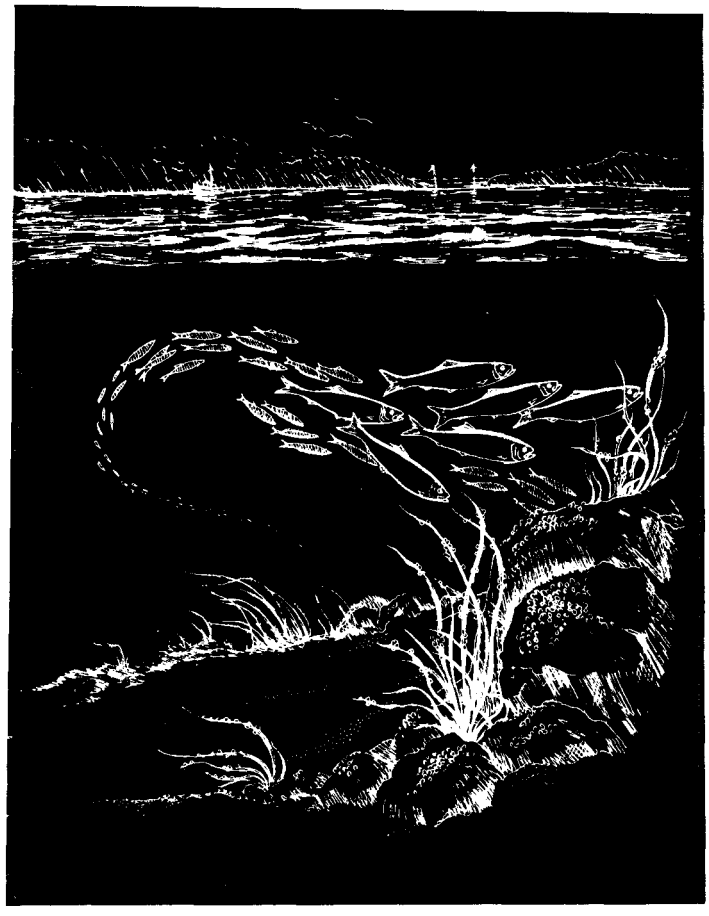

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MFR PAPER 1018

In a classic conflict, herring tests the ability of the political process to manage a renewable natural resource.

San Francisco Bay Area's Herring Resource — A Colorful Past and a Controversial Future

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and W. MICHAEL KAILL

INTRODUCTION

Discuss Pacific herring with the people of Tomales Bay or the northern counties of San Francisco Bay (Figure 1) and you will very likely encounter the two edges of a sharp sword. The sword aims at a fish resource which has become a classic example of the conflict over natural resources. The issue is still unsettled.[1] The Pacific herring fishery remained quiescent over the last two decades, and there has been little interest shown for management of the population. The fishery landed 53,235 pounds five years ago and only 21,700 pounds during the 1971-72 season. Then a new market opened this last winter and the catch rose to over 2 million pounds. The rush to the harvest brought attention from local conservationists and legislators. Their efforts resulted in legislation which effectively controlled the herring fishery.

This paper includes some historic background of the San Francisco Bay area Pacific herring (*Clupea harengus pallasi*) which predates the gold rush days. It discusses the known biology of the herring and the research being conducted to find out more about the species. Lastly, it presents the latest in a series of events which may ultimately determine the fate of this population of fish.

HISTORY OF THE RESOURCE

Studies of the bottom sediment of Tomales Bay showed that Pacific herring were residents of the San Francisco Bay area waters long before it was colonized by man. San Francisco was just a sleepy town with only 375 inhabitants as recently as 1847. In those early times, the local fish resources, including herring, remained relatively untouched. Then gold was discovered, and within two years the population rose to 25,000 people. With this growth came a demand for food. The first interest in herring was for fresh fish which were sold for "two bits a bucketful." The only export interest at that time was in rough salted fish which were sent to the Orient.

The fishery grew slowly; small amounts were used for smoking, curing, and canning. Attempts to export local herring to Europe to compete with Atlantic herring met with limited success. With continued efforts and the advent of World War I there eventually arose a large demand for Pacific herring for canning and reduction to oil and meal. The catch rose to 8 million pounds by 1918 (Figure

[1] Data and events current as of 23 August 1973.

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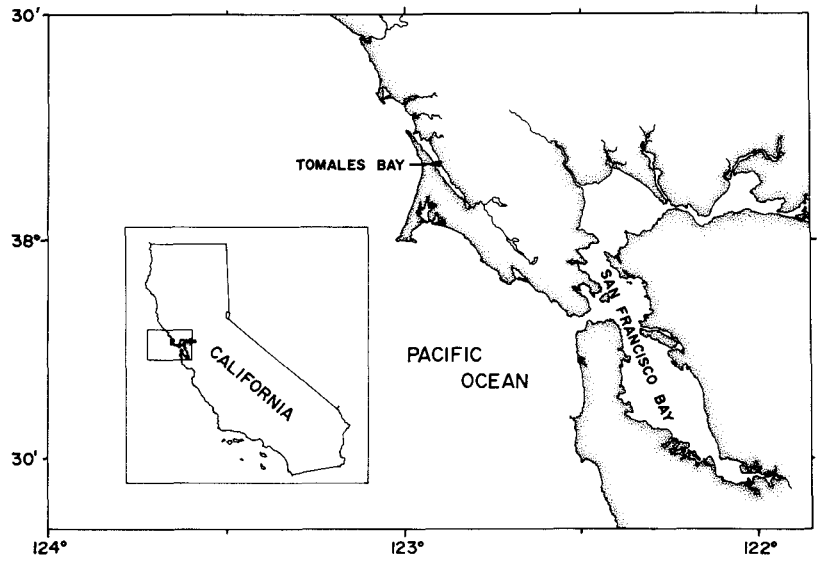


Figure 1.—Map of the San Francisco Bay area.

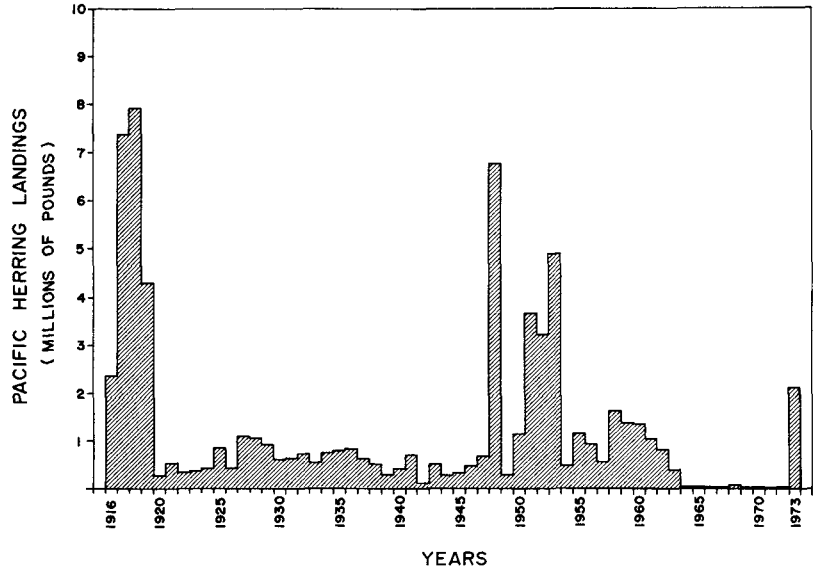


Figure 2.—Pacific herring landings of the San Francisco Bay area (Tomales and San Francisco Bays).

2). At that time the Tomales Bay herring were considered the best in California—they were fatter and longer. The fish were brought from Tomales Bay on a narrow gauge railroad to the city of Sausalito, in San Francisco Bay, then shipped upriver to canners in the Sacramento River delta. The Federal Bureau of Fisheries advised the fishery in its curing and processing. The herring were Scotch cured and canned. It was the first time the fishery was tested for its capacity and it was believed that the herring take could be doubled and still not damage the resource.

In 1919 the California State Reduction Act was passed which prohibited reduction without written permission from the California Department of Fish and Game. This legislation effectively reduced landings of herring to an all time low. The fishery returned to landing small quantities for fresh consumption (bait, smoked, and salted). This trend continued from 1920 to 1946.

With the decline of the California sardine fishery, herring became a hopeful substitute for the sardine. Canning operations began again with herring trucked in from Tomales Bay. In the early and mid-fifties boats with lampara nets sailed from Monterey to Tomales Bay, where catches brought large increases in the recorded landings (Figure 2). The Bay Area catch rose to 3.6 million pounds. However, herring proved unsuitable as a sardine substitute, and only a small pet food market continued to provide a limited demand. But even this market did not hold and the catch declined to a little over 30,000 pounds by 1964. The main use until recently has been bait.

A new fishery began in 1965-66 related to the herring eggs themselves. The products are exported to Japan as gourmet food. The roe is utilized in two forms. "Kazunoko" is entirely roe, usually the whole ovary. "Kazunoko-kombu" is the herring eggs-on-kelp product. Both are expensive specialty foods, usually consumed on holidays and special occasions.

A permit was issued for 5 tons of herring eggs-on-kelp in Tomales Bay and 5 tons in San Francisco Bay. The permit for Tomales Bay was later cancelled for two seasons to allow the Department of Fish and Game to study the resource. This permit was then reissued this last 1972-73 season. The eggs-on-kelp fishery is still in operation and has been moderately successful. On the basis of Fish and Game Department records, the San Francisco Bay fishery has never collected more than one-half of the quota, and the Tomales Bay fishery approached its quota only once.

The demand for roe was responsible

for a dramatic change in the adult herring fishery this past season. Over 2.1 million pounds of whole adult fish were landed. Due to continued restriction by the 1919 Reduction Act the whole fish could not be reduced in the United States and there was no market for other herring products. Therefore, the fish were frozen in the United States and shipped to Korea for processing. There the roe was removed and sent to Japan while the fish were dried and sold for human consumption in Korea.

The recent tremendous increase in the fishing effort, with its high catches, was one of the reasons for the controversy over the resource.

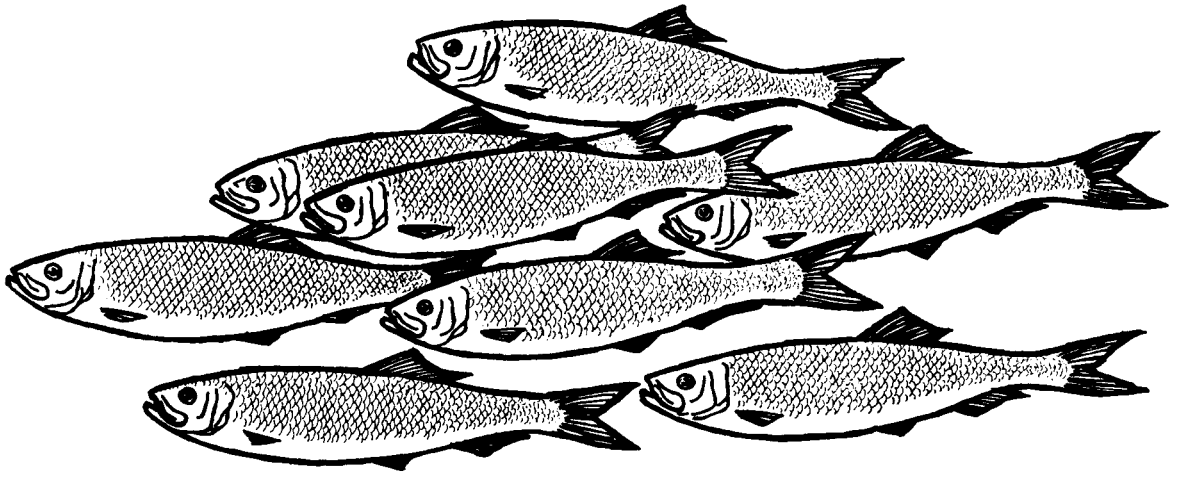
BIOLOGY OF THE PACIFIC HERRING

Probably, the biggest factor keeping the herring controversy alive and vigorous is the high visibility of the actual fishing operations. The harvesting of both the herring eggs-on-kelp and adult fish takes place in waters adjacent to populated areas. The biological nature of herring is responsible for this.

Unlike the Atlantic herring, which spawns in deeper water, the Pacific herring spawns in the intertidal waters, and in the San Francisco Bay area, they most often spawn along heavily developed shorelines. Although spawning occurs from November to June, peaks of spawning activity occur earlier in the southern populations.

We have netted larvae of the herring in San Francisco Bay as early as late October and early November, long before evidences of the adults are found. Evidently, there is some very limited early spawning. Maturing adults usually enter San Francisco and Tomales Bays up to 2 months before spawning, where they remain in loosely aggregated schools in deep holes.

Observations of the Tomales Bay herring showed that a few days prior to spawning the fish's behavior changes. The schools are more predictably found in the deeper holes of the Bay; the fish exhibit less response to adverse stimuli such as outboard motors, etc., and the densities of the individual schools change. When the right set of conditions prevail, the fish move into intertidal shallows and spawn on any suitable substrate. The fish appear to have preferences for their substrate—choosing first algae and grass, then prominent rocks, and lastly flat surfaces. But once dense spawnings begin, such as occurred in 1971-72, every available surface (including ropes, sandy beaches, and boat hulls) is covered with eggs. The eggs are extremely sticky for a short period after the eggs leave the female. Often it is difficult to remove freshly spawned eggs from one's hands or vegetation without destroying the eggs. Although most spawning seems to occur at night, we have observed spawning taking



place day and night during all tidal stages.

The act of spawning involves repeated passes close to the substrate by females, while males release their milt in the general area. The water often appears "milky" over the entire spawning area.

The eggs are usually deposited 1 or 2 eggs thick but can be in layers up to 2 inches. When the latter occurs we have found very poor survival among all but the outlying eggs.

The most noticeable eggs are those in the intertidal zones—the ones exposed at low tide stages. Actually, the spawning continues subtidally to approximately 25 feet in Tomales Bay and at least that and probably deeper in San Francisco Bay. The fish are usually 3 to 5 years old when they spawn. Work by the junior author showed that over 13 percent of the 1971-72 catch from Tomales Bay was 5 to 8 years old. This is a change from a 1955 study in which less than 3 percent were 5 years old and these were the oldest in the catch. The older age composition of this last year's catch suggests that the population has been under low fishing pressure.

The number of eggs each female produces depends on the size of the fish. For example, a female 7.6 inches long produced 18,600 eggs and one 8.7 inches long had 29,500 eggs.

The incubation time depends mostly on the temperature. Our measurements of the last season's eggs showed the larvae hatched in 10.5 days at an average water temperature of 50.7° F.

Once hatched the larvae are believed to leave the bays. Preliminary results corroborate this belief, although Alaskan and Canadian studies suggest that the juveniles leave the bays in the fall. We have caught large numbers of newly hatched larvae but few of the later stages. Undoubtedly high mortality is a factor on both eggs and larvae as many predators gather at the spawning grounds—gulls and other waterfowl, sturgeon, striped bass, sharks, etc. Depth of water is critical for egg survival. Mortality may range from <5 percent in deep water to 99 percent or more for intertidal spawnings, where the eggs are available to a larger variety of predators.

Where the fish go after they leave the bays is unknown. There is a summer fishery for the adults in Monterey Bay to the south of San Francisco Bay but their origin is also unknown. This past year the state Department of Fish and Game showed that herring could be tagged and survive. If results from Canadian tagging studies are valid for these fish, the local tagging program should show that they move offshore and return to spawn again, using a homing instinct.

Pacific herring make up a series of different intergrading populations from Japan and Korea, north to the Bering Sea and southward along the Pacific coast to Baja California. The population found in the San Francisco Bay area is small compared to those found along the British Columbia coast, where the spawnings are measured in miles of beaches covered with eggs. The San Francisco population is constituted of younger and smaller fish and by slower growth and sexual maturation at younger ages and earlier spawning. The San Francisco population size has been estimated only once, in 1955, at 12,000 tons. The Tomales Bay population was estimated in 1971-72 at approximately 4,000 tons by State biologists and again this last season by the junior author at around 4,000 tons.

Because of the biology of the herring, prediction of forthcoming population size is difficult. Many more eggs are produced than are needed to maintain the population. Losses are high due to predation, exposure, and smothering. Even after the eggs hatch, mortality of larvae, due to predation and drift away from proper food supply, is commonly 99 percent. Those that make it through such a risky early life are still reduced by about half each year. That is, in the process of growing one year older (e.g. three to four years of age) 40 to 60 percent of the population is lost. Because of the interaction of high reproductive potential and high losses due to natural mortality, strange things can happen. Unsatisfactory conditions can cause high mortality of a spawn, regardless of the tonnage of eggs produced. Thus, a poor spawn may produce a very good crop of young fish; or an abundant spawn may produce a poor result, if conditions are poor. Understandably, prediction of the amount of fish produced based on spawning success is difficult. Herring do not enter the shallow water spawning runs until they are two or three years old. Thus, studies based on spawning populations of herring are forced to exclude many of the fish in the total population.

When a spawning does encounter advantageous conditions, many of the fish of that particular spawning (for instance, 1971-1972) survive, producing what biologists call a successful year-class. By studying the age composition of the spawning adult populations it is possible to follow a successful (i.e. abundant) year-class over a number of years.

RESEARCH

Despite the long history of the fishery and the resource, very little biological research was done on the San Francisco Bay area population until recently. In 1955, two State biologists, D. J. Miller and J. Schmidtke, presented results of the commercial catch sampling from 1947 to 1952. They also studied the spawning population that occurred in the winter of 1954-55. In this study, age composition of the population and the density of spawned eggs were determined. The biologists attempted to delimit the school size by echo-sounding equipment when the fish were held up in the deeper portions of San Francisco Bay, but they found the schools too mobile. For the first time, they estimated the

Figure 3.—Examples of a natural rock (left) and artificial spawning substrate used in recent studies of the San Francisco Bay, January 1973.

size of the Tomales and San Francisco populations using the amount of spawned eggs as the measure.

No further work was carried on for another 15 years. Then the herring eggs-on-kelp fishery brought the need for an assessment of the herring egg resource. J. Hardwick, also of the Department of Fish and Game, studied intensively the spawning populations of herring for two consecutive seasons beginning in 1970-71. He surveyed the spawned eggs and vegetation in Tomales Bay using techniques developed by Miller and Schmidtke, and himself. This study was set up to evaluate both the adult fish population and herring eggs-on-seaweed resources. As a result, he recommended that "a harvest of 10 percent (16 tons) of the eggs that hatch would not significantly reduce the number of eggs that hatch," and "should tonnage of whole fish exceed 500 tons it may be necessary to reduce the quota on eggs."

Both the senior and junior authors have conducted independent studies this last 1972-73 spawning season. The senior author's work consisted of two transects or lines of numbered cement discs (Figure 3) which were used for artificial spawning substrates. The commercial catch was sampled to look at the ages, sex ratio, fecundity, and size of the spawners. Preliminary results show a very light spawning in San Francisco Bay this year. The fish hatched in an average 10 days at approximately 50° F water temperature. The fish spawned along the entire transect but lower depths showed lesser egg densities, probably because of poor substrate and high sediment at the deeper locations.

The junior author simultaneously studied the herring in Tomales Bay. The commercial catch was also sampled and an attempt was made to estimate the size of the spawning population by sonar equipment and by surveying the amount of eggs actually spawned in the Bay. Besides the results we have already mentioned other interesting facts were noted.

From observing schools of herring as they became ready to spawn, characteristic behavior was seen which might be of value in predicting the time of spawning. By virtue of the school's compactness and stable positioning, relatively good success was achieved in estimating the volume of herring schools. This could provide a much simpler and less time-consuming method of estimating the population than surveying the actual spawned eggs with the aid of SCUBA gear or by using specialized bottom samplers.

Some answers to questions concerning migration of juvenile and adult fish between spawnings could result from a tag and recovery program begun last year by the State. San Francisco Bay fish were tagged and released after spawning. This next fishing season should show results if the fish, in fact, do remain in or return to local waters.

FISHERY

The methods employed by the commercial fishery over the years are fairly traditional, reflecting the efficacy of those processes. The original fishery used beach seines and gill nets (Figure 4). In 1917, the Bureau of Fisheries advised the fishermen to develop purse seines, lampara nets and larger boats.

The decline of the fishery evidently discouraged such development and the fishing gear and methods did not change until 1952 when lampara boats equipped with sonar equipment fished the populations in Tomales Bay. Up to this last year the same methods have been used, with the introduction of lighters being the only advancement in technology (Figure 5).

The herring eggs-on-kelp are harvested by hand by divers. Since the weather during the spawning season is usually the most inclement time of the year, it is understandable why the quotas have not been filled.

Adult herring have been sold fresh, salted and cured, and attempts at canning have met with varied success. Competition from Atlantic herring and larger northern Pacific herring from Canada and Alaska have made the product not economically profitable. The recent export market includes the sale of dried whole fish to Korea for domestic consumption and the sale of roe to Japan.

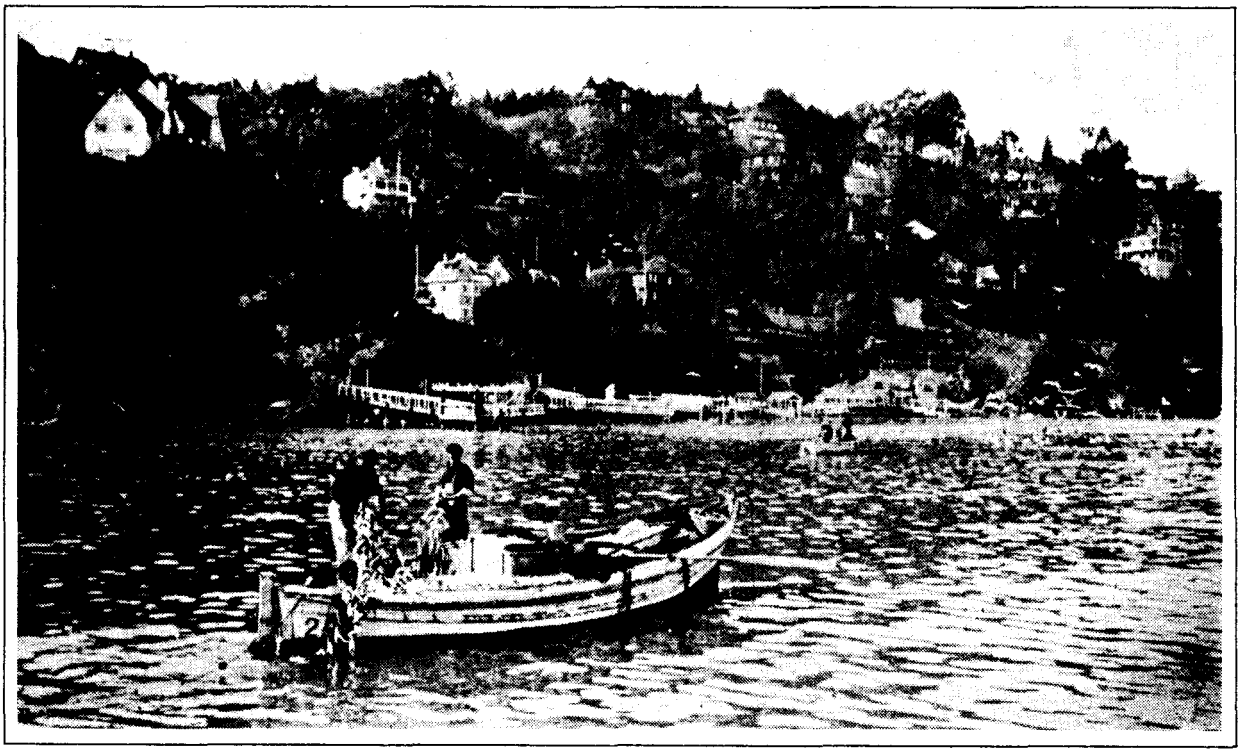


Figure 4.—Herring gill netters at Belvedere Cove, San Francisco Bay, January 1918.

THE DEVELOPING CONTROVERSY

Over 20 years ago the local citizenry openly criticized the fishermen for their use of large boats and new gear which resulted in the large landings of Tomales Bay herring. Now in 1973, essentially the same gear and boats fished the same resource resulting in much the same reaction from the public. The difference, however, is that the most recent public concern was converted to political action limiting the take of herring.

One common feature of both whole fish and eggs-on-kelp fisheries is the high visibility of the fishing activities. Local citizenry, especially some sportsman's organizations were alarmed with what they saw; alarmed to the extent that they persuaded a State Senator to introduce legislation immediately, which subsequently passed, instituting a revocable, nontransferable permit system for harvesting herring and herring eggs in Tomales and San Francisco Bays. It also directed the Department of Fish and Game to develop a management plan and present it to the Commission with the Department responsible for management in the interim period. The bill was signed January 23, 1973, and was operative for 60 days. The Department established quotas of 750 tons for Tomales Bay and 1,500 tons for San Francisco Bay herring. Subsequently, the season in Tomales Bay was closed.

Senator Peter H. Behr, the man who introduced the previous emergency legislation, entered a bill (S.B. No. 502) which prohibits the taking of herring for commercial purposes, except for bait. Another bill (A.B. No. 2309) introduced by Assemblyman Bob Wood at the request of the California Department of Fish and Game, is designed to allow management of the resource through permit issuance by that Department. Both bills are being reviewed by legislative committees.

Whatever decision is made on these bills will most likely be a compromise which will establish a set quota on the fisheries. Thus, a long and heated controversy may soon be resolved as a compromise is reached by legislators acting on information from state, federal, and private research efforts.

The character of the compromise will reflect the ability of a political process to manage a wildlife resource.

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Figure 5.—Lampara net catch of Pacific herring from Tomales Bay, January 1973.

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