Staff Report

on

Commercial Fishing

May, 1986

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San Francisco Bay Conservation and Development Commission

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INTRODUCTION

Although fishing has been an important use of San Francisco Bay for hundreds of years, the San Francisco Bay Plan does not include findings or policies on commercial fishing activities or facilities. The commercial fishing facilities around the Bay existed in the same locations in 1969 when the Commission became a permanent state agency. As part of its the 1983-84 planning program, the Commission directed its staff to review the future of commercial fishing, shellfishing, and mariculture in the Bay, and to determine whether new findings and policies should be added to the Bay Plan.

The staff has reviewed the status of commercial fishing activities around the Bay, focusing on the types of support facilities essential to the Bay commercial fishing industry and future opportunities for shellfish cultivation and harvesting and other mariculture.

This report is divided into four sections. Section I describes commercial fishing in the Bay Area today, the number and location of fishing boats, fishing boat mooring areas, offloading and handling areas, and the type and numbers of fish landed. This section also reviews the future needs of the industry for new mooring, offloading, and processing facilities. The second section looks at commercial shellfishing in San Francisco Bay. Section III reviews other opportunities for San Francisco Bay mariculture--the raising of plants or animals in controlled aquatic environments. Finally, the report makes recommendations for Commission action, including amending the Bay Plan to add a new section on commercial fishing with new findings and policies, and adding policy notes to specific Bay Plan maps.

PART I: COMMERCIAL FISHING

An Overview of Commercial Fishing in the Bay Area

In 1984, about 38.5 million pounds[1/] of fresh fish were unloaded at the Bay Area's three major fishing ports--Sausalito, Oakland, and San Francisco. Minor catches are also unloaded at Richmond, Berkeley, San Jose, Vallejo, Fremont, Emeryville, San Leandro, San Rafael, Hayward, and Benicia. The Bay Area catch represents about ten percent of the catch from the State's waters and almost nine percent of the total catch landed at California ports[2/] (see Table 1).

Commercial fishing in the San Francisco Bay Area has changed over time. Much of this change has been a shift from harvesting longer lived fishes to more quickly reproducing species. Overfishing diminished the sardine and shrimp fisheries; water pollution has eliminated commercial shellfish harvesting. Years ago whales, sardines, and Dungeness crab were the basis for the commercial fishing industry. Now herring make up a big portion of the total catch. Despite these changes, the Bay Area's rank among California commercial fishing ports has not changed significantly in the past 30 years (see Table 2). However, in the past decade the weight of the catch unloaded in Bay Area ports has more than doubled and the value of the fish has quadrupled (see Table 3). The commitment and flexibility of the Bay Area fishing community has allowed the industry to thrive as the fish and the markets have changed over time.

Based on the recent increases in the Bay Area fish landings, modest further increases should continue in the Bay Area commercial fishing industry

TABLE 1

SAN FRANCISCO BAY'S PORTION OF CALIFORNIA LANDINGS

Millions of Pounds

	1940	1954	1965	1975	1984
San Francisco Bay	189	20	17	18	38
State	1,225	621	544	861	444
Bay's Percentage of State Landings	15.4%	3.2%	3.1%	2.1%	8.6%

Value in Millions of Dollars

	1940	1954	1965	1975	1984
San Francisco Bay	1	2	5	13	16
State	16.9	64	66	126	163
Bay's Percentage of State Landings	5.9%	3.1%	7.6%	10.3%	8%

TABLE 2

RANKING OF CALIFORNIA PORTS BASED ON POUNDS LANDED

RANK	1940	1954	1965	1975	1984
1.	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Los Angeles
2.	Monterey	San Diego	San Diego	Santa Barb	Eureka
3.	San Fran	Santa Barb	Eureka	San Diego	Monterey
4.	San Diego	Eureka	Monterey	Eureka	San Diego
5.	Eureka	Monterey	Santa Barb	Monterey	San Fran
6.	Santa Barb	San Fran	San Fran	San Fran	Santa Barb

San Fran: San Francisco

Santa Barb: Santa Barbara

TABLE 3

COMMERCIAL FISH LANDINGS AT CALIFORNIA PORTS

Millions of Pounds

	1940	1954	1965	1975	1984
Los Angeles	522	359	383	602	237
San Diego	128	138	65	70	43
Santa Barbara	5	51	22	76	28
San Francisco	189	20	17	18	38
Eureka	11	27	30	55	50
Monterey	370	26	25	38	45
TOTAL	1,225	621	544	861	444

Value in Millions of Dollars

	1940	1954	1965	1975	1984
Los Angeles	7	35	45	81	85
San Diego	6	22	9	18	20
Santa Barbara	.3	2	1	5	13
San Francisco	1	2	3	4	16
Eureka	.6	2	5	13	19
Monterey	2	1	1	4	7
TOTAL	16.9	64	66	126	163

in the next ten years. Another substantial rise in the catch is unlikely in the near future because the harvest of herring, which has made up a large portion of the increase in Bay Area landings, is limited by Department of Fish and Game. However, the stability of the Bay Area's fishing industry indicates that it should be able to maintain its recent growth in the near future. Relative to other California ports, the Bay Area has been largely unaffected by the dramatic changes that have impacted the West Coast commercial fishing industry in the past ten years.

Increased investments in new boats and the creation of the "200 mile fishery conservation zone" have opened the industry to new fishermen. This fishery zone is the area contiguous to the three mile territorial sea of the U. S. and extends seaward 200 nautical miles. The zone was established by the 1976 Magnuson Fishery Conservation and Management Act to protect fisheries within this area from overharvest by both foreign and domestic fishermen. Foreign fishermen must receive permission to fish in this area and are only allowed to catch fish not harvested by U. S. fishermen.

At the same time, "El Nino", the intrusion of warm water offshore California, caused fish to move from their traditional grounds. Impacts of El Nino plus increased regulation and dwindling supplies of salmon on the north coast have severely limited the catch. As a result, many fishermen in the Pacific Northwest are facing bankruptcy. The El Nino has also caused tuna to depart from southern California coastal waters. This, in combination with the increased impact of tuna from the Far East, has resulted in a sharp decline in landings at Los Angeles and San Diego fishing ports (see Table 3).

These changing conditions have posed less of a problem for the Bay Area fishing community which has not made large investments in new, bigger boats, but instead still uses smaller, older vessels in the 20 to 60 foot range.[3/]

These boats are capable of traveling long distance but not taking full advantage of the 200 mile fishery conservation zone. They are more than adequate to carry on the traditional short trips to the Gulf of the Farallones and other nearby coastal fishing areas and can take short trips into the 200 mile zone. The traditional nearby fishing grounds contain rockfish, halibut, and other table fish that have increased in popularity. Thus, the Bay Area fleet has escaped many of the problems that have affected the West Coast fishery, and it has benefitted from the increased popularity of fish in the American diet.

Year-round the Bay fleet seeks bottom fish including flounder, sole, and rockfish (commonly sold as red snapper). Seasonally, the Bay Area fleet fishes for salmon, crab, herring, albacore tuna, swordfish, halibut, and black cod. Herring and anchovies are the only commercial fish actually caught in San Francisco Bay. All the others are caught outside the Golden Gate, although many spend some of their lives in the Bay. In summer much of the fish is sold to Bay Area restaurants and consumers, although virtually all of winter's herring catch is exported to Japan.

Most of the Bay Area's commercial fishermen offload directly to a buying facility. In Sausalito and Oakland, boats can also moor at these facilities. The buyers offload, clean, and cut-up the fish, then ice them for distribution. At Fisherman's Wharf the close proximity of the boat berthing to the location of the buyers adds to the efficiency of the overall fish processing process. Although there are pressures to relocate the berths and the onshore facilities to the less valuable property south of the Bay Bridge, commercial fishing facilities will probably remain at Fisherman's Wharf because the Port of San Francisco is committed to renovating both the berthing and the onshore warehouses and offices.

All of the waterfront commercial fishing facilities handle fish caught locally and some Bay Area seafood wholesalers, handlers, and brokers also import large amounts of fish and shellfish. Imported seafood ranges from Tomales Bay oysters and Monterey Bay squid to Maine lobster and Norweigan salmon. Scallops, large shrimp, and lobsters, which are not caught by Bay Area fishermen, must be imported. Other fish, such as the Norwegian salmon, are imported when local salmon is out of season or unavailable. Some waterfront firms handle 100 percent local fish; others handle up to 50 percent imported fish. Therefore, not all commercial fishing operations require waterfront locations.[4/] Firms that handle only imports are sometimes located at inland sites where they are closer to transportation facilities.

For those firms handling local catches, a pier is always required for offloading fish. However, the offloading can be accomplished in a variety of ways. For example, herring are offloaded at many different piers, often using suction pumps. Some fishermen offload directly to trucks which transport the fish to a handling facility.

The Bay Area commercial fishing fleet, whose owners reside in one of the nine Bay Area counties (except Sonoma), is made up of over 3,000 boats, which is about 40 percent of the State's licensed fleet. Because it costs only $125 a year to register a fishing boat, the fleet includes many boats used only part-time, weekends, or seasonally. Only about 200 boats are used full-time for commercial fishing. During the December to March herring season, an additional 100 boats from other ports come into the Bay to fish.[5/]

Economic Importance of Commercial Fishing

Commercial fishermen make up a very small fraction of the Bay Area population, and the commercial fishing industry is less than one tenth of one percent of the region's economy.[6/] Yet commercial fishing is a critical component to other Bay Area economic activities and generates regionwide revenue well beyond the value of the fish. The fresh fish caught are essential to the success of the many fresh seafood restaurants and markets in the region. In 1985, the two Bay Area restaurants with the highest gross profits--Spenger's Fish Grotto in Berkeley and Scott's Seafood Grill in Oakland--depended on fresh fish for their success. The fishing industry is one of the few extractive, basic industries in the Bay Area. The industry also generates secondary economic benefits through boat maintenance costs, berth rentals, boat financing, insurance, fisherman profits, wholesaler profits, processor profits, and retail profits.

According to multipliers developed by the University of California to determine direct, indirect, and induced economic impact of California fisheries,[7/] every $1.00 worth of herring landed contributes $3.46 to the State's economy. Therefore, in 1984 the $1,800,000 worth of herring landed in the Bay Area resulted in an overall economic impact of $6,228,000. The overall value of Bay Area commercial fishing to the State's economy is estimated to be about $30 million.

The fishing industry is also a key component of the Bay Area tourist industry. A recent study [8/] determined that 84 percent of tourists who visited San Francisco named Fisherman's Wharf as their favorite attraction. Thus, fishing activities played a role in generating the $1.4 billion in spending that tourists contributed to San Francisco's economy in 1984.

The Facilities Needed for Commercial Fishing

In addition to requiring mooring space or berths in the water, commercial fishing also requires onshore support facilities in fishing harbors, such as: buyers and processors, cold storage, cargo hoists, vessel haul-outs, repair yards, ice, waste disposal, water, and fuel supplies.[9/] In addition, facilities normally found at recreational marinas are useful and necessary to commercial fishermen. These facilities include showers, storage lockers, parking, trash containers, and restrooms. Because the berthing, haul-outs, hoists, and repair yards must be partially in or over the Bay, they are considered "fill" by the Commission. The remaining support facilities can and often are located on land.

Historically, the buyers, processors, and cold storage facilities have been built on large docks, with mooring and off-loading facilities around the edge of the dock. Although these facilities can also be located on dry land, a location over the water speeds up off-loading and minimizes the time the fish are exposed to the elements, protecting the quality of the seafood.

Based on the cost of northern California's newest commercial fishing harbor, Spud Point in Bodega Bay, which was completed in 1985 at a cost of eight million dollars, a commercial fishing port costs about $33,000 per berth. Spud Point Marina includes 244 boat berths, two service docks, a lift dock, fuel station, water and electricity at the berths, showers, restrooms, maintenance center, laundry facility, lighting, and parking. Providing fish offloading, processing, and storage facilities would add to the cost.

While the cost of any marina is dependent on size, location, and the need for expensive facilities such as a breakwater, the Department of Boating and Waterways estimates the lowest overall cost of a new recreational boat berth is $20,000.[10/]

The Bay Area's Fishing Ports

The Bay Area's principal fishing ports are located in San Francisco, Sausalito, and Oakland. The fishing ports in Sausalito and Oakland each consist of one operators's offloading facility; Sea-K in Sausalito and Producer's Seafood in Oakland. At Fisherman's Wharf in San Francisco, there are about 15 independent commercial facilities,[11/] each leasing space from the Port of San Francisco. At all of these facilities, the fish are off-loaded, cleaned and cut-up, then packed on ice for market distribution.

When not at sea, most of the Bay Area fishing vessels are moored at one of the three areas. Sea-K and Producers, the two private facilities, allow the boats from which they buy fish to moor free of charge. Because there are so many boats at some times, the boats must "raft", that is tie up to each other parallel to the dock, sometimes four and five deep. This practice reduces the amount of berths needed at a commercial fishing facility. Usually about 20 to 30 boats are moored in Sausalito, although it has had up to 80 boats there.[12/] About 30 boats are moored in Oakland[13/] and another 115 are moored in San Francisco.

1. San Francisco. At San Francisco's Fisherman's Wharf, located east of Aquatic Park at the foot of Taylor Street, the fishermen and the buyers are tenants of the Port of San Francisco. Although the Port recently raised berth rentals, the $1.20 to $1.80 per foot rate is still much less than $3.05 to $3.60 per foot rental for a similarly sized berth at a recreational marina. However, the existing San Francisco berths have no facilities for the tenants except some storage. At San Francisco's new redevelopment agency recreational marina, berth rentals will cost approximately $6.95 per foot per month.[14/] Most recreational marinas have safe and sturdy facilities, and provide

parking, storage, garbage, running water, electricity, restrooms, and other facilities for lessees. In contrast, at Fisherman's Wharf, much of the berthing is dilapidated, and there is little or no parking, no restrooms, and little storage. In addition, lucrative tourist-oriented facilities that bring in higher revenues to the Port than do the commercial fishermen have usurped space that had been used to support fishing. The Port of San Francisco is developing plans to renovate the berths and support commercial fishing with icing facilities, storage, restrooms, showers, and other amenities. 15/

Four herring buyers use Pier 33 as an unloading area. The herring are trucked to processing and freezing facilities in the Monterey Bay area and then returned to Oakland for shipping to Japan.

A total of 18.7 million pounds of fish valued at $5.7 million were landed in San Francisco in 1984.16/

2. Sausalito. The Sea-K facility has been in Sausalito since 1975 and since 1982 has occupied the pier between the Corps of Engineers Operations Base and the Clipper Yacht Harbor. Although the City has adopted policies calling for the protection and enhancement of the commercial fishing indstury, no waterfront sites are available for expansion of the industry. Sea-K buys chinook salmon, pacific herring, albacore tuna, California halibut, and Dungeness crab from both local fishermen and seasonal fishermen who come to the Bay Area to fish for particular species.

2,759,000 pounds of fish worth $1.25 million were landed at Sea-K in 1984.17/

3. Oakland. Producers Seafood is located on the Oakland Estuary just north of the Dennison Street Bridge to Coast Island Island. The Port of Oakland obtained a Commission permit in 1980 to develop a commercial fishing facility on a vacant parcel of land near the bridge. The project was never

built, Producers Seafood has no plans to expand, and the Port of Oakland staff does not believe that Oakland will need a new commercial fishing facility in the near future. Producers buy chinook salmon, swordfish, albacore tuna, herring, and Dungeness crab from local and seasonal fleets.

2,452,000 pounds of fish worth almost two million dollars were landed at Producers in 1984.[18/]

The Threats to the Fishing Industry

Degradation of the natural environment has caused serious problems for the commercial fishing industry. Some of these are continuing and threaten the future of commercial fishing in the Bay Area.

In the American, Sacramento, and San Joaquin Rivers, placement of riprap, development of recreational and residential projects which create sediment, dredging, and filling are removing spawning areas used by salmon, striped bass, and other anadromous fish. Construction of Shasta Dam in 1944 eliminated half of the salmon spawning habitat in the Sacramento River System.[19/]

The diversion of upstream freshwater inflow also adversely affects downstream habitat. Poor water quality also affects anadromous fish. California Department of Fish and Game studies of striped bass are finding increased numbers of lesions on the fish, which are believed to be caused by toxics, chemicals, sewage, and other pollutants.

Fill, including riprap, and dredge projects along the shoreline of the Bay can adversely impact commercial fishing by circulating sediment or removing shallow water, marsh, intertidal, or mudflat habitats used by commercial species.

In the past, overfishing of certain species has dramatically affected other species. For example, overfishing of Bay shrimp and sardines may have contributed to the decline of larger fish species, birds, and mammals that eat these small creatures. Because herring now play an important role in the food chain of Bay wildlife, they are carefully monitored to ensure the population is not decimated by overfishing.

Another threat to the commercial fishing industry is the pressure to convert commercial fishing facilities into recreational facilities.[20/] Although the berthing facilities required for commercial fishing boats and recreational boats are basically the same, space for recreational boats can be rented at far higher rates. In commercial fishing, the berth fee is a business expense, which so long as amount of fish landed remains stable, cannot be changed without affecting either the profit of the commercial fisherman or the price of his product. In contrast, the rate charged for a recreational berth is related only to the amount the recreational boater is willing to pay to enjoy a relatively expensive leisure experience.

On the shoreline, land available for offloading and light processing is being converted to other uses. In San Francisco, Pier 45, currently used for commercial fishing is proposed for development as a hotel. In Sausalito, the one undeveloped site suitable for a commercial fishing facility is currently being developed as recreational marina with water-oriented businesses on land. The Port of Oakland, which holds a current Commission permit for a new commercial fishing facility, proposes to develop recreational boat berths and an office building on the site.

In addition, in marinas where both recreational boats and commercial fishing boats are berthed, there may be conflicts. Commercial fishing boats are big, sometimes old, sometimes smelly, and they come and go at all hours.

Recreational boaters generally seem to prefer a cleaner, tidier, quieter area than is typically associated with a commercial fishing port. Conflicts have not been a major problem in the Bay Area, probably because few marinas mix commercial fishing boat and the recreational boat berthing. However, recently problems have resulted from the offloading of fish in the Richmond and Berkeley marinas. Twenty boats, making up the Vietnamese Fisherman's Association, had to relocate from the Richmond Marina to the Berkeley Marina because of fishing acitivies. In Berkeley, they have been forbidden to offload fish because these activities are felt to be incompatible with the recreational use of the marina.[21/]

Opportunities for Improving the Fishing Industry

To dramatically increase the productivity of the commercial fishing industry in the Bay Area, either new high tech processing facilities or larger and newer vessels would have to be added to the fishing fleet, with new offloading and mooring facilities to serve these larger vessels would have to be built. These improvements would require an investment of capital in an industry that is currently plagued both by environmental factors that are causing a decline in some important commercial species and by competition from foreign, government-subsidized fishermen. Yet without these improvements it will be difficult for Bay Area fishermen to take full advantage of the 200 mile, federally designated fishery conservation zone.[22/] According to some experts, effective harvesting in this zone requires boats to be out of port for weeks at a time and either have on-board handling and freezer storage or work with a larger processing vessel. The boats needed for this work are 150 feet or larger and can cost ten million dollars each.[23/]

To be financially successful, a new on-shore processing facility would require a steady flow fish. A Pacific Whiting processing facility, one of the most high-volume, low value fisheries in the industry would require at least 100,000 pounds of fish a day.[24/] The plant would need to operate a minimum of 200 days per year, require at least two and a half acres of land, and cost roughly two to three million dollars plus land acquisition costs. Such a facility is proposed for location in Crescent City on the Northern California coast and is expected to cost $6.4 million and create about 200 jobs. Several such processing plants already exist in the Pacific Northwest along with mooring and offloading facilities. New, large fish processing facilities in the Bay Area would have to compete with these existing facilities. Vacant tuna canneries in southern California could also be rehabilitated for this purpose. New fish handling facilities have recently been constructed in the Monterey Bay area. These facilities are near landing and offloading facilities and relatively near to Bay Area shipping centers.

An alternative to the traditional high bulk frozen fish processing facility is the new concept of gaining larger profits from smaller quantities of fish by increasing quality standards. For example, fish auctions increase the availability of fish. In addition, new onshore facilities should have the flexibility to handle different species of fish in the same day.[25/]

It does not appear cost-effective to develop large-scale new fishing facilities in the Bay Area; however, renovation and expansion of the existing facilities seems necessary in order for the commercial fishing industry to survive, especially because many fishermen believe there are inadequate physical accommodations and access to the market place.[26/]

1. Fisherman's Wharf. "Fisherman's Wharf" is an area along the San Francisco northern waterfront consisting of Fish Alley located along Jefferson

Street, Hyde Street Pier at the foot of Hyde Street, and Pier 45 at the foot of Taylor Street. The fishing facilities in this historic fishing area are old, dilapidated, and inadequate for a modern commercial fishing industry. Fortunately, the Port of San Francisco is committed to improving the facilities for commercial fishing. In addition, the Corps of Engineers has begun construction of a new $10.6 million breakwater to protect the area from wave and tidal surge.

The Port of San Francisco's plan to redevelop this area is critical to the future of the Bay Area fishing industry for three reasons. First, this fishing port has the best access to the local fishing grounds which lie between the Golden Gate and the Farallones Islands. Second, the site is naturally deep and needs little maintenance dredging. Finally, because the area has been the center of the Bay Area fishing industry since the late 1800's there are more berths, greater off-loading capacity, and more handlers, processors, and distributors than at the other ports. Replacing these facilities at another location would be extraordinarily expensive.

Efforts to capture more tourist dollars have brought many changes to the Fisherman's Wharf area. Although tourism at Fisherman's Wharf generates more revenue than does commercial fishing, some doubt exists that tourism would continue to flourish if retail shops completely displace commercial fishing operations. For this reason, retailers in the Fisherman's Wharf area generally support the Port's plans to improve the facilities for commercial fishermen at the Wharf.

The Port's plans for the Fisherman's Wharf area include renovating the berthing, offloading, and handling areas and adding convenience facilities such as restrooms and showers. Hyde Street Pier would be rebuilt and expanded to accommodate new facilities for off-loading, handling, storage, office,

transporation, refrigeration, and public access. In addition, parking and truck loading areas are critically needed in this area. The Port believes that it cannot complete the redevelopment of the area before 1989. The San Francisco Waterfront Special Area Plan, adopted by the Commission in 1975, supports this enhancement and maintenance of commercial fleet mooring and commercial fish handling and processing at the Hyde Street Pier and Fish Alley areas.

2. Sausalito, Oakland, and other locations. Presently, the fish off-loading facilities in the Bay Area are all controlled by firms that buy fish. Therefore, fishermen find it difficult to sell fish directly to the public or to other wholesalers. In response to this situation, some fishermen are considering leasing and developing a site to provide mooring for commercial fishing boats, a public off-loading facility, and a small fish market open to the public. Both Richmond and Oakland have shoreline land that they could use for such a project.

The other smaller fishing "ports" identified in Department of Fish and Game data are, in fact, statistics which indicate that fish are offloaded at recreational marinas or other minor shoreline facilities. No major processsing companies are located in these ports; the fish are sold to buyers who transport them to other areas for processing.

The reestablishment of extensive commercial fishing in the Bay itself would be necessary for other locations to become suitable for the developmment of commercial fishing ports. Although other sites may be physically suitable for new facilities, their distance from ocean fishing grounds and the high cost of developing all new facilities may make the development of new commercial fishing ports less economical. A facility would have to be within 30 to 45 minutes of travel time by the Golden Gate to be useable by fisherman.[27/]

3. Fish Markets. Fish markets are commonly found in major fishing centers in other areas of the United States and the world. In Europe and Australia, wholesale fish auction houses are often associated with the wharf and off-loading area. In Seattle and Vancouver, British Columbia, retail fish outlets are located on the waterfront as part of larger produce markets. An auction house could be built at any of the three Bay Area fishing ports to distribute the fish not covered by standing orders. A public retail fish market appears to be most feasible in San Francisco where it would be accessible to a large population of residents, buyers, and restaurants. This type of market would improve the fishermen's ability to sell "extra" fish not covered by contracts, would diminish wasting fish, some of which are thrown away or dumped into the ocean, and would provide a public service and could lead to more competitive pricing of fish for the consumer.

Government's Role in Commercial Fishing

1. The Commission. The Commission can affect commercial fishing in the San Francisco Bay Area in a number of ways, although other impacts on the industry are largely beyond the Commission's control and influence. Any additional use of the shoreline or new Bay fill for commercial fishing facilities would require a Commission permit. Because a waterfront site is required for offloading fish, a commercial fishing harbor is a specialized type of port operation. Furthermore, because a waterfront location for fish processing facilities allows a higher quality of fresh fish to be marketed, the processing operation is a water-related industry. Therefore, the Commission can authorize some Bay fill to accommodate commercial fishing operations as a port facility and a water-related industry activity.

Similarly, the Commission can designate commercial fishing ports on the Bay Plan Maps as either water-related industries or ports to give priority to waterfront commercial fishing facilities and to protect existing fishing ports from conversion to other uses. Finally, the Commission can adopt Bay Plan policies to guide its consideration of proposals for new or expanded commercial fishing facilities and for the use of existing fishing ports. The Commission can also continue its positions regarding protection of water quality in the Bay and in upstream waters and can continue to protect and enhance marshes and mudflats around the Bay which serve as juvenile fish nursery habitat.

Existing Commission policies include:

1. Bay Plan Map 4 includes a suggestion which states: "Brooklyn Basin: Expand commercial fishing and recreation facilities."
2. Bay Plan Map 10 includes a policy which states: "San Francisco Waterfront Special Area Plan No. 1: See special area plan for detailed planning guidelines for the shoreline between the east side of the Hyde Street Pier and the south side of India Basin."

The San Francisco Waterfront Special Area Plan (1975) states, in part:

"Hyde Street Pier

The reconstruction or improvement of the east side of the Hyde Street Pier for fish processing should be permitted. It need not be rebuilt to its present configuration, but any new fill should be the minimum necessary."

"Fish Alley

Fish Alley facilities should be improved and expanded to serve the commerical fishing fleet and to maintain and enhance the area as a center for commercial fishing uses. Improved berthing, docking and related activities for commercial fishing boats, including necessary sanitation facilities, should be permitted.

"A breakwater between the Hyde Street Pier and Pier 45 should be permitted if a breakwater will: (a) protect commerical fishing boats moored in Fish Alley from damage caused by wave action and (b) significantly enhance the Fish Alley area as a center for commercial fishing activities."

Although the Commission can take positive steps to protect commercial fishing in the Bay Area, generally the Commission cannot regulate diversions from upstream inflows, the taking of fish, or the location of inland commercial fishing activities. The Commission cannot fund development or enhancement of commercial fishing facilities. These and other impacts are under the control of local, other state, and federal agencies. And lastly, the Commission cannot affect market demand or prices or predict or mitigate catastrophic natural phenomenon, such as "El Nino," which can devastate the fisheries and the fishermen's incomes.

2. California Department of Fish and Game. The Department of Fish and Game (DFG) has primary responsibility for regulating the use of the commercial fishing resource within California. DFG also carries out scientific studies to determine the amount, size, and age of fish of different species; establishes the seasons for harvesting those fish vulnerable to overfishing; polices collection of fish as they are unloaded in ports; breeds, raises, and

releases fish to enhance the natural population; comments on proposed projects that might affect spawning and juvenile fish habitat; carries out habitat enhancement projects; and through its authority to license commercial fishermen and boats, can limit the numbers of boats fishing for species that are vulnerable to overharvesting.

DFG uses a variety of techniques to monitor the health of the fish populations. For example, tiny metal tags are planted on the bodies of juvenile salmon that are raised in hatcheries. DFG personnel recover these tags when the fish are caught as adults and are unloaded in port. In addition, fishermen and buyers must report their catches and purchases to the DFG. Although the accuracy of this system depends on the cooperation of the buyers and fishermen, the data collected are useful as a rough estimate of the catch.

Certain fish can be harvested only during limited seasons; others are not available for commercial fishing at all. Striped bass have not been caught commercially since 1935, largely to protect the population for recreational anglers. Salmon, herring, and crab are the big seasonal catches in the Bay Area. Salmon season runs from May to October, herring season runs from December to March, and dungeness crab season runs from November to June. These limited seasons help ensure adequate spawning takes place to continue the species population. The overall tonnage of the seasonal catch for these species is also limited, and the tonnage limitations are reviewed annually.

DFG inspects catches offloaded in ports and works to arrest and prosecute persons who fish out of season. In the Bay Area, one warden is responsible for overseeing all of the commercial fishing activities in San Francisco and one is assigned to Oakland. Other areas have no permanent DFG staff.

DFG operates several hatcheries in the state. Most of the hatcheries raise trout for freshwater, recreational release and salmon, which are released and swim to the ocean for several years growth. In 1984, DFG raised and released over 25 million chinook, steelhead, and coho at six DFG hatcheries. A total of 48.5 million fish were raised and released statewide in 1984.

DFG staff reviews and comments on environmental documents for projects that might impact fisheries habitat. For example, proposals to dredge or place fill in shallow water portions of the Bay might adversely impact spawning and juvenile fish feeding areas in the Bay. The DFG staff also suggest project changes to reduce adverse environmental impacts.

3. Other Agencies. In addition to the DFG's regulation of fish and the commercial fishing industry, the state Department of Health Services and the local departments of health supervise and inspect the facilities where the fish are cleaned, filleted, iced, and packed for distribution. The purpose of these inspections is to ensure clean and sanitary conditions for the preparation of the fish for human consumption.

The State Coastal Conservancy is involved in several commercial fishing projects in California, including planning, economic feasibility analysis, and implementation of Port of San Francisco projects at Pier 45; construction of a fish processing facility in Crescent City; and planning and constructing of fishing boat berths at Spud Point in Sonoma County. In 1984, the Conservancy also conducted a comprehensive analysis of the need for fishing boat berthing in California and developed recommendations for improving the State's support for commercial fishing.

Within the federal government, the National Marine Fisheries Service (NMFS) has primary responsibility for fishery programs. NMFS has

jurisdiction over the harvesting of fish that pass between states, fish captured off foreign lands, marine mammals, species regulated by Congress, and the fishery conservation zone, which extends 200 miles seaward of the three mile coastal zone that is part of each state. In the Bay Area, NMFS regulates salmon and groundfish, for which it establishes size limits, quotas, and seasons. NMFS also has authority over seafood and shellfish shipped between states.

For each of the fisheries regulated by NMFS, a management plan is prepared by a regional fishery management council, for review and approval by the Secretary of Commerce. The Pacific Fishery Management Council, one of the eight regional fishery management councils, oversees development of management plans for the waters more than three miles off California, Oregon, and Washington. The 13 voting members include representatives of the state fish and game agencies and from NMFS, and eight members appointed by the Secretary of Commerce. The council also includes representatives from Idaho. Five non-voting members represent the Governor of Alaska, U. S. Fish and Wildlife Service, Coast Guard, Department of State, and Pacific Marine Fisheries Commission. This Council prepares management plans for the species within its area of jurisdiction and prepares federal regulations to carry out the plan. Bay Area commercial fishermen operate under the Pacific Coast Groundfish Plan which covers Lingcod, Pacific whiting, Sablefish, Pacific Ocean perch, other Rockfish, Pink shrimp, Spot and Ridgeback prawns, and Dover, English and Petrale sole.[28/]

The U. S. Fish and Wildlife Service (FWS) does not regulate commercial fisheries; its work is limited to recreational fishing species.

4. Other Countries. The United States government is involved in managing the fisheries resources, but is not actively involved in the

development of technology, research, and direct market price controls as found in other nations. In the USSR, all the fishing vessels are government owned and the government is investing in development of groundfish processing facilities. Canada actively supports prices to make commercial fishing a lucrative industry for Canadians. Canada is also developing a research and testing facility for the fishing industry in Halifax. Norway and Denmark each have active research facilities. In addition, Norway is involved in salmon aquaculture and controls production as part of a worldwide program to manage the market in Norwegian salmon. Japan has some of the most advanced government programs based on the extensive nationwide planning for the commercial fishing industry that was carried out in the 1960 and early 1970's. The Japanese government developed zoning to set aside areas for fishing, for processing, for aquaculture, and for recreation, to eliminate conflicts between uses. Japan now produces a large percentage of its seafood through mariculture.

NOTES

1. Department of Fish and Game data, Long Beach
2. Department of Fish and Game data, Long Beach
3. BCDC Staff Phone Survey, April 1-5, 1985
4. Personal Comment, Patrick J. Flanagan, Standard Fisheries Corp.
5. Personal Comment, Denise Turner, wharfinger, Port of San Francisco
6. Based on Association of Bay Area Governments data for 1982, Information and Analysis Section
7. King, Dennis M. and Kenneth L. Shellhammer, The California Interindustry Fisheries Model: An Economic Impact Calculator for California Fisheries, Vol. I., p.14

8. Fisheries Development Associates, Fisherman's Wharf: A Proposal for Development, 1985, p. 6

9. State Coastal Conservancy, Commercial Fishing Facilities in California, 1984, p.11

10. Personal comment, William Curry, staff, Department of Boating and Waterways, March 26, 1986

11. Personal Comment, Patrick J. Flanagan, Standard Fisheries Corp.

12. Personal Comment, Joe Garofalo, Sea-K Fish Co.

13. Personal Comment, Stephanie Thorton, Producers Seafood

14. San Francisco Chronicle, May 13, 1985

15. Port of San Francisco, Request for Proposal, April 24, 1985

16. Department of Fish and Game data, Long Beach

17. Department of Fish and Game data, Long Beach

18. Department of Fish and Game data, Long Beach

19. Nichols et.al., "The Modification of an Estuary" in Science, February, 1986

20. State Coastal Conservancy, Commercial Fishing Facilities in California, 1984, p. 61

21. Personal Comment, Connie Ryan, Sea Grant

22. Port of Oakland, Commercial Fisheries Development Study, 1981, p.31

23. Personal comment, Zeke Grader, Pacific Coast Federation of Fishermen's Associations, Inc.

24. State Coastal Conservancy, Staff Analysis of Crescent City Pacific Whiting Processing Plant, 1985

25. Personal comment, Patrick J. Flanagan, Standard Fisheries Corp.

26. Letter of Robert E. Barton, San Francisco Bay Fishermens' Association, February 19, 1986

27. Letter of Robert E. Barton, San Francisco Bay Fishermens' Association, February 19, 1986

28. Personal Comment, Henry Wendler, staff, Pacific Fishery Management Council, March 21, 1986

PART II: COMMERCIAL SHELLFISHING

Overview of Shellfish Harvesting in the Bay

Large numbers of shellfish have inhabited the Bay for hundreds of years. The native oyster (Ostrea lurida), mussel (Mytilus edulis), and bent-nose clam (Macoma nasuta) were staples in the diet of native Californians.[1/] Around 1850, commercial cultivation of oysters began. Immature Eastern oysters (Ostrea virginica) and later Japanese oysters (Ostrea gigas) were imported and "planted" in fenced beds. Although these oysters grew larger than the native species, juveniles had to be imported continuously because the exotic species could not reproduce in the cool Bay waters. Clams that were inadvertantly imported with these oysters have reproduced and now thrive in the Bay.[2/] The soft shell clam (Mya arenaria) and the Japanese littleneck or cockle (Tapes japonica) are now the primary species in Bay shellfish beds.[3/]

Shellfish beds of varying sizes exist along the shoreline of the Central and South Bays. The presence of a shellfish bed depends on a number of factors, including bottom conditions, food supply, and water salinity. The best bottom condition is rocky cobble with mud and shell mix.[4/] Precise figures on the number of shellfish in the Bay are not available. Appendix C includes 1977 and 1981 estimates of the Japanese littleneck and softshell clam populations over the last 20 years and a map of the bed locations.

Because of water quality problems, since the 1930s shellfish harvesting in San Francisco Bay has been limited to recreational collecting. Recreational harvesting is regulated by the California Department of Fish and Game, which issues fishing licenses, sets daily harvest limits for each species, and establishes the minimum sizes that can be collected. The California Department of Health Services is responsible for determining when consumption of shellfish can be hazardous to the public health. Although the Department of Health Services suspects that many of the shellfish collected from the Bay may be contaminated, overall the Department does not believe the consumption of Bay shellfish poses a "severe health hazard." [5/] Furthermore, since 1982 the Department has "sanctioned the consumption of shellfish from the shellfish beds" by recreational harvesters[6/] during summers only along the San Mateo County shoreline between Coyote Point Yacht Harbor and Ryder Park. This has been the first sanctioned recreational shellfish harvesting in the Bay since the 1930s. Recreational harvesting is not limited to these officially opened areas, but instead takes place throughout the Bay.

To satisfy the Bay Area's large demand, shellfish must be imported from other coastal areas in the U.S. and abroad. Some oysters are raised on California's ocean shoreline. Recent research has shown the shellfish can be grown in the Bay, but Bay shellfish operations must overcome problems associated with water quality to become commercially successful.

To reestablish commercial shellfish operations, growing waters would have to be certified to be of suitable quality, a testing program initiated, and, to ensure public health, a depuration (or cleansing) process developed. Without a depuration facility, public health and safety cannot be guaranteed because unexpected incidents, such as sewage treatment plant malfunctions,

overflows, or toxic spills can quickly impact shellfish beds. Depuration is consistently effective in reducing bacteria (such as fecal coliform), although depuration experiments have not proven depuration effective in eliminating, virsues (such as hepatitis A), trace metals (such as mercury), or hydrocarbons. One of the most effective ways of destroying microbial contamination is cooking at high heat, e.g. deep frying. A recent study in the New England Journal of Medicine linked gastrointestinal illness in New York to the consumption of raw oysters and clams or lightly steamed clams.[7/]

The Threats to Shellfish Harvesting

Water quality is a key element in commercial shellfish harvesting. Under the voluntary National Shellfish Sanitation Program, the State's water is divided into four classifications. They are:

1. Approved areas where the health authority has, as a result of a sanitary survey, reliable assurance that, all year round, sewage from nearest sources will not reach the area in concentrations to constitute a public health hazard. (No Bay waters fall into this category.)
2. Conditionally approved areas where information from a sanitary survey has indicated that the discharge from a nearby community waste treatment plant adversely effects the quality of the water in the area and the area would have been classified as prohibited had treatment not been provided. The water quality requirements for an approved area are met at all periods when the area is approved as a source of shellfish for direct marketing.
3. Restricted areas where a sanitary survey has revealed a limited degree of pollution which makes it unsafe to harvest shellfish for direct

marketing. Shellfish from this area may be marketed after "relaying" in an approved area under regulations set by the state certifying agency. (Most Bay waters are either conditionally approved or restricted.)

4. Prohibited areas where sanitary surveys have indicated the area is receiving pathogenic microorganisms from known sources of contamination. The median coliform MPN (most probable number) of the waters exceeds 700 per 100 ml. or more than 10 percent of the samples have a coliform MPN in excess of 2300 per 100 ml. (Any areas not in a testing program are designated "prohibited".)

In San Mateo County where collection in the summer has been approved, the Bay water is tested weekly by the County Health Department, and the clam meat is tested every two weeks to ensure compliance with the following standards for total coliform bacteria and fecal coliform bacteria.[8/]

	TOTAL COLIFORM	FECAL COLIFORM
Five sample median	70 MPN/100 ml	14 MPN/100 ml
Maximum allowed	230 MPN/100 ml in 90 percent of samples	46 MPN/100 ml in 90 percent of samples

Other pollutants which can be ingested through shellfish consumption and can adversely impact human health include viruses; marine biotoxics such as paralytic shellfish poisoning; trace metals such as cadmium, chromium, copper, lead, mercury, and zinc; arsenic; chlorinated hydrocarbons; petroleum hydrocarbons; and radionuclides.[9/]

Future Opportunities for Shellfish Harvesting

Due to improvements in water quality in parts of the Bay, commercial shellfish operations may soon reappear. Recently the Department of Fish and Game carried out oyster culture experiments.[10/] Mesh bags containing juvenile Eastern and Pacific oysters were tied to racks placed on mudflats in San Leandro, San Mateo, and Redwood City. Within a year about 90 percent of the oysters reached cocktail (small) or small half shell (medium) size. However, considerable labor was required to maintain the racks and remove algae from the bags.

DFG research also shows that stake culture can be used to grow Pacific oysters to half shell (medium) size. Stake culture involves attaching juvenile shellfish to a pole sunk into the Bay bottom. Growth is faster than bag growth, the stakes can be placed close together, and there is virtually no maintenance. Yield per unit area for stake culture could be double or more than that of bag culture. Likely areas for stake cultivation include Anza Lagoon in Burlingame, San Mateo, San Leandro, and Point Isabel in Richmond.

In 1984 the Morgan Oyster Company completed a three-year study at 100 sites along the East, South, and West Bay shorelines, between Burlingame and Hayward. Immature oysters and clams were placed in mesh bags attached to racks, and clams were buried in the Bay bottom. At each of the sites, growth rates were excellent. As a result of these experiments, the company is interested in commercially raising shellfish in the South Bay. To accomplish this, the firm proposes to lease approximately 3,000 acres of underwater State-owned lands, and has developed an aquaculture agreement with Department of Fish and Game. This project will begin with five acres of racks and a five year research and development lease. The lease can be extended for up to 25 years.

Shellfish grown in the Bay would have to go through depuration, or cleansing, before they could be marketed for human consumption.[11/] In one method, shellfish could be transported to another area, such as Tomales Bay, for depuration. This method will probably be used by the Morgan Oyster Company for the first few years. The depuration process would take several weeks and up to 20 percent of the oysters may be lost in transit through breakage.[12/] Another depuration method involves the construction of a depuration plant made up of large, shoreline tanks through which disinfected water flows. A period of only 48-72 hours may be enough to purify shellfish in such tanks.[13/] One demonstration project cleansed San Francisco littleneck clams in six hours.[14/] Such plants have been used in Europe and Japan for up to 60 years; however, there are few in the United States. The Morgan Oyster Company may build such a plant in the future to speed up marketing and to minimize losses due to transportation. Large tanks, a minimum of 10' x 25' x 3', would be enclosed in a warehouse similar in size to a fish off-loading facility or other light, small, industrial facility.

The Commission's Role in Shellfish Harvesting

Bay Plan policies currently call for public access to the shoreline for recreational harvesting of shellfish and several of the Bay Plan Maps identify areas along the shoreline with shellfish harvesting opportunities. The Bay Plan Map notes identify and promote public access to the shellfish beds.

If commercial shellfish operations return to the Bay, support facilities would be needed for docking, offloading, warehouses, offices, and truck parking. These facilities would require a shoreline location near the shellfish beds, adjacent to water of adequate depth, and near transportation

routes. Some dredging may be needed to prepare an offloading area, although existing dock or port facilities may be appropriate as long as the shellfish harvesting use does not preempt deep-water access sites needed for maritime activities.

When the Commission reviews a permit application for shellfish culture, it would have to address any use conflicts in the proposed area. Cultivation will entail the placement of stakes or metal racks which may interfere with small craft boating, other water sports, or commercial herring fishing. The culture structures about three to four feet above the bottom, and stakes, up to two feet above the bottom, may be visible at certain tidal levels which could impact views of the Bay from the shoreline. Recent research by the Morgan Oyster Company indicates that oysters that are continually submerged grow more quickly than oysters in the intertidal zone.[15/] Therefore, placing racks where they are submerged all the time would eliminate view impacts and improve oyster growth. Clearly marking culture areas with buoys, siting in areas not used for fishing, and/or reserving adequate water areas for launching and maneuvering small boats would lessen impacts on those uses and on commercial fishing. Because commercial shellfish operations take place in relatively shallow water areas, they would not interfere with charted navigation channels in the Bay.

As with every permit application, the environmental impacts of each specific project proposal would have to be reviewed in depth prior to issuing a permit. Any impacts on sedimentation, water circulation, and wildlife would have to be addressed in light of a specific project.

NOTES

1. Jones and Stokes, San Francisco Bay Shellfish, p. 4
2. Skinner, p. 106
3. McAllister, p. ii
4. McAllister, p. 10
5. Regional Water Quality Control Board, January 1983, p. 5
6. Regional Water Quality Control Board, January 1983, p. 5
7. San Francisco Chronicle, March 13, 1986
8. San Francisco Chronicle, July 22, 1985
9. Jones and Stokes, pp. 28-76
10. McAllister, p. 82
11. Jones and Stokes, pp. 79-84
12. Jones and Stokes, p. 82
13. Jones and Stokes, p. 82
14. Jones and Stokes, p. 82
15. Reports submitted as a condition of BCDC Permit No. M80-88

PART III: MARICULTURE

Overview of Mariculture

Aquaculture is the cultivation of plants or animals in water under controlled conditions. Mariculture is aquaculture carried out with marine species in sea water. Both aquaculture and mariculture are akin to farming in that an area is reserved for the use, the plant or animal is "seeded" in that area, and many species must be fed to survive.

Mariculture has the potential for making important contributions to society.[1/] It can increase the food supply (Japan, for example, is producing ten percent of its fish supply through aquaculture). Fisheries can be preserved by consuming "ranched" stock so that the wild stock can be protected from depletion. Mariculture contributes to environmental quality; it is a clean industry and can, in some instances, be used to supply tertiary treatment to sewage. As a source of seed animals to restock natural populations, mariculture can be part of natural resource enhancement programs. Finally, mariculture offers employment opportunities and economic growth in the seafood industry.

The process closest to mariculture in the Bay is the harvesting of small brine shrimp from the Leslie Salt Company's salt ponds in the south Bay. Brine shrimp, which are native to the Bay, are swept into the salt ponds when they are filled with Bay water. Between one-half and three quarters of a million pounds of these tiny creatures are harvested each year [2/] and marketed largely as pet fish food.[3/]

Modern mariculture is currently focused on a few limited species, and much of the work is at the experimental, research level. A great deal of research is necessary to understand the reproduction process, feeding, and other functional aspects of a species before there is adequate confidence to make an investment in a mariculture project. Work in California is focused on five species: (1) oysters, (2) abalone, (3) anadromous fish, (4) lobster, and (5) seaweed.[4/]

The oyster industry is currently the most successful mariculture program. Oysters are raised in Humboldt Bay, Drakes Estero, Tomales Bay, and Morro Bay in two ways; seed or baby oysters are placed directly on the bottom of the bays or they are attached to racks placed in the bays.

Abalone is being experimentally raised in the Santa Barbara area. Abalone can be raised onshore in tanks, offshore in natural or artificial habitats, or hatched onshore and raised offshore.

Salmon and other anadromous fish spawn, spend their early lives in fresh water and their adult lives in the open ocean. They are raised and released into the ocean with the hope they will return in two to three years to the area where they were spawned. The returning adults can then be easily harvested. Farming of anadromous fish is closely regulated; special legislation must be passed to approve a project site. One firm, the Silver King Oceanic Farms, has approval for three sites, Waddell Creek and Davenport Landing Creek in Santa Cruz County, and Elk Creek in Mendocino County.

The American lobster is the only crustacean being cultivated in California. Preliminary reports say "domestication of the American lobster is as hard as trying to housebreak a rhinocerous"[5/]; they are ill-tempered, cannibalistic, slow growing, and die easily.

The last area of interest is seaweed culture. There are many different types, some of which may be appropriate for San Francisco Bay. In Southern California, kelp is being studied to discover if the plant biomass can economically be converted to energy. If so, interest in seaweed cultivation may increase. In some experiments, tanks of microscopic seaweed have been grown to feed oysters; other tanks of seaweed cleanse the wastewater from the oyster tanks. Because such food material may be needed for oysters held in an onshore depuration tank, this type of system may have applicability in the Bay.

Although mariculture seems to have a great deal of potential, establishing profitable operations has proven difficult. As noted, extensive research is essential before a species can be raised in a maricultural operation. Government support for such research has declined, and it is difficult to readily apply research on one species to another species. Therefore, most successful aquaculture efforts involve hearty species like catfish, or species that have a long history of cultivation, like clams and oysters. Considerable capital investment is also necessary to initiate a mariculture operation. Without a success story to attract investors, it is difficult for entrepreneurs to raise the necessary venture capital. For this reason, many of the successful aquaculture ventures occur in foreign countries which provide considerable subsidies to the operators or concentrate on species with a high unit cost, like lobsters.

Mariculture can conflict with public uses of coastal waters, such as boating and swimming. It may be difficult for mariculture proponents to convince public officials that areas currently used for recreation or other public purposes should be allocated to mariculture, especially since the industry has had such a limited success in either producing significant

amounts of food or making a large economic impact. For this reason, the industry has often faced what it perceives to be unreasonable government regulation.

The Opportunities for Mariculture in the Bay

Of the species currently under study for mariculture, oysters and brine shrimp appear to be the most likely candidates for mariculture in San Francisco Bay in the near future. Neither abalone nor the seaweed on which it feeds are native to the Bay. Therefore, problems can be expected in trying to raise them in the Bay. Although many anadromous fish pass through the Bay on their way to up river spawning areas, sites for spawning projects are very rare and it is unlikely any appropriate site exists within the Bay itself. Nor does the American lobster appear to be a candidate for San Francisco Bay mariculture.

Sea Grant researchers cultivated the seaweed Laminaria on racks which they floated in San Francisco Bay and are attempting to induce herring to lay their eggs on the Laminaria. The researchers released a ton of herring eggs near the seaweed in 1984 in hope that herring will "home", or return to their place of hatching to lay their eggs as adults. Herring eggs currently sell for up to $10 a pound in Japan.

If mariculture is developed in the Bay Area, it would likely be proposed for location in three types of areas: (1) shallow areas of the Bay, (2) low-lying, flat seasonal wetlands and (3) existing ponds.

Creation of ponds in the Bay would entail building new dikes in the Bay and installing water control structures. The reduction in the size of the open Bay would result in dimunition of the tidal prism and could adversely impact marsh, mudflat, and intertidal habitats.

Proposals to develop new ponds on the shoreline would probably focus on the large expanses of low-lying flat lands, such as diked historic baylands, lands diked off from tidal action of the Bay in the past, or managed wetlands flooded in winter for duck clubs. These lands are seasonally wet and provide habitat for Bay-related waterfowl, shorebirds, raptors, and other animals and birds. These lands are very vulnerable to filling and development. Conversion to mariculture use would eliminate the seasonal wetland values to Bay wildlife, but would keep the lands unfilled, increase water surface area, and provide habitat for aquatic wildlife and water-oriented birds.

Some of the thousands of acres of existing salt ponds could be converted to mariculture use if no longer needed for salt production. The change of use would have little effect on the Bay ecosystem; the dikes and water control systems are in place and water surface areas would be retained. The brine shrimp is the most likely candidate for cultivation in the salt ponds because it thrives in the shallow, warm water with high salinity levels. Most other high salinity-tolerant species are tropical and would require higher year-round water temperatures than are found in the Bay Area. Brine shrimp would also be a good mariculture candidate because it is used as food for other species raised in mariculture. Thus, the brine shrimp market would grow as mariculture generally grows. Other species of shrimp such as the penaeid shrimp or the Giant Asiatic prawn are also possible candidates for cultivation in the salt ponds.

The Department of Fish and Game believes that some ponds could continue to be used to raise brine shrimp. Other ponds have accumulated extensive salts in the soil. Prior to any specific proposal, the DFG's Marine Culture Laboratory recommends a one or two year background study of the ponds to log dissolved oxygen, salinity, and water temperature in all four seasons. With

this information, either DFG or private mariculturists could determine more precisely which species could be raised here.

In addition, before a definite project is approved, the impacts on the existing wildlife users of the salt ponds would need to be studied. The salt ponds currently provide important resting areas for migratory waterfowl and other birds.

Government's Role in Mariculture

To promote mariculture in the State, in the last five years the State of California has amended its laws, clarified its regulations, and simplified the licensing procedures. The state Legislature has also adopted a resolution supporting mariculture/aquaculture.

Within the existing regulatory framework, new permits can be processed simply; processes and areas of authority have been centralized in the Department of Fish and Game. The most recent aquaculture application handbook, updated in August, 1985, includes reference materials, a list of species which could be raised, state codes, and application forms. This handbook covers shellfish, fish, and seaweed raising.

The Commission's Role

Existing Bay Plan policies address the development of mariculture in the Bay, in salt ponds, and in managed wetlands and diked historic baylands.

While the Commission could legally authorize fill for new levees in the Bay to create new ponds for mariculture, Bay Plan policies call for maintaining and enlarging the Bay surface area and tidal prism to promote

water circulation and aquatic habitat and call for protection of marshes and mudflats. Because construction of levees for new ponds in the Bay would restrict tidal circulation and impact existing intertidal habitat areas, it would be difficult for the Commission to approve the creation of mariculture ponds within the Bay.

Existing Bay Plan policies allow filling of portions of salt ponds if they are no longer needed for salt production. Conversion of these ponds to mariculture would retain the water surface areas and tidal circulation in the ponds. Retention of the ponds would protect the waterfowl habitat values of the ponds. Mariculture use would protect the possibility of future restoration to full tidal action and would allow pond owners an alternative, economic use of these lands.

Changes of use in the salt ponds and physical work at the ponds, such as repair of levees and of water-control facilities, would require Commission permits. In addition, use of the shoreline for mariculture support facilities would require Commission approval.

Managed wetlands, used in winter by duck clubs, and diked historic baylands, low lands inundated by winter run-off, have seasonal values as wetlands. Current Commission policies would allow filling and development of these areas if they cannot be kept in their current use and cannot be purchased by the public and restored to tidal action. Commission policies place highest priority on restoring these lands to tidal action, where feasible. A possible alternative, if tidal restoration is not possible, would be to use these areas for mariculture ponds. Creation of ponds in these lands would enlarge water surface area and provide aqautic habitat. To an extent, ponds would increase tidal circulation and flushing. Mariculture would allow an economic use of these lands. However, in some cases, inundating these

areas would destroy valuable wildlife habitat. Therefore, managed wetlands should be used for mariculture only if this would be the sole alternative to filling the area.

NOTES

1. Personal comment, Henry Alexander, Leslie Salt Co., May 1, 1985
2. Personal comment, Bill Smith, San Francisco Bay Brands, March 27, 1986
3. Bowden, 1981, pp. 4-5
4. Bowden, 1981, pp. 6-14
5. Bowden, 1981, p. 13

CONCLUSIONS

To maintain existing and promote future commercial fishing in the Bay Area, the Commission should incorporate new findings and policies into the Bay Plan. These findings and policies should be in a new section of the Plan and should supplement the existing Bay Plan and San Francisco Waterfront Special Area Plan provisions regarding commercial fishing.

Recommended new Bay Plan findings and policies regarding commercial fishing include:

Findings

a. The construction and use of commercial fishing facilities are consistent with state and federal policies promoting public trust and water-oriented uses of the State's waters.

b. Existing commercial fishing facilities in the San Francisco Bay Area are centered principally in three areas: the Fisherman's Wharf area of San Francisco, north of Dennison Street Bridge in Oakland, and south of the Corps of Engineers Operations Base in Sausalito. Facilities at each location include boat docking and mooring and fish unloading, handling, cleaning, filleting, and distribution facilities. There are no public fish markets at these facilities.

c. Commercial fishing continues to be a valuable part of the Bay Area economy and culture. The commercial fishing industry provides fresh fish for area residents and restaurants and generates primary and secondary economic benefits to the state. Additionally, because visitors are attracted by commercial fishing activities,

the industry is an important part of the Bay Area's multi-billion dollar tourist industry.

d. Because of the relatively low direct economic return and the character of commerical fishing operations, there is pressure to convert fishing boat berths to recreational boat berths and to replace commercial fishing facilities with retail, commercial, recreational, and other uses.

e. If the existing facilities are protected, it is not necessary to reserve shoreline areas for commercial fishing.

f. Although clam and native oyster beds are located throughout the Bay Area, shellfish harvesting is currently limited to recreational harvesting due primarily to Bay water quality problems.

g. If and when not needed for salt production, salt ponds may have continued commercial value for mariculture operations. Managed wetlands and diked historic baylands are low-lying seasonal wetlands which could be appropriate sites for construction of mariculture ponds.

Policies

1. Commercial fishing facilities are water-oriented uses (port use and water-related industry) for which the Commission can allow some Bay fill subject to fill policies contained in the McAteer-Petris Act and elsewhere in the Bay Plan.

2. Modernization of existing commercial fishing facilities and construction of new commercial fishing boat berthing, fish offloading, and fish handling facilities on fill may be permitted at appropriate sites with access to fishing grounds and to land

transportation routes, if no alternative upland locations are feasible. Support facilities for the resident fleet and transient fishing vessel crew use, such as restrooms, parking, showers, storage facilities, and public fish markets should be provided, and, where feasible, located on land.

3. Existing commercial fishing mooring areas, berths, and onshore facilities should not be displaced or removed unless adequate new facilities are provided or the Commission determines that adequate facilities of the same or better quality are available.

4. New commercial facilities should be approved at any suitable area on the shoreline, preferably with good land transportation and space for fish handling and directly related ancillary activities. Commercial fishing boats do not need deep water to dock and offload cargo.

5. If commercial shellfish harvesting is reactivitated in the Bay Area, handling and depuration facilities should be allowed only on land. Commercial shellfish harvesting facilities and activities should not interfere unduly with recreational uses of San Francisco Bay. New Bay projects should not destroy or otherwise adversely impact existing shellfish beds.

6. Where consistent with the protection of fish and wildlife, mariculture operations should be permitted in salt ponds that are no longer needed for salt production.

7. Mariculture ponds should be permitted in managed wetlands or diked historic baylands which cannot be retained in their existing uses.

In addition, the Commission should revise the Bay Plan findings and policies on Salt Ponds and Other Managed Wetlands by adding the following new finding:

h. Salt ponds are currently used to raise and harvest between one-half and three-quarters of a million pounds of brine shrimp per year and have commercial value for mariculture operations.

The Commission should add the following criterion to Policy #3 (page 26):

d. If public funds do not permit purchase of all the salt ponds or marshes proposed for withdrawal from their present uses, and if some of the ponds or marshes are therefore proposed for development, consideration of the development should be guided by the following criteria.

   a. Just as dedication of streets, parks, etc., is customary in the planned unit development and subdivision laws of many local governments, dedication of some of the pond or marsh areas as open water can and should be required as part of any development. Highest priority to such dedication should be given to ponds that (1) would, if opened to the Bay, significantly improve water circulation, (2) have especially high wildlife values, or (3) have high potential for water-oriented recreation.

   b. Depending on the amount of pond or marsh area to be dedicated as open water, the public may wish to purchase additional areas. Plans to purchase any ponds or marshes should give first consideration to the priorities in paragraph a. above.

   c. Development of the ponds or marshes should provide for retaining substantial amounts of open water, should provide

for substantial public access to the Bay, and should be in accord with the Bay Plan policies for non-priority uses of the shoreline.

d. Mariculture operations should be encouraged in abandoned salt ponds to provide salt pond owners with an economic use of their property that does not require the ponds to be drained or filled. Managed wetlands no longer used as duck clubs may be developed for mariculture to allow an economic use of the land which does not require filling.

The Commission should also add the following map policy note to Plan Map 10:

Fisherman's Wharf: Protect existing commercial fishing area from intrusion by other uses, improve and expand fishing support facilities, and enhance public access to and economic value of Fisherman's Wharf area by adding a public fish market.

SOURCES

Barrett, Elinore M., The California Oyster Industry, 1963

Bowden, Gerald, Coastal Aquaculture Law and Policy: A Case Study of California, 1981

CH2M Hill, Commercial Fisheries Development Study, Port of Oakland, 1981

Conomos, T. J., Editor, San Francisco Bay: The Urbanized Estuary, 1979

Fay, James, S., Anne G. Lipow, and Stephanie W. Fay, California Almanac, 1984/85 Edition, 1984

Department of Fish and Game, A Survey of the Marine Environment from Fort Ross, Sonoma County to Point Lobos, Monterey County, 1968

Department of Fish and Game, California Marine Fish Landings for 1969, 1970, 1971, 1972, 1973, 1975, and 1976 (seven separate volumes)

Department of Fish and Game, Coastal County Fish and Wildlife Resources and Their Utilization, 1973

Department of Fish and Game, Fish and Wildlife Resources Relationships and Water Quality Requirements, 1972

Department of Fish and Game, Preliminary Fish and Wildlife Plan for San Francisco Bay-Estuary, 1966

Fitch, John E. and Robert J. Lavenbey, Marine Food and Game Fishes of California, 1971

Jarvis, Fred E., San Francisco Bay Shellfish Program: Preliminary Sanitary Survey Report for the South Bay Study Area, 1980

Jones and Stokes Associates, Incorporated, San Francisco Bay Shellfish, 1977

Jordan, David Starr and Warren Everman Barton, American Food and Game Fishes, 1923

King, Dennis M., and Kenneth L. Shellhammer, The California Interindustry Fisheries (CIF) Model: An Economic Impact Calculator for California Fisheries, Volume I, 1982

Bureau of Marine Fisheries, The Commercial Fish Catch of California for the Year 1947 with an Historical Review 1916-1947, 1949

McAllister, Robert O. and Thomas O. Moore, Jr., Selected Shellfish Resources of San Francisco Bay: Their Distribution, Abundance, Use, Public Access, and Recommended Management Alternatives, 1982

Milnes, Terry, The Ultimate Bay Book: The Discovery and Delights of San Francisco Bay, 1979

National Marine Fisheries Service, A Study to Determine the Export and Domestic Markets for Currently Underutilized Fish and Shellfish, 1978

National Marine Fisheries Service, Determination of West Coast Groundfish Primary Marketing Channels, 1982

National Marine Fisheries Service, Fisheries of the United States-1983, 1984

National Marine Fisheries Service, Seafood Dealers of the Southwest Region, 1984-1985 Editon, 1984

Pacific Fishery Management Council, Draft Pacific Coast Groundfish Plan, 1980

Port of San Francisco, Fisherman's Wharf Action Plan, 1981

San Francisco Bay Conservation and Development Commission, San Francisco Bay Plan, 1979

San Francisco Bay Conservation and Development Commission, San Francisco Waterfront Special Area Plan, 1975

Sausalito, City of, Fishing Industry Report, Memorandum dated October 31, 1978

Sausalito, City of, Revisions of Sausalito's Fishing Industry Report, Memorandum dated January 29, 1979

Sausalito, City of, Sausalito Fishing Industry Report, 1983

Skinner, John E., An Historical Review of the Fish and Wildlife Resources of the San Francisco Bay Area, 1962

State Coastal Conservancy, Commercial Fishing Facilities in California, 1984

Sutton, James, Shellfish Resources of Eastern San Francisco Bay: Distribution, Abundance, Public Access and Use, 1981

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APPENDIX A

FISH LANDED IN SAN FRANCISCO BAY (1984)

FISH	POUNDS
Rockfish or Rockcod (Total all varieties)	14,254,822
Herring, Pacific	8,125,448
Rockfish, Unspecified	6,911,641
Sole, (Total, all varieties)	5,297,525
Sole, Dover	3,731,975
Rockfish, Group Bocaccio/Chilipepper	3,587,354
Anchovy, Northern	1,185,437
Tuna, Albacore	1,619,170
Sablefish	1,529,628
Salmon, Chinook (King)	1,476,802
Rockfish, Widow	1,444,812
Lingcod	1,234,084
Rockfish, Bocaccio	852,390
Rockfish, Group Red	693,341
Sole, English	657,685
Thornyhead	531,840
Rockfish, Group Rosefish	459,569
Croaker, White	426,301
Swordfish	381,898
Sole, Petrale	368,007
Flounder, Starry	337,154
Sole, Rex	317,546
Halibut	305,405
Sanddab	203,403
Salmon, Coho (Silver)	183,105
Sole, Sand	110,068

Sole, Fantail	95,474
Rockfish, Yellowtail	74,267
Shark, Unspecified	71,827
Shark, Common Thresher	70,836
Rockfish, Goup Bolina	68,138
Rockfish, Brown	64,548
Unspecified	53,047
Skate, Total	52,591
Surfperch	42,943
Mackeral	35,616
Rockfish, Group Small Reds	33,985
Shark, Leopard	32,299
Yellowtail	32,281
Shark, Soupfin	32,060
Flounder, Unspecified	31,069
Salmon	20,451
Rockfish, Chilipepper	19,165
Rockfish, Blue	16,164
Smelt, Whitebait	14,213
Opah	13,154
Rockfish, Black	12,097
Cabezon	11,954
Rockfish, Canary	11,125
Sole, Rock	10,440
Smelt, Surf	7,754
Shark, Brown smoothhound	5,662
Shark, White	5,501

Shark, Bonito	5,437
Hake, Pacific	5,423
Smelt, True	4,537
Sole, Unspecified	4,305
Shark, Bigeye Thresher	4,233
Shark, Pacific Angel	4,214
Rockfish, China	4,112
Flounder, Arrowtooth	3,885
Turbot	3,125
Sole, Butter	2,025
Tuna, Total	1,725
Rockfish, Whitebelly	1,165
Bonita, Pacific	1,024
Louvar	1,023
Silversides	987
Butterfish, Pacific	949
Jacksmelt	882
Seabass, White	607
Sheephead, California	647
Shark, Cow	566
Shark, Spiny Dogfish	515
Rockfish, Pacific Ocean Perch	352
Rockfish, Yelloweye	307
Shark, Gray Smoothhound	268
Grenadiers	204
Wolf-eel	196
Rockfish, Gopher	157

Eel	118
Rockfish, Shortbelly	115
Tomcod, Pacific	111
Smelt, Night	100
Ray, Bat	71
Greenling, Kelp	35
Bass, Giant Sea	35
Rockfish, Cowpod	18
Shark, Sevengill	14
Shark, Sixgill	13
Scorpionfish	10
Barracuda	5

OTHER

Crab, Dungeness	626,594
Squid, Market	213,769
Abalone, Red	52,957
Crab, Rock	36,700
Shrimp, Pacific Ocean	10,657
Urchins	8,768
Mussel	6,567
Snail, Sea	5,559
Octopus	3,801
Clam, unspecified	2,650
Crab, Box	535
Clam, California Jackknife	471
Shrimp Ghost	461

Lobster, California Spiny	283
Limpet	120
Squid, Jumbo	77
Abalone, Pinto	73
Abalone, Black	52

APPENDIX B

DESCRIPTION OF FISH LANDED IN SAN FRANCISCO BAY

(Fish landed in quantities of 10,000 pounds or more in 1984)

Source: Marine Food and Game Fishes of California

Anchovy, Northern (Engraulis mordax)

Small, slim fish with very large mouth; rarely longer than seven inches long; rarely lives longer than two to three years. Mature at one year and 4-1/2 to 5 inches. Fish swim in schools; adults remain further offshore and go deep (400 to 600 feet) during daylight. Spawn year round in the open ocean. Filter feeders, eating mostly crustaceans and other tiny organisms. Are eaten by every fish-eater that swims in or flies over the ocean.

Fish were canned for human consumption and pet food and processed into fish meal and oil. Thousands of tons are netted each year for use as live bait.

Cabezon (Scorpaenichthys marmoratus)

Member of the sculpin family; with smooth scaleless wrinkled-looking skin. Mature at two (males) and three (females) years and 13-1/2 and 17-1/2 inches long. Spawn in the same rocky areas every year in "community nesting sites;" males guard "nests" until eggs hatch. Young are pelagic; when two inches long, move onshore and live in rocky habitat from intertidal area to depths of 250 feet. Feed on crab, mollusks, and small fish.

Cabezon is marketed fresh; the flesh is bluish-green raw and turns white when cooked.

Croaker, White

Closely related to the white sea bass (drum family); oblong fish with spines on dorsal fin. Mature at three to four years. Spawn late spring through summer. Adults prefer depths of 75 to 150 feet. A 40 pound fish may be 20 years old. Feed on small fish and squid.

Usually marketed as steaks or fillets.

Flounder, Starry (Platichthys stellatus)

Flatfish with all fins striped with black, and rough scales. Grow to two feet long and six to seven pounds. Can live to 15 years. Mature at two to three years and 14-1/2 to 16-1/2 inches. Spawn November through February. Live over mud, sand, or gravel bottom areas, and most abundant in shallow coastal waters, including bays, sloughs and estuaries. Have been caught offshore in depths of 1,000 feet. Feed on eat worms, crustaceans, clams, and small fish.

The commercial catch is made almost entirely with trawl nets and is usually filleted and sold fresh. No commercial fishing in the Bay.

Halibut (Paralichthys californicus)

A large flatfish with a large mouth, sharp teeth, and a high arch in the lateral line above the pectoral fin; brown on top, white on the bottom. Usually found on sandy bottoms in water shallower than 120 feet. Mature at three to five years; a five year old fish is usually 15 inches long but can grow to 50 inches and 50 pounds. Spawn in shallow waters February to July. Feed on small fish, particularly anchovies.

Most habibut is sold in fillets; flesh is white and very mild.

Herring, Pacific (Clupea haregus pallasi)

A small, elongated fish which matures at about two years of age and about 10 inches long. A schooling species, herring come into the Bay to spawn December to March. Filter feeders.

The fish and the eggs are food for birds, fish, and sea lions. The fish are caught largely for the roe which is shipped to Japan. Season: December - March.

Lingcod (Ophiodon elongatus)

Moderate sized, elongated fish with long dorsal fin with spines; color is dark grayish-blue to greenish-brown with blotches and mottling. Adults live near rocky bottoms at depths shallower than 350 feet. Adults mature at three years and 26 inches and about four pounds. Spawn December to March. Eggs attach to rocky substrate, males guard "nest" until eggs hatch. Feed on small fish.

Lingcod sold fresh as steaks and fillet. Flesh is greenish but turns white when cooked.

Mackerel (Scomber japonicus)

Elongate body with widely separated fins. Schooling fish found from Mexico to Alaska. Year-round resident of West Coast waters. Mature at two to three years. Spawn March to May. Live to 12 years, up to 18 inches and two pounds. Feed on small fish and squid.

Opah (Lampris regius)

A disk-shaped body with white spots and crimson fins whih can grown to 160 pounds and 4-1/2 feet long. Feed on other medium sized fish.

Often caught by tuna fishermen, the salmon colored flesh is tastey but dry when cooked.

Rockfish or Rockcod As a group, the largest Bay Area catch in 1984 (14 million pounds). Includes bocaccio, chilipepper, Red, and Rose; all are marketed as Red Snapper.

Bocaccio (Sebastes paucispinis) An oblong olive-brown fish with no spines on the head and a long upper jaw. Juveniles found in shallow waters just outside surf zone. Adults found in 250-750 foot depths where bottom is firm sandy-mud, rubble, or solid rock. Mature at 4 years old and 14 to 16 inches long. Spawn December - April. Feed on small fish and crustaceans.

Sablefish (Anopolopoma fimbria)

Medium sized, elongated fish; black or gray on top, lighter below. Adults live on the bottom over areas of firm mud in deep water (1,000 feet). Mature at five years to six and 24 inches, about 4 to 6-1/2 pounds. A 20-year fish will be 30 pounds and 40 to 42 inches. Spawn late winter to early spring in deep water. Feed on fish, squid, octupi, and small bottom organisms.

The flesh is fine grained and very oily. Marketed as "butterfish fillets" or sold as smoked Alaskan cod.

Salmon, King or Chinook (Oncorhynchus tshawytscha)

Medium sized oblong fish, adults have small black spots on upper body. Salmon are pelagic schooling fish; school is 100 or less. Average ocean caught salmon is 10 pounds; spawner is about 20 pounds. Males usually spawn at three or four; die after spawning run up the Sacramento River. Young migrate downstream, tail first, at night. Fish often travel hundreds of miles before they return to the home stream to spawn two to seven years later. Feed on small fish, squid, and larval crabs.

Commercial fishermen catch salmon on lines. Ocean caught fish are superior in quality, flavor, and condition to river-caught fish. Chinook is used almost exclusively fresh.

Sanddab, Pacific (Citharichthys sordidus)

A small mouthed, left-eyed flatfish. Mature at three years and 7-1/2 inches long, but grow to 12 inches long, weighing 12 ounces. Live on the bottom over firm sand or sandy mud, usually at depths of 120 to 300 feet. Spawn July to September. Feed on a variety of small fish, crustaceans, and worms.

Sanddabs are often prepared by removing head, fins, tail, and scales, then deep frying.

Shrimp, Ocean (Pandalus jordani)

Usually live to age three; mature at 18 to 30 months old. Spawn in November and December. The young start out as males and change to females at about two years. Found over green mud or green mud and sand. Tend to school in localized areas or "shrimp beds." Ocean shrimps eat worms, porifera, diatoms, and appendages of isopods and amphipods.

Smelt (Osmeridae - Smelt Family)

Small elongated fish with white body. Grow no longer than six inches. May live to three years old. Gather in large schools and spawn in the surf at night, January through September. Prefer beaches with coarse and gravelly sand. Feed on small crustaceans and are eaten by just about every fish-eating bird, seal, and fish.

Smelt are often used for food for animals in aquariums and are excellent for eating, crisp-fried.

Sole There are eight species of sole landed in San Francisco Bay, a total of over 5 million pounds in 1984. All are marketed as fillet of sole. Dover sole is most common.

Sole, Dover (Microstomus pacificus)

A member of the righteye flounder family, the Dover sole is distinguished by the abundance of slime it secretes making it very slippery to handle. Mature at five years old and 12 inches long; maximum size is 10 pounds and two feet long. Spawn in deep water from November to March. After spawning, adults migrate to shallower waters. Live over mud bottoms at depths ranging from 100 feet to 3,000 feet. Feed on worms and other soft bodied invertebrates.

Catch is marketed as fresh or frozen fillets.

Surfperch (Amphistichus)

Stubby, oblong-shaped fish, sides are bronze, brassy, or gold bars and spots against a whitish background. Live to seven to nine years old and to 16 inches. Mate in fall and early winter, females give birth to live young March to July. Average "litter" is 45 young. Live in the breaking surf along sandy beaches and offshore waters. Feed on sand crabs and other small crustaceans.

Swordfish (Xiphias gladius)

Large scaleless fish with long flattened sword. Usually found June to September south of Point Conception but may come as far north as Oregon, depending on water temperature. Closest spawning area is Marquesas Islands. Range from six to 14 feet long and 38 to 1,200 pounds. Eat largely anchovies and squid, also small fish.

Very popular fish, often sole in steaks.

Tuna, Albacore (Thunnus alalunga)

Oblong fish with long pectoral fins. Mature at about 36 inches long. Spawn in mid-Pacific between January and June. Seasonally migrate to California coast. Prefer warm water but have been taken in Alaska. Travel large circle from California to Japan. Eat small fish, squid, and shrimplike organisms. Gains six to eight pounds per year for first six to seven years, thus six year old fish would be 40 inches to fork of tail and about 45 pounds.

Historically canned but with recent closure of last California tuna cannery, now marketed as fresh steaks.

Yellowtail (Seriola dorsalis)

Oblong fish of the Jack family. Schooling fish, ranges north to Monterey Bay. Usually found close to shore. Largest fish are up to five feet and over 90 pounds. Spawn at two to three years and 10 pounds. Spawn June to October, off Baja California. Eat small fish and squid.

Most yellowtail is marketed fresh.

APPENDIX C

BAY AREA SHELLFISH BEDS

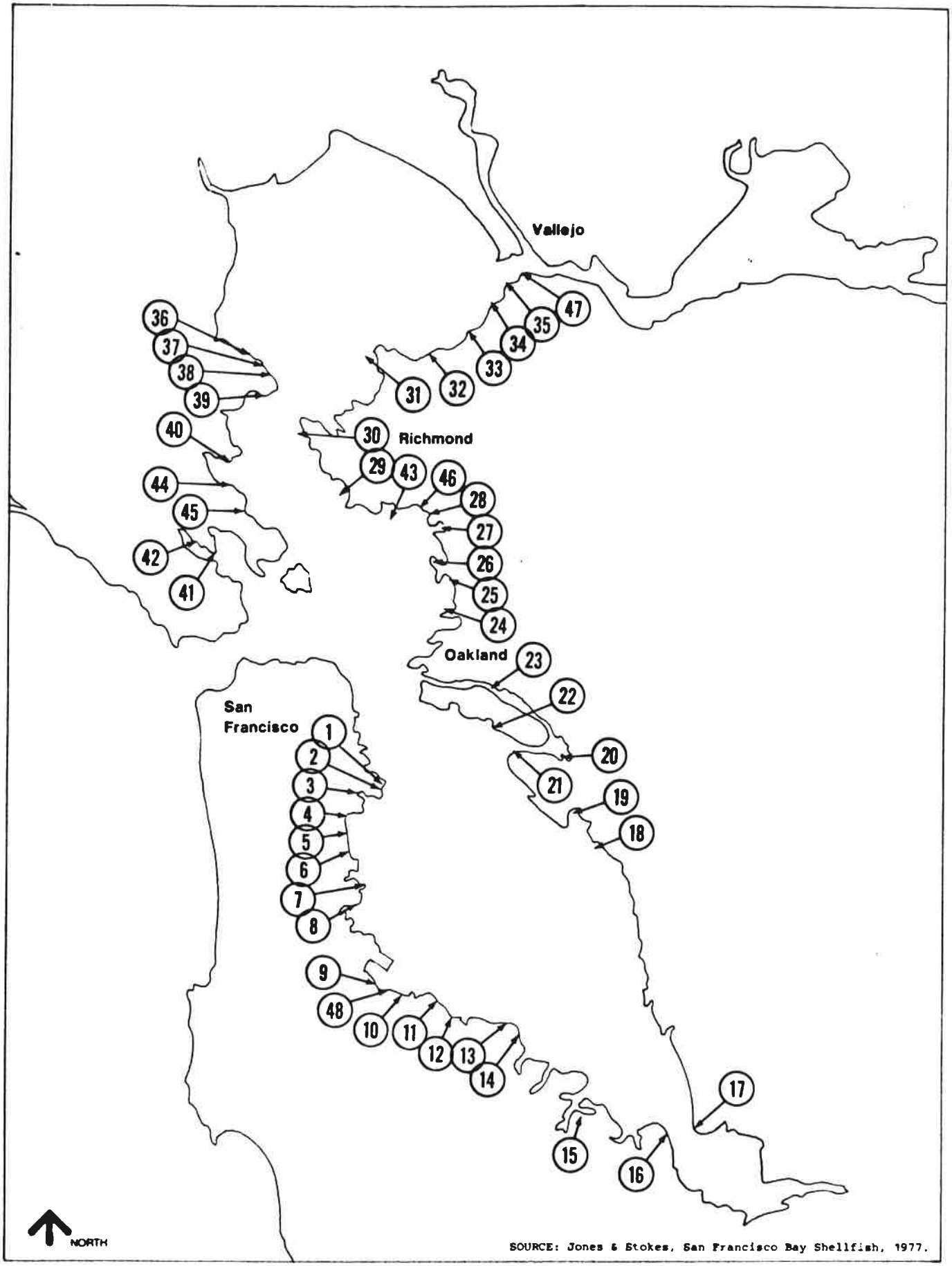
APPENDIX C

Bay Area Shellfish Beds

Bed Number	Location	Area (sf)	Number of Adult Clams: Mya	Tapes	Source
1	Candlestick Point	500	0	500	Wooster
2	NE of Bayview Park	176	264	176	Wooster
3	Bayview Park	19,000	57,024	38,016	Wooster
4	East of Bayshore	1,500	1,500	0	Wooster
5	East of Visitacion Valley	15,450	0	41,715	Wooster
6	East of Brisbane	5,410	104	2,750	Wooster
7	Oyster Point	600	0	23,000	Wooster
8	South of Pt San Bruno	17,880	38,640	22,880	Wooster
9	Burlingame	249,984	664,138	312,276	Wooster
10	North of Coyote Pt	102,600	10,800	700,600	Wooster
11	South of Coyote Pt	78,000	0	78,000	Wooster
12	San Mateo Creek	unk	unk	unk	Dahlstrom
13	North of San Mateo Bridge	1,200	13,200	0	Wooster
14	Foster City	1,106,424	0	9,913,000	Dahlstrom
15	Redwood Creek	18,000	9,000	594	Wooster
16	West end Dumbarton Bridge	1,872	3,744	11,232	Wooster
17	East end Dumbarton Bridge	7,152	11,904	44,106	Wooster
18	San Leandro Marina	41,400	318,780	0	Wooster

19	Oakland Airport	84,000	10,080	20,160	Wooster
20	San Leandro Bay	100,800	705,600	383,040	Wooster
21	SW Corner of Alameda Island	7,200	21,600	79,200	Wooster
22	Alameda Memorial State Beach	17,357	1,000	116,910	Wooster
23	Oakland Inner Harbor	39,000	0	507,000	Wooster
24	Emeryville	1,600	4,800	1,600	Wooster
25	Berkeley, Bancroft Way	22,800	48,600	42,960	Wooster
26	Berkeley, University Ave	800	8,000	0	Wooster
27	Albany Hill	3,780,000	12,096,000	0	Wooster
28	Point Isabel	1,104	15,456	1,104	Wooster
29	Point Richmond	200,000	0	850,000	Jones & Stokes
30	Castro Point to Point San Pablo	128,400	64,800	49,200	Wooster
31	Point Pinole	0	0	unk	RWQCB
32	Tara Hills	48,000	326,400	0	Wooster
33	Tara Hills to Pinole	61,500	86,100	0	Wooster
34	Pinole	60,032	792,422	0	Wooster
35	Rodeo	5,000	40,000	0	Wooster
36	South of Gallinas Creek	2,328	15,132	0	Wooster
37	Between Gallinas Creek and Rat Rock	1,120	16,800	0	Wooster
38	Rat Rock Area	2,000	16,000	0	Wooster
39	San Rafael Bay	25,000	260,000	50,000	Wooster

40	San Quentin	9,600	201,600	0	Wooster
41	West Side of Strawberry Point	28,800	31,680	54,720	Wooster
42	Richardson Bay	12,000	54,000	6,000	Wooster
43	Brooks Island	unk	unk	unk	Jones & Stokes
44	Paradise Cay, Northside	150,000	1,000,000	unk	McAllister
45	Pardise Cay, Southside	1,800	7,000	12,600	McAllister
46	Point Isabel	unk	20,000	30,000	Wooster
47	Rodeo Marina	Small	2,000	unk	Wooster
48	Anza Lagoon	unk	330,000	20,000	RWQCB



San Francisco Bay Conservation and Development Commission

Bay Area Shellfish Beds