1936. The 1969 postal card survey is the most recent of these. Previous surveys have been reported by Curtis (1940), Calhoun (1950, 1951, 1953), Skinner (1955), Ryan (1959), Seeley, Tharratt, and Johnson (1963), and McKechnie (1966).

The postal card design was described by Ryan (1959) and the same format has been used for all surveys since. An additional question, "Did you fish for trout in 1969?", was placed in the upper portion of the 1969 questionnaire card, to provide an estimate of the number of trout anglers.

For the first time this year a space was provided to evaluate the sturgeon (*Acipenser* spp.) catch. Sturgeon have been legal sport fish since 1954, but only since the development of effective angling techniques in the early 1960's have fishermen been able to catch them regularly.

These evalutions do not cover salmon other than kokanee (*Oncorhynchus nerka*), steelhead rainbow trout (*Salmo gairdneri*), or ocean fish, since other means are more accurate in determining these catches. Spaces for these fishes were included on the form, however, so that anglers would separate them from the catches of inland species.

A review was made of the analytical methods of previous surveys in preparation for analysis of the 1969 survey data. Discrepancies in methodology of the 1964 survey (McKechnie 1966) became apparent. These discrepancies involved calculation of the projection factor, the mean catches for some species, and the totals of the postal card returns. Estimates of the successful anglers, total catches, total days of fishing, and standard errors were affected. Corrections were made and the results are presented here.

[1] Accepted for publication December 1970.
[2] Now with Environmental Services Branch, Sacramento

Information from successful anglers only is the primary basis of this report. The questionnaire design does not permit evaluation of information from unsuccessful anglers.

METHODS

The name and address of every 25th person purchasing a license were recorded by the license agents and compiled by the Department's License Section. Every sixth such licensee was mailed a questionnaire. For the 1969 survey, 12,550, or 0.6%, of the resident sport fish license purchasers were mailed questionnaires. About 40% of the cards were returned, a somewhat higher return than from previous surveys. The total sample size was about 0.3%. After deletion of unacceptable returns, the sample usable for the species tables was about 0.2% (Table 1). This portion of the survey data for 1964 was accepted as accurately reported.

TABLE 1—**Characteristics of the Two Surveys**

Item	1964		1969	
	Number	Percentage	Number	Percentage
a. Resident sport fishing licenses sold	1,585,615		1,935,593	
b. Questionnaires mailed	12,215	**0.8** (of *a*)	12,550	**0.6** (of *a*)
c. Questionnaires returned	4,479	**36.7** (of *b*)	5,047	**40.2** (of *b*)
d. Usable returns	4,300	**96.0** (of *c*)	5,041	**99.9** (of *c*)
e. Respondents who did not fish	169	**3.9** (of *d*)	232	**4.6** (of *d*)
f. Successful respondents	3,593	**83.6** (of *d*)	4,073	**80.8** (of *d*)
g. Unsuccessful respondents	538	**12.5** (of *d*)	736	**14.6** (of *d*)
h. Projection factor	475.73		383.97	
i. Usable returns for species tables	2,785	**64.8** (of *d*)	3,572	**70.9** (of *d*)
j. Mean days fished	11		17	
k. Number of respondents who fished for trout			3,234	**64.2** (of *d*)

Statewide estimates (Tables 2 and 3) were obtained with a projection factor, which in all surveys except for 1964 and 1969 is the quotient of the number of sport fishing licenses sold divided by usable returned questionnaires. Because only the names of resident licensees were available for the 1964 and 1969 surveys, projection factors were obtained with these totals. However, McKechnie's (1966) projection factor of 570 for the 1964 survey was obtained by dividing the resident licenses sold by the usable returns for the species tables. This method produces overestimates, since it assumes that all anglers are successful. As presently revised, the projection factor was developed by a method quite different from that of the other surveys to compensate for another discrepancy in the 1964 data. This discrepancy involves the definition of postal card reports used for the species tables. Calhoun (1950, 1951, 1953), Skinner (1955), and Ryan (1959) considered as postal card reports those that indicated the number of each species caught. Seeley, Tharratt, and Johnson (1963) considered the postal card reports to include all that reported catches by species, whether or not the number caught is given (those not listing the number caught are few; e.g., 7 out of 1,690 trout reports in 1960). This same procedure was used for the 1969 survey. On the other hand, the 1964 postal card reports consist of

TABLE 2—Summary of Successful Anglers' Responses to the 1964 Statewide Angling Survey

Item	Trout	Striped bass	Black bass	Catfish	Panfish
Postal card reports	1,657	425	457	596	685
Successful anglers	788,000	202,000	217,000	284,000	326,000
Standard error	15,180	9,310	9,610	10,780	11,420
Percentage of all licensees	49.7	12.8	13.7	17.9	20.6
Mean annual catch	41.0	9.1	13.8	27.1	51.6
Standard error	±1.5	±0.6	±0.9	±1.3	±3.0
Median annual catch	20.6	4.1	8.0	11.0	19.6
Total annual catch	32,296,000	1,838,000	2,992,000	7,684,000	17,793,000
Standard error	1,343,000	151,000	235,000	471,000	1,168,000
Mean annual days	10.3	11.6	9.0	9.0	8.0
Standard error	±0.3	±0.8	±0.6	±0.6	±0.5
Median annual days	7.2	6.7	4.2	4.3	4.1
Total annual days	8,127,000	2,353,000	1,959,000	2,543,000	2,604,000
Standard error	277,000	202,000	166,000	193,000	178,000
Percentage of total days	46.2	13.4	11.1	14.5	14.8
Mean catch per angler day	4.0	0.8	1.5	3.0	6.8

TABLE 3—Summary of Successful Anglers' Responses to the 1969 Statewide Angling Survey

Item	Trout	Striped bass	Sturgeon	Black bass	Catfish	Panfish
Postal card reports	2,620	557	79	798	1,098	1,206
Successful anglers	1,006,000	214,000	30,000	306,000	422,000	463,000
Standard error	13,620	8,550	3,390	9,950	11,250	11,630
Percentage of all licensees	52.0	11.0	1.6	15.8	21.8	23.9
Mean annual catch	38.3	8.2	3.0	19.8	29.2	53.3
Standard error	1.2	0.6	0.5	1.2	1.7	2.7
Median annual catch	18.3	1.0	2.0	8.9	9.8	21.6
Total annual catch	38,520,000	1,747,000	91,000	6,067,000	12,319,000	24,668,000
Standard error	1,330,000	152,000	18,000	420,000	789,000	1,381,000
Mean annual days	11.1	13.0	15.6	11.3	11.0	10.2
Standard error	0.3	1.1	2.7	0.8	0.7	0.6
Median annual days	7.1	6.1	5.0	4.9	4.7	4.7
Total annual days	11,146,000	2,780,000	472,000	3,475,000	4,633,000	4,728,000
Standard error	366,000	262,000	96,000	273,000	306,000	295,000
Percentage of total days	40.9	10.2	1.7	12.8	17.0	17.4
Mean catch per angler day	3.5	0.6	0.2	1.7	2.7	5.2

only those reporting the number of each species caught and the days fished for each. Thus, a number of anglers who reported a species caught in 1964, did not give the number or days fished, and were not included as postal card reports. The number of these returns could not be determined because the original data had been destroyed. The projection factor used to compensate for this discrepancy was obtained by multiplying the resident sport fishing licenses sold by the successful respondents and dividing this total by the product of the usable returns multiplied by the usable returns for the species table. Using the items in Table 1, this would be $a \times f \div d \times i$.

Other minor errors in methods and computations of the 1964 data were also corrected. One of these was calculation of the mean catches of some species, which involved arithmetical mistakes in the data tabulation. Another was the calculation of usable returns. As revised this total is 4,300, which is the sum of the respondents who did not fish, the suc-

cessful respondents, and the unsuccessful respondents. The third error concerns the cards considered as unusable returns. In 1964 this included cards returned blank, illegible, or otherwise useless, and those returned by the Post Office as undeliverable for various reasons. In previous surveys, and in the 1969 survey, the undelivered cards were deducted from the total mailed.

Possible sources of sampling error and factors compensating for them have been given in previous survey reports. The extent of these factors is unknown, hence the data are not true estimates. Their effect is probably comparable from survey to survey, so the data are useful in indicating trends.

RESULTS

The results of this survey are presented in a form similar to that of previous surveys, to preserve the continuity of the series.

Certain species were grouped on the cards, because anglers often have difficulty identifying closely related species. The "trout" category was specified on the cards as including kokanee salmon and steelhead under 1 lb. The warmwater fishes were divided into three categories: "black bass", "catfish", and "panfish". "Black bass" included largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), redeye bass (*M. coosae*), and spotted bass (*M. punctulatus*). "Catfish" included all catfish and bullheads (*Ictalurus* spp.), which most anglers have difficulty in distinguishing. "Panfish" included sunfish, crappie (*Pomoxis*) spp.), and various fish not in the other categories. Sturgeon and striped bass (*Morone saxatilis*) are not likely to be confused with other inland fishes.

TABLE 4—**Trends in California Trout Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	12,000,000	149,000	50	80	50
1937	11,900,000	151,000	48	78	50
1938	12,900,000	160,000	46	79	50
1939	12,800,000	179,000	49	71	37
1941	15,700,000	238,000	53	66	40
1942	16,400,000	234,000	54	70	42
1943	15,700,000	213,000	48	75	37
1946	17,660,000	357,000	47	49	25
1948	18,400,000	415,000	43	44	20
1949	16,700,000	431,000	43	39	
1951	18,600,000	429,000	42	43	20
1953	22,300,000	530,000	44	42	22
1954	28,600,000	578,000	47	50	22
1956	26,200,000	640,000	46	41	21
1957	30,700,000	718,000	50	43	21
1959	27,480,000	660,000	45	41	21
1960	28,000,000	709,000	48	39	21
1964	32,296,000	788,000	50	41	21
1969	38,520,000	1,006,000	52	38	18

Trout

Trout remained a favorite of California anglers (Figure 1). In 1969, 64.2% of the respondents reported that they fished for trout (Table 1). The estimated catch in 1964 was 15% above that of 1960, and the 1969 catch reached a new record high (Table 4). Although the total catch increased greatly, the mean and median catches have changed little. The estimated number of successful anglers surpassed 1,000,000 for the first time in 1969.

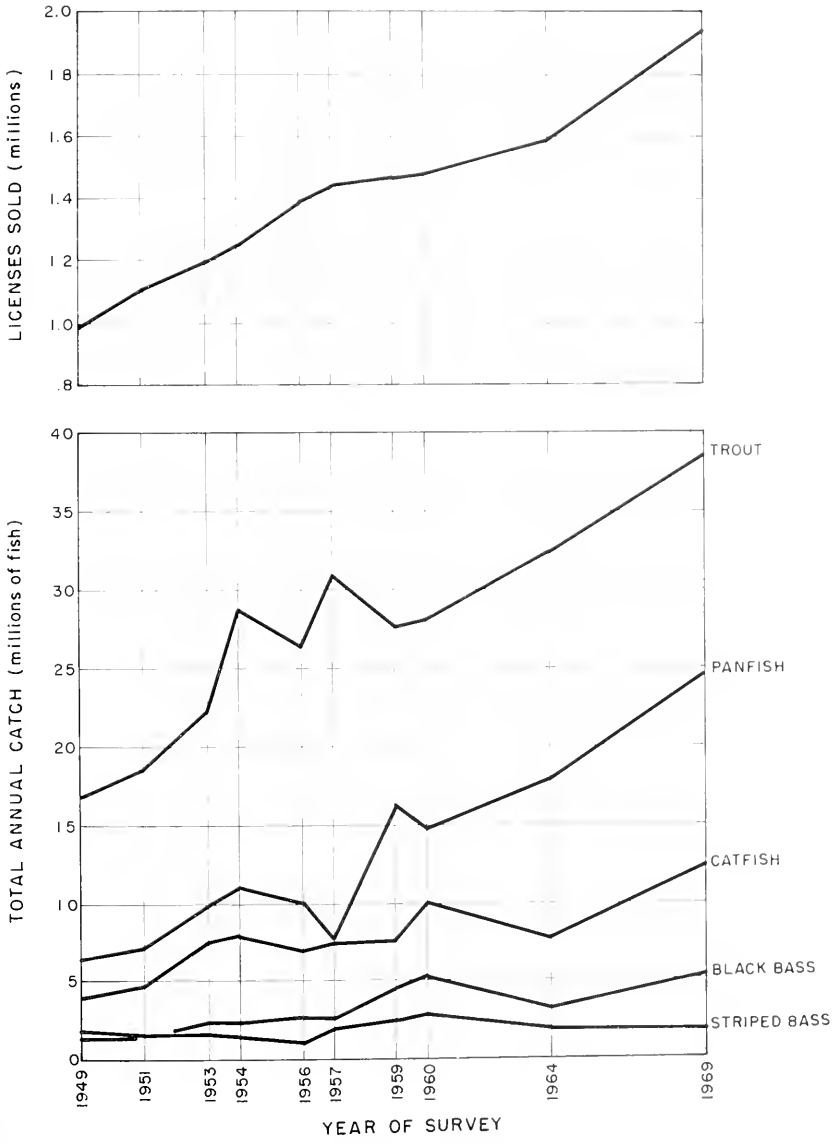

FIGURE 1. Trends in California sport fishing.

TABLE 5—**Trends in California Striped Bass Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	2,110,000	84,400	28	25	
1937	2,040,000	81,900	26	25	
1938	1,940,000	92,800	27	21	
1939	1,880,000	89,300	24	21	12
1941	1,940,000	106,900	23	18	10
1942	1,680,000	88,200	20	19	
1943	1,680,000	75,000	17	22	9
1946	1,380,000	113,000	15	12	6
1948	1,650,000	161,000	17	10	5
1949	1,750,000	165,000	17	11	5
1951	1,490,000	144,000	14	10	5
1953	1,590,000	166,000	14	10	6
1954	1,140,000	158,000	13	9	5
1956	1,000,000	127,000	9	8	5
1957	1,890,000	230,000	16	8	5
1959	2,260,000	224,000	15	10	5
1960	2,770,000	231,000	16	12	5
1961	1,838,000	202,000	13	9	4
1969	1,747,000	214,000	11	8	4

Striped Bass

The 1964 striped bass catch was 34% lower than the 1960 catch (Figure 1, Table 5). The catch declined again in 1969, and was 5% lower than in 1964. This decrease contrasts with increases by the other species. The estimated number of successful anglers increased in 1969, but did not reach the 1960 peak. Yearly average catches have remained much the same.

Sturgeon

Some indication of the sturgeon fishery was obtained for 1969, the first year that data were available. This fishery occurs mainly in the Sacramento-San Joaquin Delta, but some sturgeon are taken in the larger rivers of the North Coast, and in a few reservoirs. The fishery is small, hence standard error estimates are rather large (Table 3).

Black Bass

Although the black bass catch was about 42% less in 1964 than in 1960, the 1969 catch surpassed the 1960 level and more than doubled that of 1964 (Figure 1, Table 6). The estimated number of successful anglers also showed a marked increase. The mean annual catch has fluctuated considerably, but the median catch has remained at about 8 or 9.

Catfish

As with most of the other species, the 1969 catfish catch reached a record high (Figure 1, Table 7). Following a decline of 24% from 1960 to 1964, the increase from 1964 to 1969 was about 60%. Fishing effort for catfish nearly doubled from 1964 to 1969 (Tables 2 and 3), but the average catches remained much the same. Increased demand for catfish will be met with a new stocking program in heavily used southern California waters during the 1970's.

TABLE 6—Trends in California Black Bass Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	930,000	34,000	11	27	
1937	849,000	33,000	11	26	
1938	1,190,000	46,000	13	26	
1939	1,340,000	67,000	18	20	
1941	1,530,000	75,000	17	20	
1942	1,340,000	66,000	15	20	
1943	1,570,000	79,000	18	20	
1946	1,700,000	104,000	14	16	
1948	1,890,000	128,000	13	15	6
1949	1,160,000	116,000	12	10	5
1951	1,280,000	108,000	11	12	6
1953	2,300,000	161,000	14	14	9
1954	2,300,000	151,000	12	15	8
1956	2,550,000	161,000	12	16	9
1957	2,440,000	179,000	12	14	8
1959	4,493,000	218,000	15	20	9
1960	5,150,000	235,000	16	22	9
1964	2,992,000	217,000	14	14	8
1969	6,067,000	306,000	16	20	9

TABLE 7—Trends in California Catfish Angling

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1936	2,940,000	38,000	13	78	
1937	2,810,000	43,000	14	65	
1938	3,480,000	48,000	11	72	
1939	4,333,000	75,000	20	58	
1941	6,100,000	97,000	21	63	
1942	8,250,000	110,000	25	75	
1943	7,060,000	101,000	23	70	
1946	6,530,000	149,000	19	44	
1948	5,560,000	182,000	19	31	15
1949	3,930,000	161,000	16	24	12
1951	4,710,000	171,000	17	29	12
1953	7,500,000	225,000	19	33	15
1954	7,990,000	220,000	18	37	13
1956	6,970,000	217,000	16	32	10
1957	7,370,000	259,000	18	28	13
1959	7,674,000	232,000	16	32	10
1960	10,100,000	275,000	19	37	15
1964	7,684,000	281,000	18	27	11
1969	12,319,000	422,000	22	29	10

Panfish

The marked increase in the catch of panfish is clearly evident (Figure 1, Table 8). Despite large declines in the total catch of other warmwater species in 1964, the panfish catch was up 21%. The 1969 catch showed a marked increase over 1964, being nearly 40% greater. As with catfish, total fishing effort nearly doubled from 1964 to 1969, but average catches remained much the same.

TABLE 8—**Trends in California Panfish Angling**

Year	Total catch	Successful anglers		Annual catch per successful angler	
		Number	Percentage of angling licensees	Mean	Median
1954	10,970,000	205,200	17	53	26
1956	10,020,000	225,000	16	44	18
1957	7,680,000	244,000	17	31	17
1959	16,114,000	281,000	19	56	22
1960	14,740,000	296,000	20	50	22
1964	17,793,000	326,000	21	55	20
1969	24,668,000	463,000	24	53	22

ACKNOWLEDGMENTS

Leo Shapovalov, Alex Calhoun, Ralph Carpenter, and Harold Chadwick reviewed the manuscript and made many helpful suggestions for improvement. Harold Chadwick deserves special mention for suggesting calculation of the projection factor used in revising the 1964 data. Figure 1 was drawn by Cliffa Corson.

REFERENCES

Calhoun, A. J. 1950. California angling catch records from postal card surveys: 1936–1948, with an evaluation of postal card nonresponse. Calif. Fish and Game 36 (3) : 177–234.

———. 1951. California statewide angling catch estimates for 1949. Calif. Fish and Game 37 (1) : 69–75.

———. 1953. Statewide California angling estimates for 1951. Calif. Fish and Game 39 (1) : 103–113.

Croxton, Frederick E. 1953. Elementary statistics with applications in medicine. Prentice-Hall, Inc., New York. 376 p.

Curtis, Brian. 1940. Anglers' catch records in California. Trans. Amer. Fish. Soc. 69 : 125–131.

McKechnie, Robert J. 1966. California inland angling survey for 1964. Calif. Fish and Game 52 (4) : 293–299.

Ryan, James H. 1959. California inland angling estimates for 1954, 1956, and 1957. Calif. Fish and Game 45 (2) : 93–109.

Seeley, Charles M., Robert C. Tharratt, and Richard L. Johnson. 1963. California inland angling surveys for 1959 and 1960. Calif. Fish and Game 49 (3) : 183–190.

Skinner, John E. 1955. California statewide angling estimates for 1953. Calif. Fish and Game 41 (1) : 19–32.

Snedecor, George W., and William G. Cochran. 1967. Statistical methods. Iowa State Univ. Press, Ames, Iowa. 593 p.

Calif. Fish and Game, 57(2) : 107–112, 1971.

AGE COMPOSITION OF SARDINE LANDINGS ON THE PACIFIC COAST OF THE UNITED STATES AND MEXICO IN 1964–1965[1]

by

MAKOTO KIMURA
National Marine Fisheries Service
Fishery-Oceanography Center
La Jolla, California

and

C. E. BLUNT, JR.
Marine Resources Region
California Department of Fish and Game

California landings of Pacific sardines, *Sardinops caeruleus* (Girard), during the 1964–65 season amounted to 5,297 tons. During the interseason, 994 tons were landed.

Baja California sardine landings totaled 24,675 tons for this period, almost all of which came from San Sebastian Vizcaino Bay and Bahia de la Magdalena.

The age structure of the catch and low landings off California and northern Baja California reflect continued failure of the sardine population in the north to produce good year-classes.

INTRODUCTION

The rise and fall of the fishery for Pacific sardines is well known. Because of the continued interest in the sardine population and its apparent interaction with the northern anchovy, *Engraulis mordax* Girard, we continue to sample the landings for age and length composition.

Detailed reports of age and length composition of landings through the 1963–64 season have been reported in *California Fish and Game*. Beginning with the 1964–65 season, the reports will be abbreviated and follow the present format. A more detailed discussion of the sardine fisheries on the Pacific Coast of the United States and Mexico for 1964–65 and subsequent periods is available in various Marine Resources Region Reference Reports and may be obtained from the Marine Resources Region, 350 Golden Shore, Long Beach, California, 90802.

This report, the 19th of a series, summarizes the age composition of the 1964–65 period landings. We wish to acknowledge the assistance of John MacGregor, National Marine Fisheries Service; Harold Hyatt and Richard Wood, California Department of Fish and Game; and William W. Hatton, California Academy of Sciences.

[1] Accepted for publication January 1971. This article was prepared in part while the junior author was working in cooperation with the Department of Commerce, National Marine Fisheries Service, under Public Law 88-309, Project M-63-R.

TABLE 1—**Age and Year Class Composition of the Sardine Catch in the 1964–65 Season**

	Catch		Numbers of fish in thousands by age and year class								
			1	2	3	4	5	6	7	8	9
	Tons	Number	1963	1962	1961	1960	1959	1958	1957	1956	1955
Central California											
"August"[1, 2]	41	181	--	--	--	18	76	87	--	--	--
"September"[2]	118	511	--	--	--	15	157	213	126	--	--
"October"	57	321	64	141	13	--	--	45	58	--	--
"November"	14	65	--	5	2	--	22	27	9	--	--
"December"	68	308	--	24	41	35	31	57	78	14	28
"January"[3]	1	4	--	--	--	.6	.4	1.5	.8	.5	.2
"February"	5	19	--	--	--	3	2	7	4	2	1
"March"[4]	--	--	--	--	--	--	--	--	--	--	--
Total Central California	304	1,409	64	170	56	71.6	288.4	437.5	275.8	16.5	29.2
Percentage	--	99.99	4.54	12.07	3.97	5.08	20.47	31.05	19.57	1.17	2.07
Southern California											
"September"[5]	3,556	29,066	--	3,895	13,806	5,755	3,168	1,599	814	29	--
"October"	589	4,359	--	863	1,726	1,160	357	122	131	--	--
"November"	450	3,484	7	418	1,345	1,526	125	32	31	--	--
"December"	311	2,100	--	158	588	746	462	73	73	--	--
"January"	31	179	--	11	39	36	79	14	--	--	--
"February"[6]	4	27	--	--	7.3	11	7.2	.5	1	--	--
"March"[4]	52	296	--	--	80	122	80	4	10	--	--
Total Southern California	4,993	39,511	7	5,345	17,591.3	9,356	4,278.2	1,844.5	1,060	29	--
Percentage	--	100.00	.02	13.53	44.52	23.68	10.83	4.67	2.68	.07	--
Total California	5,297	40,920	71	5,515	17,647.3	9,427.6	4,566.6	2,282	1,335.8	45.5	29.2
Percentage	--	100.00	.17	13.48	43.13	23.04	11.16	5.58	3.26	.11	.07

Northern Baja California											
"September"[5]	38	236	--	--	21	97	104	14	--	--	--
"October"	215	1,449	--	--	406	609	319	72	43	--	--
"November"	899	5,784	--	--	983	2,892	1,678	231	--	--	--
"December"[7]	967	6,264	--	--	1,064	3,132	1,817	251	--	--	--
"January"[7]	262	1,698	--	--	289	849	492	68	--	--	--
"February"[7]	145	939	--	--	160	469	272	38	--	--	--
"March"[4, 7]	109	709	--	--	121	354	206	28	--	--	--
Total Northern Baja California	2,635	17,079	--	--	3,044	8,402	4,888	702	43	--	--
Percentage	--	100.00	--	--	17.82	49.20	28.62	4.11	.25	--	--
Central Baja California											
"September"[8]	651	5,510	--	309	1,435	1,899	1,391	397	88	--	--
"October"	1,363	11,436	--	640	2,974	3,934	2,882	823	183	--	--
"November"	775	6,500	--	182	1,378	2,392	2,288	130	130	--	--
"December"	970	8,117	--	349	1,567	3,060	2,167	869	105	--	--
"January"	734	6,489	--	260	2,660	1,492	1,493	584	--	--	--
"February"	1,439	12,056	--	--	1,929	6,028	2,170	723	1,206	--	--
"March"[4]	633	5,573	--	56	836	2,062	1,616	1,003	--	--	--
Total Central Baja California	6,565	55,690	--	1,796	12,779	20,867	14,007	4,529	1,712	--	--
Percentage	--	99.99	--	3.22	22.95	37.47	25.15	8.13	3.07	--	--
Total Baja California[9]	9,200	72,769	--	1,796	15,823	29,269	18,895	5,231	1,755	--	--
Percentage	--	100.00	--	2.47	21.74	40.22	25.97	7.19	2.11	--	--

[1] August 1–21.
[2] No samples; ages estimated from "July" sampling.
[3] No samples; ages estimated from "February" sampling.
[4] February 16–March 2 landings.
[5] September 1–20.
[6] No samples; ages estimated from "March" sampling.
[7] No samples; ages estimated from "November" sampling.
[8] No samples; ages estimated from "October" sampling.
[9] Includes Cedros Island and Ensenada only—2,847 tons from southern Baja California not sampled.

THE FISHERY

Fishing off California was poor with catches consisting primarily of sardines mixed with mackerel (jack mackerel, *Trachurus symmetricus*, and Pacific mackerel, *Scomber japonicus*). The age structure of landings for central and southern California (Table 1) reflected the continuing failure of the sardine population in the north to produce good year-classes.

In California the sardine season (also called the canning season) extends from August 1 through March 2 in central California (Pt. Arguello north) and September 1 through March 2 in southern California. The interseason for each area represents the period between successive seasons. Baja California landings are summarized on the same interseason and season basis.

During the interseason, California landings totaled 994 tons, with only 3 tons landed in central California. Season landings were 5,297 tons with 304 tons taken in central California and 4,993 tons landed in southern California. This brought the California total to 6,291 tons for the period March 3, 1964 to March 2, 1965.

The fleet off central California during the season consisted of two large (60 ft or over) and two small purse seiners and 12 lampara boats. The large purse seiners spent part of the season in southern California because of fish scarcity in central California. The fishermen were paid $65 per ton for sardines and $52.50 per ton for mixed sardines (30–70% sardines) and mackerel.

A total of 38 large purse seiners and 25 small purse seiners and lampara boats fished exclusively in southern California (two other large purse seiners from Monterey joined the southern California fleet during part of the season). One cannery in Oxnard and five in the Los Angeles-Long Beach area processed fish.

The sardine industry in Baja California has been processing a greater portion of the Pacific Coast catch in recent years. Sardine fishing here is permitted throughout the year; but for purposes of comparison with southern California catch statistics, the fishing period is divided into similar season and interseason periods.

Catches of sardines in the Ensenada (northern Baja California) area were insignificant. The bulk of sardines processed at Ensenada came from San Sebastián Vizeaíno Bay, which also provided fish for the cannery at Cedros Island (central Baja California). The cannery at Puerto Adolfo López Mateos (southern Baja California) was supplied with fish caught in Bahía de la Magdalena.

Season landings in the Ensenada, Cedros Island, and Puerto Adolfo López Mateos areas amounted to 12,047 tons (Table 1), and interseason landings amounted to 12,628 tons (Table 2). These landings (total) represent an increase of 27%, as compared to the 1963–64 period landings of 18,115 tons.

A total of 33 purse seiners and lampara boats fished in Baja California waters; 25 were based and landed catches at Ensenada, 4 at Cedros Island, and 4 at Puerto Adolfo López Mateos. Two of Ensenada's larger purse seiners equipped with refrigerated holds were based at Cedros Island during a part of the fishing season.

TABLE 2—**Age and Year Class Composition of the Sardine Catch in the 1964–65 Baja California [1] Interseason**

	Catch		Numbers of fish in thousands by age and year class							
			0	1	2	3	4	5	6	7
	Tons	Numbers	1964	1963	1962	1961	1960	1959	1958	1957
Northern Baja California										
"March"	244	2,797	--	--	895	503	504	699	196	--
"April"	134	1,499	--	--	445	474	58	193	279	--
"May"	148	2,141	--	364	1,263	511	--	--	--	--
"June"	214	2,531	202	339	1,522	354	84	--	--	--
"July"	873	9,758	781	1,307	5,982	1,366	322	--	--	--
"August"	511	5,197	--	--	--	729	2,183	1,663	--	624
"September" [2, 3]	5	52	--	--	--	7	22	17	--	6
Total Northern Baja California	2,129	23,925	983	2,010	10,136	3,945	3,173	2,572	475	630
Percentage	--	100.00	4.11	8.40	42.37	16.49	13.26	10.75	1.99	2.63
Central Baja California										
"March" [4]	598	1,738	--	--	569	2,085	1,611	473		--
"April" [4]	847	6,710	--	--	805	2,953	2,281	671	--	--
"May"	373	3,020	--	--	362	1,329	1,027	302	--	--
"June" [4]	370	2,999	--	--	360	1,320	1,019	300	--	--
"July"	1,130	9,450	--	--	567	3,591	4,158	851	283	--
"August"	1,185	9,188	--	--	478	1,691	3,932	1,874	1,213	--
"September" [2]	54	427	--	--	21	111	147	108	37	--
Total Central Baja California	4,566	36,532	--	--	3,165	13,080	14,175	4,579	1,533	--
Percentage	--	99.99	--	--	8.66	35.80	38.80	12.53	4.20	--
Total Baja California	6,695	60,457	983	2,010	13,302	17,025	17,348	7,151	2,008	630
Percentage	--	100.00	1.63	3.32	22.00	28.16	28.70	11.83	3.32	1.04

[1] Includes Cedros Island and Ensenada only—5,933 tons from southern Baja California cannery not sampled.
[2] August 22–September 1 landings.
[3] No samples; ages estimated from "August" sampling.
[4] No samples; ages estimated from "May" sampling.

Five canneries operated in the Ensenada area, one on Cedros Island, and one at Puerto Adolfo López Mateos. The domestic demand for canned sardines was good and the price to the fishermen ($32–$42/ton) fluctuated very little with $40 per ton being the average price paid during the 1964–65 period.

Calif. Fish and Game, 57(2) : 113–123. 1971.

CANADA GOOSE NEST PLATFORMS

WARREN C. RIENECKER[1]
Wildlife Management Branch
California Department of Fish and Game

Six different designs of Canada Goose (*Branta canadensis*) artificial nest platforms were tested on the Honey Lake Wildlife Area, Lassen County, California, during 1966–1970. The split drum platform design is the most promising of those tested for acceptance by the geese, low cost, stability, hauling and assembly in the field. Size and location of the platform are the main factors which determine whether a platform will be utilized or ignored. All of the large platform designs are readily accepted as nesting sites if they are located in areas favored by the geese. High winds, wave action and shifting ice are the major causes of platform damage. Platform use increased from 15% at the end of the first year of study to 35% the second year, 44% the third year and 53% the fourth year. This increasing annual use of artificial nest platforms seems to be a normal process of learning by Canada geese. During this study period 104 goose nests were built on test platforms. Of these nests, 102 (98%) had hatched eggs and 2 (2%) were deserted.

INTRODUCTION

To the waterfowl hunter the large Canada goose is a trophy bird. Consequently, a great deal of hunting pressure is exerted on the species, which causes the wildlife manager to be constantly on the alert for changes in the population and to seek means for improving its management.

The management of this prized bird is accomplished largely through the use of hunting regulations and sanctuaries. However, management programs for the Canada goose are improved through a continually better understanding of the basic needs of this species. Studies have shown that Canada geese prefer elevated nest sites with an unobstructed view of the surrounding area. The use of artificial nest platforms seems to fulfill this need.

Since much of the Canada goose breeding range is within the United States, man has a much greater effect, both good and bad, on the nesting habitat of the Canada goose as compared to those species of geese nesting in remote areas of Alaska and Canada.

The Great Basin Canada Goose (*Branta canadensis moffitti*) whose breeding range covers much of the northwestern states including northeastern California is the race of Canada goose with which we are most concerned in California.

During the past decade there has been an increasing awareness by state and federal agencies and private organizations of the value of artificial nest platforms to increase the preferred nesting habitat of the Canada goose. Platforms were set up in California during this period but with little knowledge as to the types of platforms to use and where to place them. As a result, success of these early constructed platforms was limited to chance.

[1] Accepted for publication, December 1970. This study was supported by Federal Aid in Wildlife Restoration Project W-30-R "Waterfowl Studies."

The increasing construction of water impoundments, such as reservoirs, in California, the interest in artificial nest platforms and the desire to improve conditions on the breeding grounds was the reason for this study. The work began during the summer of 1966 and ended after the 1970 nesting season. The principal objective of the study was to determine the most efficient and practical Canada goose nest platform.

The study area is located on the state-operated Honey Lake Wildlife Area in Lassen County, specifically on Hartson Reservoir and adjacent ponds (Figure 1). Hartson Reservoir is a relatively shallow body of water that varied during the study period from approximately 900 acres in late winter to 500 acres in late summer. A chain of islands across the north half of the reservoir, and the dikes and islands on the eastern part of the reservoir were the preferred nest sites for the Canada goose. The history and detailed description of the area has been recorded (Anderson 1965).

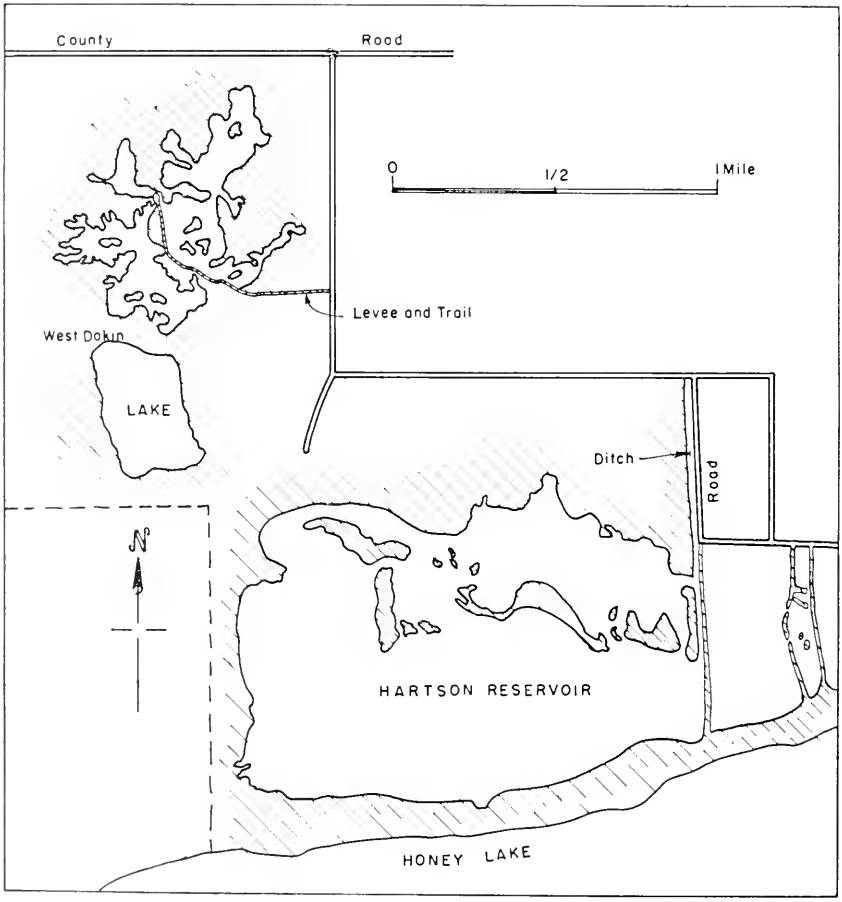

FIGURE 1. Map of study area.

METHODS

Six different designs of Canada goose nest platforms were installed during the study period. Four types were installed during the summer of 1966: the floating platform, haystack platform, Dill platform and drum-end platform. One type (split drum) was installed during the summer of 1967 and another type (half drum) during the summer of 1968.

The platforms were placed at approximately 200-ft intervals along the shoreline of the reservoir, some over water and some on land. Platforms were also installed on the north half of the reservoir. This area is not as deep (30 inches maximum during the nesting season to dry ground by late summer) as the south half and is somewhat protected from the prevailing winter storms by a chain of islands. The ponds to the east and to the northwest of Hartson Reservoir were also used as platform sites. An effort was made to remove bias in picking the platform site thereby giving each design an equal chance of being on desirable sites. The majority of the platforms were set up during late summer when the water in the reservoir was at its lowest level. At this time many of the platform sites were dry enough to drive to, thus simplifying hauling and setting up the platforms. Repairs and the replenishing of nest material, when necessary, was also done at this time of the year. Hay and wood chips were placed on the platforms as nest material for the geese.

The platforms were inspected for use during peak nesting and again shortly after nesting. Platform type, location, condition and use were recorded for each site.

Following is a brief description of each type of platform and the number installed.

Floating Platform (10)

A 4 x 6 ft raft made of 3 x 12 x 72 inch cull cedar planks was used to float the nest platform. The platform, consisted of a frame constructed of 3 x 12 x 24 inch cedar lumber and filled with hay, and was nailed to the center of the raft. The raft was secured to the reservoir bottom with an anchor.

Haystack Platform (10) (Figure 2)

Each layer of hay bales consisted of 4 bales. 1½ bales on each side. Each stack was 4 layers high, approximately 5½ ft. This arrangement left a hole in the center of the stack which was filled with 1½ bales placed on end. Each stack was fenced to prevent cattle damage.

Dill Platform (12) (Figure 3)

Original design was by Herbert H. Dill, U. S. Fish and Wildlife service. This structure consisted of a 48 x 48 x 18 inch wire platform framed and braced with angle iron and supported by 4 angle iron legs 7 ft long set at 60 degree angles. Because of its large size, bolting the legs to the platform was delayed until the platform was hauled to its site on the reservoir. The angle iron legs proved to be too light to withstand the constant pounding by ice and wave action in areas exposed to open water. They were replaced with 6 ft legs made from 1 inch

pipe. An 18-inch section of 1-inch pipe threaded with a coupling on the bottom end was welded to each of the four corners. Thus the legs were unscrewed to facilitate hauling.

FIGURE 2. Haystack platform.

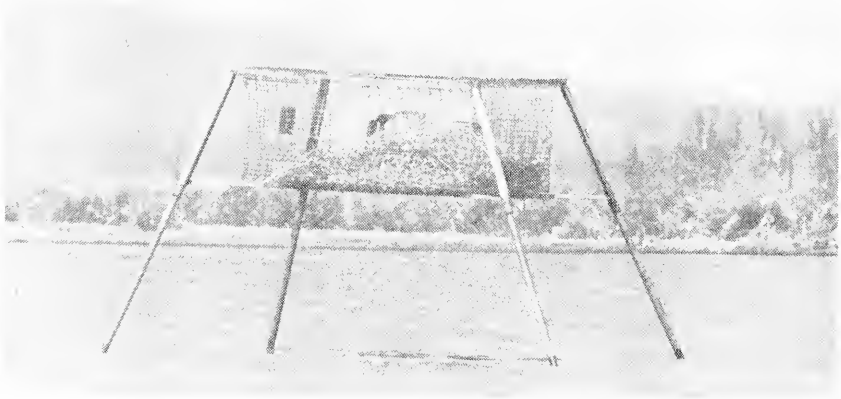

FIGURE 3. Dill platform.

Drum End Platform (50)

The end one third of a 55 gallon steel drum was mounted approximately 5 ft above the ground on 3 angle iron fence posts. Three collars (2 inch length of 2 inch pipe) were welded equidistant around the drum. The drum was placed on its side at the platform site and the fence posts were passed through the collars to the blade on the posts. The drum and posts were then placed in an upright position and the posts were driven into the ground. After all three posts were positioned the drum was raised to the top of the posts and held there by a 40 penny nail inserted into each post under each collar. Forty penny nails fit snugly in the slots which were spaced at 2-inch intervals along the length of the post. The platform was then wired to the posts to prevent it from being blown off.

On 25 of these drum end platforms a landing platform to frame the top of the drum was added. This frame consisted of three pieces of 1 x 12 x 36 inch lumber which formed a triangle around the drum.

Split Drum Platform (10) (Figure 4)

A 55 gallon drum was cut in half lengthwise and the two halves were placed side by side. The halves were held together with angle iron welded across the two ends top and bottom. The inner side of each drum half was cut down along the rim approximately 9 inches on both ends. One 9 inch panel was cut out and discarded. The other 9 inch panel was bent down and spot welded to the other drum half to form the center of the platform bottom. The dimensions of the platform were 34 x 46 x 11 inches.

FIGURE 4. Split drum platform.

On five of these platforms a section of pipe 1½ x 12 inches was welded vertically to the angle iron on each of the four corners of the platform. These pieces of 1½ inch pipe served to hold the 1 inch pipe legs. The top 1 ft of the 6 ft pipe legs was bent at approximately a 60 degree angle and a stopper welded to the pipe at the bend. The legs could be easily inserted or removed from the 1½ inch pipe, thus facilitating transport to the platform site and assembly in the field.

Legs on the remaining five platforms were constructed of 2 x 4 inch lumber which proved unsatisfactory. All platforms had turned over prior to the nesting season. The following summer (1968) they were rebuilt with pipe legs.

Half Drum Platform (12)

This platform consisted of half of a 55 gallon drum split lengthwise and mounted on four legs. Six of the platforms were supported by 1 inch pipe legs as described for the split drum platform. The other six platforms were supported by four angle iron fence posts as described for the drum end platform. Rock supports were used in conjunction with two of the platforms mounted on fence posts (Figure 5). Landing platforms are installed on three of the platforms with pipe legs and three with fence post legs.

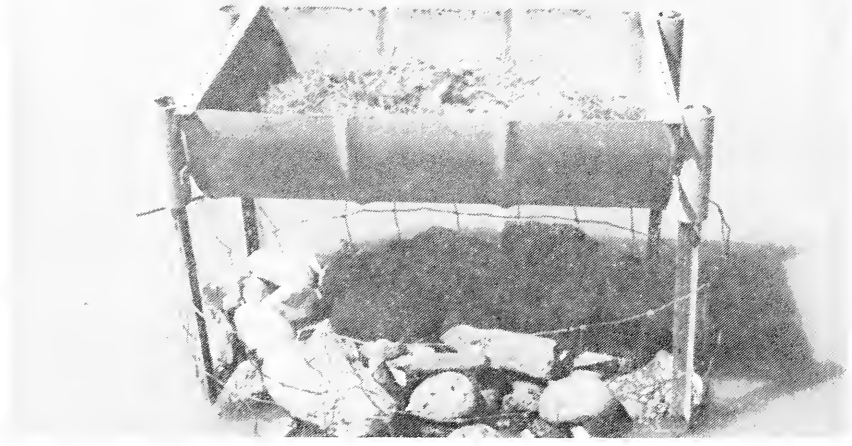

FIGURE 5. Half drum platform with rock support.

RESULTS

Floating Platform

Prior to the winter storms several of these platforms became waterlogged and were useless as nest sites. During the winter all the platforms broke loose from their anchors and drifted to shore. Although rafts may be practical under certain conditions—various types have

been used in other states—their value on the study area compared to the stationary platforms does not justify their cost and maintenance. Consequently, further testing of floating platforms was discontinued at the end of the first year.

Haystack Platform

Canada geese readily accepted this platform design as a nest site. (Table 1).

Haystacks on the more desirable locations often had the bottom layer of bales in water during the winter and early spring months. Rotting was thus hastened. The weight of the upper compressed the bottom layer of bales thereby reducing the platform height. A haystack platform was reduced to less than three layers of bales after 4 years of periodic flooding (Figure 2). The reduction in height was easily remedied by adding another layer of bales to the top of the stack.

This type platform is good but costs in time and materials can be expensive, especially if a fence is required to keep livestock from damaging the stack. However, although the cost is increased, a fence or some other method of binding the bales together should be used, even when livestock is not a problem. Those stacks located in water would undoubtedly have been destroyed by ice and wave action if they had not had a fence to hold them together. One stack moved several feet by ice and wave action.

Other than adding a layer of bales every few years, maintenance requirements are relatively minor for this type platform.

TABLE 1—Canada Goose Nest Platform Use

Type platform	Number serviceable platforms*				Number platforms used			
	1967	1968	1969	1970	1967	1968	1969	1970
Floating	0	--	--	--	0	--	--	--
Haystack	9	9	10	9	5(55%)	6(67%)	9(90%)	7(78%)
Dill	8	7	6	3	5(62%)	7(100%)	5(83%)	3(100%)
Drum end	48	47	41	40	0	7(15%)	10(24%)	15(38%)
Split drum	--	5	10	9	--	4(80%)	7(70%)	7(78%)
Half drum	--	--	11	7	--	--	3(27%)	4(57%)
Total	65	68	78	68	10(15%)	24(35%)	34(44%)	36(53%)

* Platforms that had survived the winter storms and were serviceable at the start of the nesting season.

Dill Platform

This platform design was also well accepted by the geese. Although the legs were changed to a stronger material (1 inch pipe), maintenance requirements were extensive throughout the study period. From one-half to two-thirds of the platforms were damaged beyond use each winter. It is believed that a combination of strong winds blowing against the large size platform and a simultaneous build-up of ice against the legs caused the platforms to tip over. When the platform was turned over, the legs were bent or broken off by ice action. To keep repairs to a minimum this type of platform had to be placed in areas sheltered from strong winds.

This design costs more to build and maintain and is more troublesome to transport than the drum types tested. Consequently, although it is well received by the geese it is not recommended for use in preference to the haystack and drum type platforms.

Drum End Platform

Washtubs of the same size as the drum end platforms have been used with success in other states (Yocum 1952; Brakhage 1965, 1966). However, the geese on the study area completely ignored the drum end platforms during the first year but accepted the larger haystack and Dill platforms. Size was definitely the limiting factor. The drum end platforms are 22 inches across and 10 inches deep. One half of the platforms had a landing platform frame on top of the drum but this added size had no effect on use of the platforms the first year.

Because these platforms are cheap and easy to construct and after one year of testing seemed to require little maintenance, it was decided to continue testing them although they were not used by geese the first year.

By the second year the geese seemed to be learning to use these drum end platforms in high priority nesting habitat. Fifteen percent of the platforms were used by the end of the second nesting season and this increased to 24% the third year and to 38% the fourth year. There was a slight preference by the geese for platforms with landings as compared to those without landings. Sixty-five percent of the drum end platforms used by the geese contained landings.

It is conceivable that after a number of years of increased use these smaller platforms would be utilized as readily as the larger types. If this proves to be true then this type platform would be the best because of its low cost and ease of construction plus low maintenance requirements.

Split Drum Platform

At the end of the first year of testing there was no response to the small platforms by geese but good use of the large platforms. Therefore a platform was designed that was large enough to be attractive to the geese yet have the advantage of the small platform. Since 55 gallon steel drums can usually be obtained at little or no cost it was decided to design a platform with the drum as the basic material. Ease of hauling was also given serious consideration since the platform would be hauled many miles from shop to reservoir. The split drum platform was the result of these decisions.

The platforms were readily accepted by the geese and their percent of use was comparable to that of the haystack and Dill platforms. Maintenance requirements were low. Only two platforms with pipe legs were upset by winter storms during the 3 years that this design was tested. The fact that the legs were not rigidly attached to the platform seemed to make them less vulnerable to ice damage after a platform had been tipped over.

At the present time, this platform design is the most promising of those tested with regard to acceptance by the geese, low cost, stability, hauling and assembly in the field.

Half Drum Platform

Since the split drum platform was well accepted by the geese after one year of testing, a platform was designed which had only half a drum instead of the two halves of the split drum platform. The purpose was to further reduce the cost of construction. However, if the drums were free and in ample supply, little was saved in cost or labor by reducing the platform size.

During the 2 years that this design was tested one platform with pipe legs was turned over the first year by wind and ice action and three platforms with pipe legs and one with fence-post legs and rock support were upset the second year.

A slightly higher rate of platform damage would be expected for those platforms with pipe legs compared to the split drum platforms since by reducing their size the stability is also reduced.

The percentage use of these platforms was better than that of the smaller drum end platforms but not as good as for the larger platforms. There was no obvious preference for platforms with landings. It seems that landing platforms are not important and can be deleted.

DISCUSSION

This study demonstrated that size of the platform and its location are the main factors which determined whether it will be utilized or ignored. All of the large platform designs were readily accepted as nesting sites provided they were located in areas favored by geese. The greatest use of the platforms was attained by concentrating them in areas that contained more geese than this preferred nesting habitat could accommodate. The geese readily accepted these platforms whereas those platforms located on fringe areas were mostly ignored.

The ideal platform would be 3 to 4 ft in size and located approximately 50 to 300 ft from shore. If located beyond 300 ft for best results, the platforms should be placed near something upon which the gander can loaf. This recommendation could include anything projecting above the surface of the water that would support the weight of a goose, such as an island, a rock, stump, floating log or matted tule clump. However, if this object could also serve as a nest site, placement of a platform nearby would complicate the situation. Geese are territorialistic and normally will not allow others of their own kind to nest near them. For this reason the desertion rate is great among ground nesters in high priority nesting habitat. Brakhage (1965) created loafing sites by chaining a log 4 to 10 ft from the platform, thus increasing the attractiveness of open water sites and reducing the size of the territory.

The ideal platform site would be located in open water giving the goose an unobscured view of the surrounding area. On the study area the platforms were spaced approximately 200 ft apart. However, on some of the more desirable locations they were placed closer together with no apparent adverse effects.

The water should be deep enough to discourage land predators or in the case of shallow water the platforms should be high enough to make it impossible for a predator, such as a coyote, to leap on it. The platform also should be high enough to take care of a rise in water levels.

The ideal marsh, lake or reservoir should be of sufficient size to insure an ample supply of food and water and to serve as protection for both goslings and adults during their flightless period.

High winds, wave action, and shifting ice on large expanses of open water are the major causes of platform damage. Therefore, when possible, the platforms should be placed on the lee side of islands, peninsulas, tule patches or anything else that could serve as a windbreak. If the body of water was deeper than 2 ft and more than several hundred yards across with no available windbreaks, the best sites for platform protection would be on the lee side of the area or along the shore. The lee side would be determined by the direction of the prevailing winter storms. However, should a storm come from another direction, these platforms would be in a precarious position. Consequently large bodies of deep, open water are not regarded as ideal platform sites. Shore sites on the study area were marginal nesting habitat at best. The value of shore platform sites seems to vary from area to area according to the nesting habitat available. Most studies suggest use of river and lake shorelines as platform sites when suitable habitat is limited.

Hay and wood chips were used as nesting material on the platforms. Both proved satisfactory. However, any material that the goose could shape into a nest would probably serve.

Platform use increased from 15% at the end of the first year of study to 35% the second year, 44% the third year and 53% during the fourth year (Table 1). This increasing annual use of artificial nest platforms by Canada geese seems to be a normal process of learning. Craighead (1961) reported platform use increased from 4.5% to 21% during a 5-year period. However, if the platforms are placed in an area that geese regard as marginal nesting habitat then the platforms might never be used. As an example, in 1965 a 6,000-acre reservoir in northeastern California was drained so that repairs could be made on the dam. While the reservoir was dry, and because of an interest in conservation, the property owners installed 100 drum end platforms in one end of the reservoir. Little was known at the time about where to place the platforms and as a consequence they were installed 400 to 800 yards from shore in open water and in the end of the reservoir that had very little nesting use. To date only one of these platforms has been used by a Canada goose. The breeding population of geese using the reservoir has been estimated at over 100 pairs most of which nest on wooded islands and tule mats on the far end of the reservoir. Had the platforms been placed on the end of the reservoir used by the geese they would undoubtedly have been occupied since the preferred nesting habitat is limited and the nest desertion rate is high.

Several platforms similar in size to the haystack but constructed of lava rock were observed on the Cinder Cone Wildlife Area in northeastern California. Although the platforms were not a part of this study they looked very impressive and warrant mentioning here. They are a good example of what can be done with available materials. The reservoir bottom on which these rock piles were constructed has an abundance of lava rocks some of which were piled as nesting platforms during a period of low water. If the rocks are put together carefully so

that they fit together the piles should outlast all other types of platforms discussed in this report.

Man-made earth islands as goose nesting sites should also be considered when contemplating methods of improving goose nesting habitat. On some state and federal managed waterfowl areas where heavy equipment is available and water areas can be dried, islands might be more practical than elevated platforms. However, islands also have drawbacks, some of which are: (i) high cost of construction, (ii) necessity of drying ponds, thereby inviting invasion of undesirable plant growth, (iii) not as predator proof as elevated platforms, and (iv) they cannot be moved to a better location. The main problem with islands is erosion from wind, ice and wave action. If an island is built with a means of controlling erosion it might last longer than the average platform and require less maintenance, but initial cost will be higher.

During the 4 years that the study was conducted, 104 nests were built on test platforms. Of these nests 102 (98%) had hatched eggs and 2 (2%) were deserted. Canada goose ground nesting studies were conducted on this area in 1951 (Naylor 1953) and in 1963 (Anderson 1965). As a comparison, Naylor reported a hatching success of 68.3% with 23.9% deserted and 7.8% destroyed. Anderson's results were similar with 69.2% hatched, 19.5% deserted, 3.0% destroyed and 8.3% failed due to various causes but mostly from flooding. Both stated that the high incidence of desertion was caused by territorial strife resulting from overcrowding in the high priority island nesting habitat.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to personnel of the California Conservation Center, Susanville, California, who built the Dill and drum end platforms; to Harold McKinnie, Thomas Stone and Victor Simpson for assistance in setting up and studying the platforms; to Robert Weld, in charge of the Honey Lake Wildlife Area; to Jack Slosson who disclosed the lava rock platforms; and to Frank Kozlik and Robert LeDonne for guidance and assistance with the manuscript.

REFERENCES

Anderson, William. 1965. Waterfowl production in the vicinity of gull colonies. Calif. Fish and Game 51 (1): 5–15.

Brakhage, George K. 1965. Biology and behavior of tub-nesting Canada geese. J. Wildl. Manage. 29 (4): 751–771.

———. 1966. Tub-nests for Canada geese. J. Wildl. Manage. 30 (4): 851–853.

Craighead, J. J., and D. S. Stockstad. 1961. Evaluating the use of aerial nesting platforms for Canada geese. J. Wildl. Manage. 25 (4): 363–372.

Naylor, A. E. 1953. Production of the Canada goose on Honey Lake Refuge, Lassen County, California. Calif. Fish and Game 39 (1): 83–91.

Yocum, C. F. 1952. Techniques used to increase nesting of Canada geese. J. Wildl. Manage. 16 (4): 425–428.

NOTES

SEA LION CENSUS FOR 1970, INCLUDING COUNTS OF OTHER CALIFORNIA PINNIPEDS

Censuses of sea lions along the California coast have been taken at irregular intervals since the late 1800's, and by the Department of Fish and Game since 1927. Before 1946, only the sea lions on the larger rookeries, hauling grounds, and nearby areas were counted. Censusing methods were detailed by Ripley, Cox, and Baxter (1962) who also discussed the problem and history of sea lion censusing in California.

Other California pinnipeds were counted for the first time in the 1965 census because of increased interest in these species. The 1970 census, which was conducted June 9 to 11, and June 16 and 17, included California sea lions, *Zalophus californianus*, Steller sea lions, *Eumetopias jubata*, harbor seals, *Phoca vitulina*, and northern elephant seals, *Mirounga angustirostris*. We did not attempt to count northern fur seals, *Callorhinus ursinus*, which have been on San Miguel Island in small numbers the last few years, (Peterson, Le Boeuf, and DeLong, 1968), because very few would be on the rookery in early June.

Our aerial census was made using a twin-engine Super Skymaster, flown by Warden-Pilot Leo Singer, who also assisted in the count. Weather conditions were fair to good during the 5-day census. Rain squalls prevailed in northern California during the first day, and an area about 50 miles long south of Point Arena was very foggy; this 50 mile stretch was flown again on the second day. Visual counts of small groups were made from an altitude of about 200 ft; large herds, found mostly on the islands, were photographed from 600 ft with a K-17 aerial camera mounted in the plane. All visible animals on the 9x9 inch prints were counted under low magnification. The census included the entire California coast and offshore islands, except for military closures off Fort Ord on Monterey Bay, part of the coast between Point Sal and Point Conception, and off Camp Pendleton, south of San Clemente. Because of heavy air traffic, Santa Monica Bay between Malibu Point and Palos Verdes, and San Diego Bay were not censused. Normally very few pinnipeds are found in these areas, although some harbor seals do occur in San Diego Bay.

SEA LIONS

As in previous censuses no attempt was made to distinguish between the two species of sea lions. Those north of Point Conception were considered Stellers, and those south, California sea lions. The two overlap only to a limited degree in central California during the breeding season (the period of our census).

There was little overall change in sea lion numbers from those reported by Frey and Aplin (1970). The 1970 census showed 1,967 fewer animals off northern California and 596 more off southern California, or a total of only 1,371 less for the state (Table 1).

HARBOR SEALS

The number of harbor seals counted was down somewhat and was about halfway between the 1965 and 1969 census. We believe there were more harbor seals on the southern California islands than were observed. The northern California count was close for both years (Table 2.).

NORTHERN ELEPHANT SEALS

The number of elephant seals was up considerably this year and approached the number counted in 1965 (Table 3). There is considerable variability in the time these animals leave the rookeries, which probably accounts for the low count last year.

TABLE 1—Comparison of Sea Lion Distribution on Rookeries and Hauling Grounds, 1958, 1961, 1965, 1969 and 1970

	1958	1961	1965	1969	1970
St. George Reef to Cape Mendocino	1,321	907	625	1,069	1,026
To Pt. Arena	1,050	781	278	552	102
To Pt. Reyes	936	795	259	120	197
To Pigeon Point	90	23		263	68
Farallon Islands	911	703	311	855	585
Pt. Año Nuevo	1,170	2,312	2,571	1,985	1,542
To Pt. Lobos	517	230	317	188	265
To Pt. Conception	1,028	891	631	1,521	1,101
Northern California	7,053	6,675	4,998	7,156	5,189
To Pt. Loma (mainland)	164	33	67	37	39
San Miguel Island	5,192	9,512	11,611	7,731	9,835
Santa Rosa Island	295		125		220
Santa Cruz Island	262	15	401	317	201
Anacapa Island	15	15	-		10
Santa Barbara Island	1,817	1,760	1,100	651	181
San Clemente Island	1,507	2,261	1,900	667	919
Santa Catalina Island	233	30	35	107	39
San Micolas Island	3,074	1,637	1,900	7,935	6,210
Southern California	12,672	18,363	17,169	17,151	18,017
Total California	19,725	25,038	22,167	24,607	23,236

TABLE 2—Distribution of Harbor Seals During 1965, 1969 and 1970

	1965	1969	1970
St. George Reef to Cape Mendocino	56	167	121
To Point Arena	301	409	227
To Point Reyes	78	451	591
To Pigeon Point	250	201	111
Pt. Año Nuevo	--	172	88
To Point Lobos	91	11	75
To Point Conception	70	151	148
To Point Loma	-	7	--
San Miguel Island	110	61	--
Santa Rosa Island	--	209	3
Santa Cruz Island	70	168	8
Anacapa Island	--	93	--
Total	1,062	2,139	1,675

TABLE 3—**Distribution of Northern Elephant Seals During 1965, 1969 and 1970 Censuses**

	1965	1969	1970
Point Año Nuevo	363	172	85
San Miguel Island	3,000	1,451	2,917
San Clemente Island	100	--	--
San Nicolas Island	100	191	--
Total	3,563	1,642	3,005

REFERENCES

Carlisle, John G., Jr., and J. A. Aplin. 1966. Sea lion census for 1965 including counts of other California pinnipeds. Calif. Fish and Game 52 (2) : 119–120.

Bartholomew, George A. 1967. Seal and sea lions populations of the California islands. p 229–244. *In* Ralph N. Philbrick, (ed.) Proceedings of the symposium on the biology of the California islands.

Frey, Herbert W., and J. A. Aplin. 1970. Sea lion census for 1969, including counts of other California pinnipeds. Calif. Fish and Game 56 (2) : 130–133.

Le Boeuf, B. J., and R. S. Peterson. 1968. Behavior of the northern elephant seal. Año Nuevo Repts. 2 (1967–1968) : 6–20.

Orr, Robert T., and Thomas C. Poulter. 1965. The pinniped population Año Nuevo Island, California. Proc. Calif. Acad. Sci., Fourth Series 32 (13) : 377–404.

Peterson, Richard S., Burney J. Le Boeuf, and Robert L. DeLong. 1968. Fur seals from the Bering Sea breeding in California. Nature 219 (5157) : 899–901.

Ripley, Wm. Ellis, Keith W. Cox, and John L. Baxter. 1962. California sea lion census for 1958, 1960 and 1961. Calif. Fish and Game 48 (4) : 228–231.

Carlisle, John G., Jr., and J. A. Aplin, Marine Resources Region, California Department of Fish and Game. *Accepted for publication December 1970.*

OCCURRENCE OF THE NORTHERN QUAHOG, *MERCENARIA MERCENARIA*, IN COLORADO LAGOON, LONG BEACH, CALIFORNIA

The introduction of the northern quahog, *Mercenaria* (= Venus) *mercenaria*, a commercially significant hard clam of the eastern United States, into central and northern California waters has met with varying degrees of success. The only recorded introduction of this mollusk in southern California was at Newport Bay in 1940, but there is no evidence that this effort was successful (Hanna, 1966).

In June 1967, specimens of the northern quahog from the Colorado Lagoon collected by Mrs. Eugene Wilkins, Downey, California, were brought to the California Department of Fish and Game (John Fitch, pers. comm.). On May 2, 1969, the Cerritos College Marine Biology Class made a survey of the marine life in the Colorado Lagoon, and several specimens of northern quahog were found in the intertidal sediments in the western portion of the lagoon. There are no records of this species being introduced into this southern California recreational area. A more detailed survey was conducted to record the size and density of the northern quahog population in the lagoon. Meter

square quadrats were dug 8 to 10 inches deep at 31 randomly selected stations around the lagoon down to the —1.0 tide level. The samples were then screened with a sifting box having .25 inch mesh screen. The dominant size range of the 267 specimens sampled throughout the lagoon was 20 to 40 mm (maximum dimension) with extremes of 8 mm (the smallest clam that will be retained by the screen) to 101 mm (Figure 1). The larger clams were found at stations close to the water line of a —1.0 tide. Since most samples were taken under less extreme tidal conditions, we believe the proportion of mature northern quahog is much greater than our samples indicate.

On the east coast, 60 to 70 mm is the size at which the northern quahog reaches sexual maturity (Carriker, 1956, Sieling, 1956). Since specimens of 60 mm and above were found at one-third of the stations, we believe the Colorado Lagoon colony is well established.

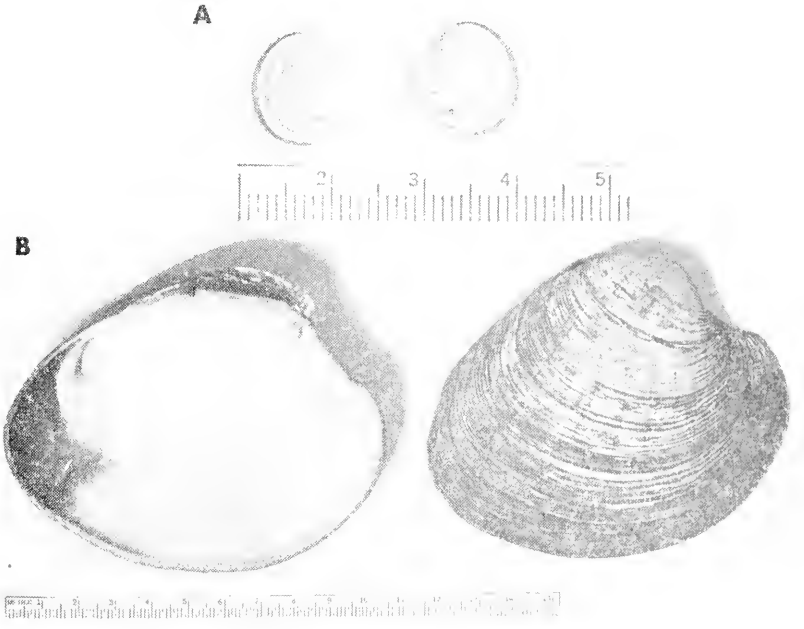

FIGURE 1. *Mercenaria mercenaria* (A) Juvenile, (B) Mature Adult. (Photo by Dean Grose)

ACKNOWLEDGMENTS

We would like to thank Mary Jo George and Donald Drysdale for their help in making the survey; and Donald Reish, California State College at Long Beach, John Fitch, California Department of Fish and Game, and Terry Paige, Long Beach Recreation Department, for their cooperation. James McLean, Los Angeles County Museum, verified the specimens, and Jules M. Crane, Jr., Cerritos College, made suggestions on methods and reviewed the manuscript.

REFERENCES

Carriker, Melbourne R., 1956. Biology and propogation of young hard clams, *Mercenaria Mercenaria*. J. of Elisha Mitchell Sci. Soc. 72 (1) : 57–60.

Hanna, G. Dallas, 1966. Introduced mollusks of western North America. Occas. Pap. Calif. Acad. of Sci. 7 (48) : 1–108.

Sieling, F. W., The hardshell clam fishery of Maryland water, Maryland Tidewater News 12 (10), supplement No. 9.

Anthony Salchak and Jeff Haas, Biology Department, Cerritos College, Norwalk, California 90650. *Accepted January 1971.*

NEW LOCALITY RECORD FOR THE PUPFISH *CYPRINODON NEVADENSIS* AT BADWATER, DEATH VALLEY, CALIFORNIA

A single specimen of the Amargosa pupfish, *Cyprinodon nevadensis amargosae* Eigenmann and Eigenmann, was collected at Badwater, Death Valley, California on July 24, 1970 at 2300 hour. Although there are several species and subspecies of the genus *Cyprinodon* found within the Death Valley drainage system, this is the first recorded capture of any fish from Badwater (R. R. Miller and E. P. Pister, pers. comm.). This fish was captured by hand near the eastern shoreline in water 4.0 cm deep. Its standard length was 43.5 mm.

The water temperature at the collection site was 30 C. The dissolved oxygen content was 0.4 ppm, and the salinity was 27.75‰. The following data recorded on the western shoreline opposite the collection site suggest that there may be an east to west gradation of these environmental parameters: water temperature, 22.5 C; dissolved oxygen, 4.5 ppm; and salinity 43.70‰.

The authors have been examining the ecology of Badwater each month since November 1969, and until July 24th had sighted no pupfishes. Further sampling has not revealed additional fishes. It is possible that this specimen was transferred to Badwater by the flooding of the Amargosa River in 1969 or by subsequent flash floods. It is significant that a pupfish could survive within Badwater during the most inhospitable time of the year.

Wayne P. Alley, Daniel S. Fertig, and Alex W. Klisherich, Department of Zoology, California State College at Los Angeles, Los Angeles, California 90032. *Accepted November 1970.*

ADDITION OF *XIPHOPHORUS VARIATUS* (MEEK), TO THE CALIFORNIA FAUNA

On December 24, 1969, we collected approximately 200 adult and juvenile variated platys, *Xiphophorus variatus*, a native of Mexico, in the Avenue 82 Drain Ditch between State Highway 86 and the Salton Sea, Riverside County, 4 miles east of Oasis. Additional platys were collected from the same location by Mark St. Amant and the senior author on January 7, 1970.

The two collections are the first verified record that *X. variatus* is established in California. St. Amant and Hoover (1969) collected *X. variatus* in the Orange County flood control canals and on July 10, 1970, St. Amant collected this species in this same area; however, it has not been confirmed that they are established in these waters. Bruce Kimsey believed he had collected platys in the Salton Sea area sometime during the 1950s, however, the specimens were lost prior to being identified.

Carl L. Hubbs confirmed the identification of the platys as *X. variatus*.

Other species collected with the platys in the Avenue 82 Drain, and also identified by Hubbs, included; redshiner, *Notropis lutrensis* (Baird and Girard); desert pupfish, *Cyprinodon macularius* Baird and Girard; mosquito fish, *Gambusia affinis* (Baird and Girard); mollies, *Poecilia mexicana* Steindachner and *P. latipinna* (Lesueur).

Jack Wood, owner of a tropical fish farm adjacent to the ditch, related that the platys had escaped from one of his ponds into the ditch about 1956.

REFERENCES

St. Amant, J. A. and Hoover, Franklin G. 1969 Addition of *Misgurnus anguillicaudatus* (Cantor) to the Californian fauna. Calif. Fish and Game 55(4): 330-331.

James A. St. Amant and Ira Sharp, Inland Fisheries Branch, Region 5, California Department of Fish and Game. *Accepted October 1970.*

SEXUAL DIMORPHISM IN THE PAINTED GREENLING AND OBSERVATION OF DEFENSE OF AN EGG MASS

The nutritional, behavioral, and reproductive relationships of several demersal fish populations found around small subtidal reefs off Cannery Row in Monterey Bay, California, were investigated from mid-July 1968 through mid-February 1969. During this study, sexual dimorphism was observed in the painted greenling, *Oxylebius pictus* Gill. The distinction between male and female is not as well defined in this species as in the kelp greenling, *Hexagrammos decagrammus* Pallas, another hexagrammid common to this area.

Between late November and mid-January, 28 painted greenling specimens ranging from 108 mm to 164 mm TL were collected. This group consisted of 16 males and 12 females. The well-developed, paired testes of the male were white and all females carried bright orange eggs.

Coloration of females was much brighter than that of males, and the irregular vertical brown bars on the body much more distinct (Figure 1). All fins on the females were yellow and light orange. The paired and caudal fins bore burnt orange and brown bars, and the vertical body markings continued onto the dorsal and ventral fins. The lower third of the body forward of the ventral fin and the lower lateral and the ventral surfaces of the head were characterized by a white and yellow background flecked with orange or light brown (Figure 2). These irregular markings were larger, darker, and more densely distributed on the head.

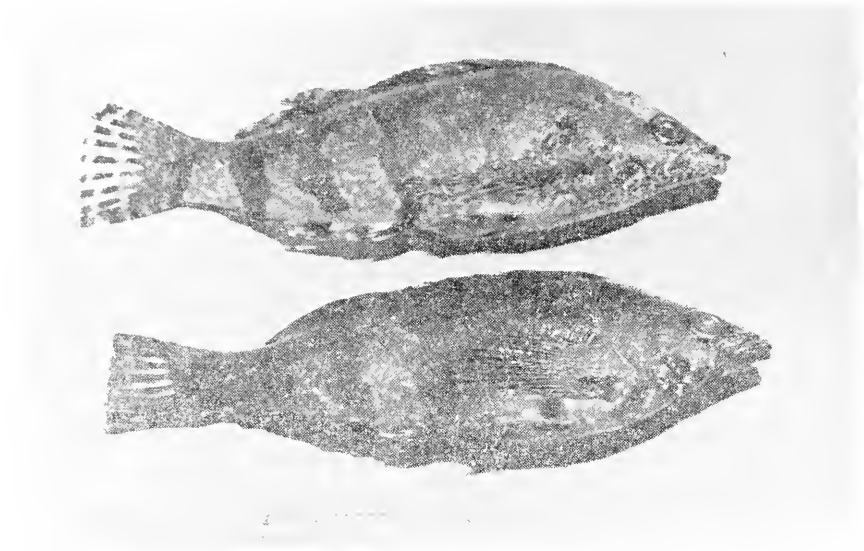

FIGURE 1. Lateral view of female (above) and male adult painted greenlings. Photograph by Michael Starmack, January 1969.

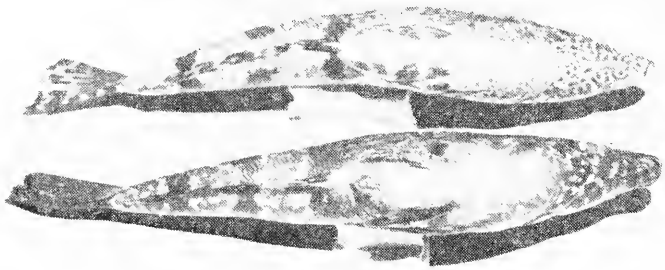

FIGURE 2. Ventral view of female (above) and male adult painted greenlings. Photograph by Michael Starmack, January 1969.

In sharp contrast, the fins of the male were a dark brown and the undersurface of the body and head were a light grey-brown and dark brown respectively. The jaws and opercle were flecked in white while the dusky, lower body surface had larger, less dense, amorphous white markings. I was unable to determine whether this dimorphism was

temporary or permanent. However, variation in the darkness of the forepart of the body and difficulty in sexing one specimen by external color pattern hinted that differences in coloration may have been only temporary or less distinct during the non-breeding season.

On November 11, 1968, a male painted greenling was observed defending a pink-orange egg mass from a larger female. This male was the darkest observed during the investigation. The eggs were situated well back into a crevice in the nearly vertical surface of a small rock formation. The larger female greenling attempted to project her snout into the crevice, turning on her side to do so. The smaller male moved around the aggressor and repeatedly vibrated its head back and forth as if scolding. The defender further attempted to position itself between the eggs and the intruder and occasionally nudged the latter with its snout. These efforts appeared to have little effect. The female fled as the divers moved closer and the male retreated down the rock surface. From there, the latter observed our efforts to determine the source of the altercation. This observation was consistent with that of Gorbunova (1962) who noted that male hexagrammids defend the egg mass in more northerly latitudes. The egg mass was absent during a November 29 dive and no young were detected. In early January another interaction between two painted greenlings, involving a male and a female, was observed on a small sandy area in the same reef formation. However, the "lunges" of the female appeared to be directed at the male, which assumed a U-shaped posture with head and tail facing the aggressor, and not at any portion of the reef. A brief search failed to reveal an egg mass.

REFERENCES

Gorbunova, N. N. 1962. Reproduction and development of fish of the family Hexagrammidae. *Tr. Inst. Okeanol. Akad. Nauk. SSSR* 59:118–182 (English summary in Biological abstracts only).

George D. Edwards, U.S. Army Edgewood Arsenal, Medical Research Laboratory, Edgewood Arsenal, Maryland 21010. *Accepted for publication December 1970.*

OCCURRENCE OF HERMAPHRODISM IN THE MARKET CRAB, *CANCER MAGISTER*

Sexes of the market crab are normally separate, and no reference to hermaphrodism was found in the literature.

In March 1970, Tom Alioto, a fish retailer, reported he had a male crab with "eggs". The crab had been cooked and partially cleaned. It was in four parts: legs, body, carapace, and abdominal flap. The body had been thoroughly washed, leaving no trace of the vas deferens. Examination of the sternum revealed no external spermatecal openings, such as those found on females. The catch location is uncertain but it is thought to be off San Francisco.

The abdominal flap was characteristically male in shape, since it was long and slender rather than broad or oval shaped. The paired copulatory organs were present and appeared normal. A small clump of orange ovarian tissue was attached to the connecting material of the abdominal flap (Figure 1).

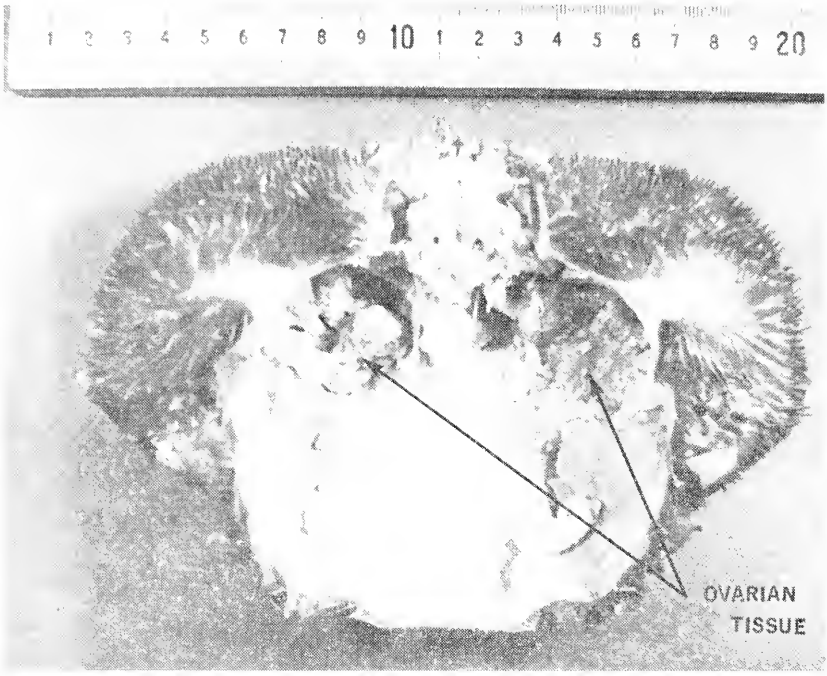

FIGURE 1. Ventral view of carapace showing the location of ovarian tissue.

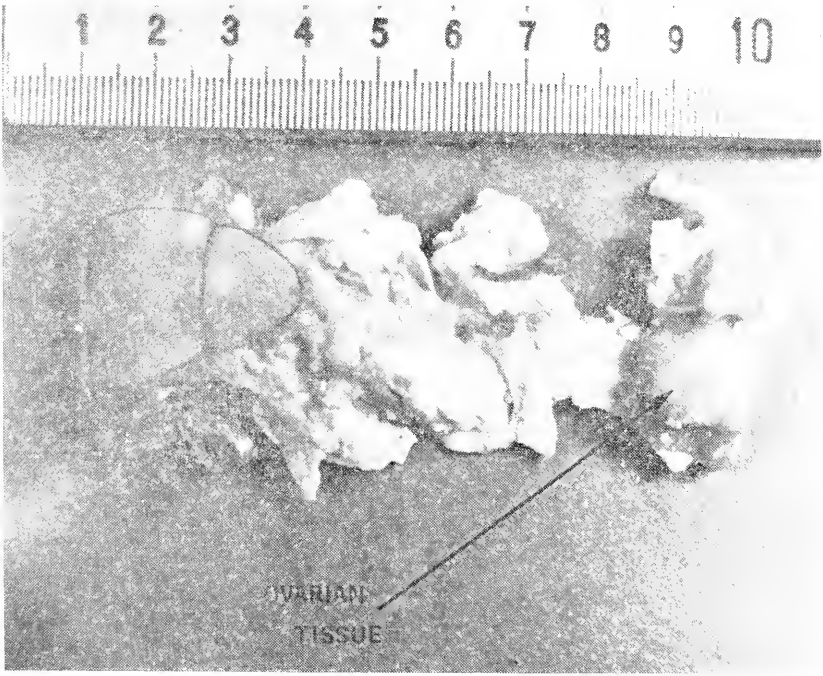

FIGURE 2. Ovarian tissue attached to abdominal flap.

The carapace was 174mm. shoulder width, and typical of a male in that it was flattened more dorso-ventrally than a female's carapace. Large masses of orange ovarian tissue were located in the anterior portion of the carapace. The position and amount of material was similar to that observed in normal females (Figure 2). Although the ovary appeared to be developing, it is doubtful spawning could have occurred since no external oviduct openings were present.

REFERENCES

Butler, T. H. 1960. Maturity and breeding of the Pacific edible crab, *Cancer magister* Dana. J. Fish. Res. Bd. Canada 17: 641–646.

Hickman, Cleveland P. 1967. Biology of the invertebrates. C. V. Mosby Co., 673 p.

Mel Willis, Marine Resources Region, California Department of Fish and Game. *Accepted December 1970.*

BOOK REVIEWS

Readings in Ecology and Ecological Genetics

Edited by Joseph H. Connell, David B. Mertz and William W. Murdock; Harper and Row, New York, 1970; 397 p., illustrated.

The authors attempted to bring together a varied selection of original papers for the undergraduate student to gain an "understanding of the practice of the science". Most of the papers are short and selected to cover a wide range of topics. The papers are divided into three major groupings: (1) life histories and ecological genetics, (2) distribution and abundance, and (3) ecological communities. Each section has its introduction by the authors. The authors point out the regrettable separation of population genetics and ecology and the difficulty of synthesis at the theoretical level. In the introduction to ecological communities the case is made for systems ecology or looking at entire ecosystems as a unit rather than the usual piecemeal approach which has typified so much of ecological investigations. It was also pointed out that man should live as part of a complex stable ecosystem rather than in an overly simplified one. I fear that ecologists may have reached this elementary conclusion 10,000 years too late.—*Lee W. Miller*

A Modern Dry-Fly Code

By Vincent C. Marinaro; Crown Publishers Inc., New York, 1970, xvi + 270 p., illustrated in color and black and white. $10.

The first edition of *A Modern Dry-Fly Code*, published in 1950, is now a collector's item. This second edition, updated with excellent black and white and color photographs, should be in the library of every serious trout fisherman.

The text is an easy-to-read potpourri of philosophy, personal observations, and reminiscences. Combined, they result in an impressive array of useful information. The margins of the pages are illustrated with examples from the text.

A Modern Dry-Fly Code is primarily a book about terrestrial insects, with the exception of three chapters on mayflies. The streams discussed are the famous limestone streams of the eastern United States. There is a discussion of rise-forms, and an extensive discourse on trout vision and the effects of vision on tying successful imitations. The three chapters on mayflies—the Hendrickson, the Sulfurs, and the Green Drake—may not be of great value to fishermen in California, where hatches are uncommon and waters less productive, but chapters on the Japanese beetle, the grasshopper, and minutae have practical application for all trout fishermen.

Where the preceding chapters discuss the terrestrials and mayflies and how to fish their imitations, the final chapter gives explicit, illustrated instructions on how to tie the imitations.

Again—an excellent, informative book; well worth the price.—*K. A. Hashagen, Jr.*

Traité de Pisciculture

By Marcel Huet; Editians Ch. De Wyngaert, 296 Ave. Georges Henri, 1200 Brussels, Belgium; xxiv + 718 p., illustrated. $19 or 950 FB.

Professor Huet is associated with the University of Louvain and is the Director of the Station of Research on Waters and Forests, Groenendaal, Belgium. His treatise represents a substantial revision of the third (1960) edition, which was primarily concerned with fish culture in temperate latitudes. The scope of the new edition has been extended to include the culture of fishes in fresh and brackish waters of the world.

The author's treatment is, for the most part, descriptive rather than prescriptive and is obviously not intended for the specialist. However, students or professionals anticipating studies or work assignments in Africa and the Near or Far East could do well to review this treatise before departure. An exposure to the author's descriptions of the culture of fish in family or communal ponds may have an appropriate humbling effect upon fortunate scientists endowed with modern facilities and sophisticated equipment.

The author employs a very precise vocabulary and a style of writing that facilitate translation. The inclusion of a French-English list of common names of fishes and more than 500 photographs with simply-worded captions is also helpful.

Traité de Pisciculture appears to be of limited value to North American workers interested in the culture of native species but an excellent reference for those seeking information on the rearing of *Tilapia*, sturgeon, European eels, gourami, grass carp, Nile perch, and other exotic species.—*Paul Giguere*

81527—800 2-71 5,300 *printed in* CALIFORNIA OFFICE OF STATE PRINTING

Notice is hereby given that the Fish and Game Commission shall meet on April 2, 1971, at 9:00 a.m. in Room 1138 of the New State Building, 107 South Broadway, Los Angeles, California, to receive recommendations from its own officers and employees, from the Department of Fish and Game and other public agencies, from organizations of private citizens, and from any interested person as to what, if any, orders should be made relating to birds or mammals, or any species or variety thereof for the 1971 hunting season.

Notice is hereby given that the Fish and Game Commission shall meet at 9:00 a.m. on April 30, 1971, in the Supervisors' Chambers of the Shasta County Courthouse, Redding, California, for public discussion of and presentation of objections to, the proposals presented to the Commission on April 2, 1971, and after consideration of such discussion and objections the Commission shall publicly announce the regulations it proposes to make relating to birds or mammals, or any species or variety thereof, for the 1971 hunting season.

Notice is hereby given that the Fish and Game Commission shall meet on May 21, 1971, at 9:00 a.m., in the Auditorium of the Resources Building, 1416 Ninth Street, Sacramento, California, to hear and consider any objections to its determinations or proposed orders in relation to birds and mammals for the 1971 hunting season, such determinations resulting from hearing held on April 30, 1971. This notice is published in accordance with the provisions of Section 206 of the Fish and Game Code.

FISH AND GAME COMMISSION
Leslie F. Edgerton
Executive Secretary

POSTMASTER: RETURN POSTAGE GUARANTEED
Editor, CALIFORNIA FISH AND GAME
CALIFORNIA DEPARTMENT OF FISH AND GAME
987 JEDSMITH DRIVE, SACRAMENTO, CALIF. 95819

BULK RATE
U.S. POSTAGE
PAID
Sacramento, Calif.
Permit No. 949