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CURRENT STATUS OF THE CALIFORNIA OYSTER INDUSTRY

by

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ABSTRACT

The oyster culture operation in Moro Bay is typical of the United States Pacific Coast *Crassostrea gigas* mariculture industry. Of this Bay's 1,000 hectares of marshes, tidelands and channels 400 hectares have been alloted by the State of California for private oyster cultivation. Approximately 180 hectares of this allotment are suitable for bottom and stake culture on a three-year growing cycle. Each year this 60 hectares is planted with cultch shell at the rate of 60 cases of cultch per hectare. Each case contains an average of 1,000 cultch shells with 10 oyster spat per shell. A typical survival rate of 30% yields, 3,000 liters of oyster meat per hectare after 36 months of growth.

The history of the California oyster industry and the start of mariculture in the state began in San Francisco following the discovery of gold. Along with the quest to strike it rich, the easterners also brought an appetite for their east coast favorite, the eastern oyster, *Crassostrea virginica*. BARRETT (1963) reported that attempts were first made to bring this eastern species to San Francisco both fresh and preserved, but evidently the few successful shipments could not satisfy the California market. In the 1850's the native Pacific oyster, *Ostrea lurida* was shipped from Shoalwater Bay (now Willapa), Washington, to San Francisco (BARRETT 1963). This Shoalwater source supplied the greatest part of the San Francisco market, yet a number of other locations in Oregon (Yaquina and Netart's Bays) and Washington's Puget Sound were harvested (HITTELL 1882). BARRETT (1963) indicates that while the oysters were initially sold wholesale and retail, the industry, with its increased size, began organizing and started the practice of holding oysters on suitable mudflats in San Francisco Bay until needed.

The completion of the transcontinental railroad linking San Francisco to the east coast marked a time of change in the Pacific coast oyster industry (BARRETT 1963). BARRETT (1963) reported that eastern oysters were immediately imported and soon the Washington source became insignificant. This involved, in addition to adults, the importation of baby (seed) oysters, and marked the beginning of relatively independent oyster production. At

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this period BARRETT (1963) reports that the major drawback to sustained mariculture was the inability of the introduced oysters to reproduce in California waters, resulting in a continued need for seed oysters.

BARRETT (1963) indicates that this seed mariculture was quite profitable in San Francisco in 1875, and continued to be so past the turn of the century at which time a noticeable decline began. There has been speculation that reports of pollution (EBERT 1973, FREY 1971) and consequent fear of contaminated oysters played a part in this period of decline, but eventually oysters failed to mature and survive in the Bay (BARRETT 1963). The importation of mature eastern oysters increased as did the imports from Washington (BARRETT 1963).

While San Francisco was the center of the organized oyster industry, San Diego, Tomales and Humboldt Bays were approached with varying degrees of success. San Diego Bay was proposed as a location to be involved in the importation of Mexican oysters (BARRETT 1963). The idea was to use the bay for freshening Mexican oysters on their way up to San Francisco (INGERSOLL 1881). TOWNSEND (1893) reported an attempt at raising easterns in San Diego Bay but apparently with no success. Tomales Bay was first used for rearing eastern oysters in 1875 (TOWNSEND 1893) but this effort ceased until the decline of the San Francisco Bay industry (BARRETT 1963). The early industry at Tomales Bay involved seed and full-grown eastern oysters as well as native Olympic oysters *(Ostrea lurida)* from Washington (BARRETT 1963). Humboldt Bay's early encounters with the culture of oysters fell to failure. In the late 19th century the U.S. Bureau of Fisheries made an unsuccessful attempt at raising oysters and later in the early 1900's the oysters translocated from the failing San Francisco beds met with similar lack of success (BARRETT 1963).

In 1902 the Pacific oyster, *Crassostrea gigas* was introduced to the waters of Washington (GALTSOFF 1932) from Japan, and in 1905 commercial mariculture of this species began (BARRETT 1963). Due to lower costs, lower mortalities, and fine success in its growth, the Pacific oyster has become the principle species of the west coast oyster industry in the U.S. (BARRETT 1963). It was not, however, until the late 1920's and early 1930's that commercial interest in the Pacific oyster in California got started (BONNOT 1935, BARRETT 1963, FREY 1971, EBERT 1973). The Tomales Bay Oyster Company made the initial experimental plantings in 1928 (BARRETT 1963) and in 1929 plantings of seed were made in Elkhorn Slough (BONNOT 1935). The major factor hampering the industry was the dependence on seed oyster imports as *Crassostrea gigas,* like *C. virginica,* does not successfully reproduce in the cold California waters (BARRETT 1963, FREY 1971). As a conse-

quence, up until 1957 the California oystermen were totally dependent on Japanese sources of seed oysters (BARRETT 1963, DAHLSTROM 1975). Since then natural seed and hatcheries in Washington have supplied an increasing amount of the California needs (EBERT 1973, DAHLSTROM 1975). Seed has likewise been imported from British Columbia in past years (DAHLSTROM 1975). EBERT (1973) also reported that hatcheries have developed both at Pidgeon Point (Pacific Mariculture, Inc.) and at Moss Landing — Elkhorn Slough (International Shellfish Enterprises), the latter being in the pilot stage (DAHLSTROM pers. comm., 1976). These hatcheries hold a potential for supplying an increasing proportion of the California needs.

In Southern California commercial oyster operations were attempted at Newport Bay, Mugu Lagoon, and Anaheim Slough in 1932 (BONNOT 1935), but none of these were financially successful (BARRETT 1963). BARRETT (1963) reported that no recent attempts have been made to commercially culture Pacific oysters in either Mission or San Diego Bays due to the polluted conditions, and efforts undertaken at Catalina Harbor on Santa Catalina Island and at Point Loma in San Diego County apparently proved a failure.

Oysters planted in Elkhorn Slough in 1929 were unsuccessful (BONNOT 1935), but good growth rates were obtained from plantings made in the 1930's (BARRETT 1963). These oysters, planted by the West Coast Oyster Farms, Ltd. were in both bottom and hanging culture. No justification was given for the 1929 failure, but the 1930's results were attributed to the relatively warm waters of the slough (BARRETT 1963). The oysters were abandoned after World War II, and in 1966 the deteriorated water quality forced public health closure (BROWNING 1972, KATKANSKY & WARNER 1974).

The history of the *Crassostrea gigas* industry in San Francisco Bay was begun in 1933 by the Consolidated Oyster Company. This effort was unsuccessful and by 1939 the venture ceased (BARRETT 1963). Today pollution prevents use of the bay for growing shellfish (FREY 1971).

Bolinas Lagoon was involved in a short-lived attempt by the Charles Johnson Oyster Company to establish a successful allotment in the upper portion of the lagoon. Rapid growth rates were observed, but a Public Health Department ordinance required transplantation of oysters to another area for "purging". This task of transplanting the stocks to the Johnson operations in Drakes Estero prooved economically unfeasible and the allotment was abandoned (BARRETT 1963, GIGUERE 1970).

A number of plantings were made in Bodega Harbor (BONNOT 1938) but because the area lacks certification due to pollution (FREY 1971) no commercial culture has been established there.

Today commercial oyster cultivation is found in Humboldt, Tomales and Morro Bays and in Drakes Estero (Fig. 1, 2, 3 and 4) and Encina Lagoon (FREY 1971, EBERT 1973). The Encina Lagoon operations involves a pilot project of Marine Futures using the heated effluent from a power plant for cultivation of Pacific oyster (EBERT 1973). In addition, commercial hatcheries are in operation at Pidgeon Point, (Santa Cruz) and Moss Landing - Elkhorn Slough (EBERT 1973, DAHLSTROM 1976, pers. comm.).

Humboldt Bay was not a part of the initial Pacific oyster cultivation (BARRETT 1963). The California Division of Fish and Game was attempting the development of an *Ostrea lurida* industry in the bay, and *Crassostrea gigas* was prohibited from the bay (BARRETT 1963, MONROE 1973). The ban was lifted and C *gigas* cultivation was begun (Fig. 1) in 1953 in northern Humboldt or Arcata Bay (BARRETT 1963). Coast Oyster Company initiated this commercial operation and is presently the only company working the area. This commercial culture is the largest oyster producer in the state (Table I). Present cultivation is on an estimated 2,900 acres of county, city and private land (DAHLSTROM 1976, pers. comm.). Bottom culture methods are employed in about ninety-five percent of the cultivation, the remainder is in hanging culture, suspended off the bottom from wooden floats (DAHLSTROM 1976, pers. comm.).

Tomales Bay (Fig. 2) has had a long history of Pacific, eastern and native (Olympia) oyster commercial cultivation (BARRETT 1963). Currently, *Crassostrea gigas* is the most important commercially, but both the Tomales Bay Oyster Company (FREY 1971, EBERTS 1973) and the Frank Spenger Company (EBERT 1973; DAHLSTROM 1976, pers. comm.) hold mature eastern oysters for the "half shell" market. The 40 acre Tomales Bay Oyster Company's *Crassostrea gigas* operation located above Millerton Point (Fig. 2) is about ninety percent hanging and ten percent bottom culture (DAHLSTROM 1976, pers. comm.). The half acre bottom culture Frank Spenger operation at Sacramento Landing (Fig. 2) produces for their nearby restaurants (DAHLSTROM 1976, pers. comm.).

The Hamlet Oyster Beds operations have been in commercial production since 1939 (BARRETT 1963). These operations are strictly bottom culture (EBERT 1973; DAHLSTROM 1976, pers. comm.) and are located on an 89 acre state allotment (Fig. 2) (DAHLSTROM 1976, pers. comm.). The Buchan Oyster Company farms a 260 acre allotment in the Vincent Landing (Fig. 2) area with approximately seventy percent rack cultivation, the remainder being bottom culture. Bordering the Buchan area to the South is the 116 acre stake culture farmed by the Ben Johnson firm (DAHLSTROM 1976, pers. comm.).

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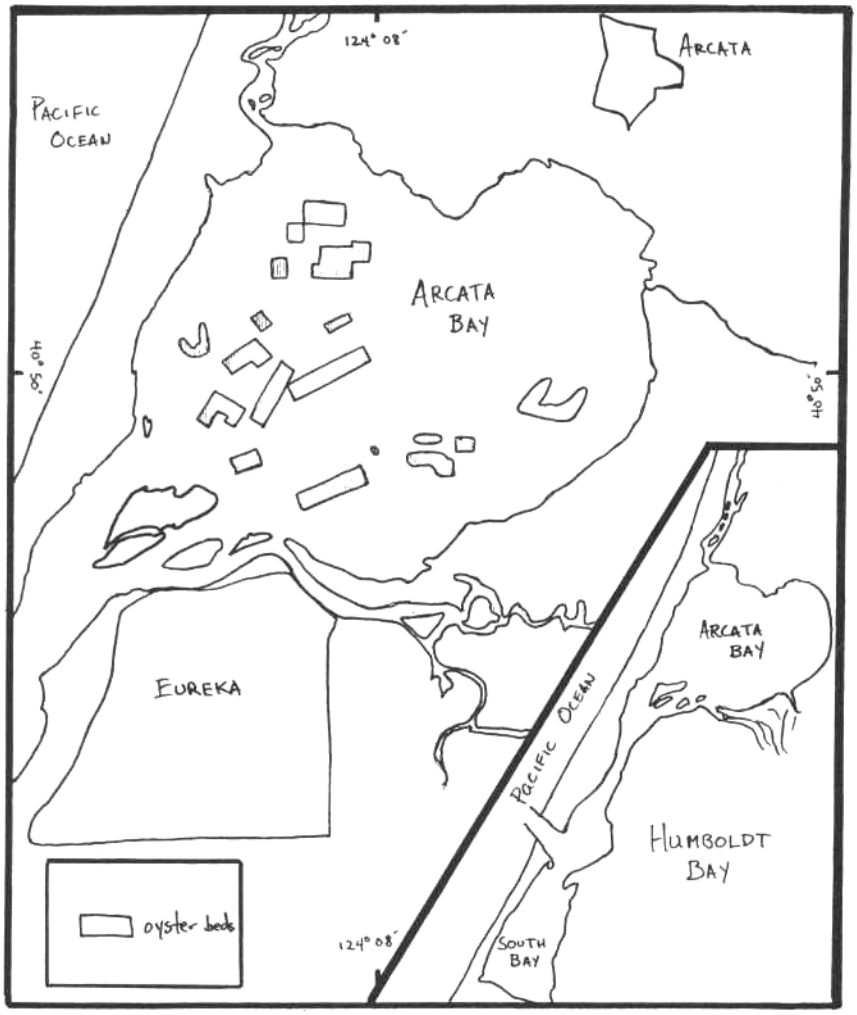

Figure 1. Humboldt Bay Oyster Cultivation, (modified from Katkansky and Warner, 1974; Monroe, 1973).

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TABLE I. Yearly California Oyster Production and Market Value 1964 — 1974*

Year	Humboldt Bay		Tomales Bay (eastern below)		Drakes Estero		Morro Bay		Total **	
	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$
1964	894,512	161,012	30,602	5,508	172,338	31,020	243,483	43,826	1,359,647	253,163
			4,910	10,277						
1965	687,092	158,031	34,891	8,025	152,117	34,987	174,846	40,215	1,062,792	263,440
			7,982	20,833						
1966	535,908	123,529	35,737	8,220	185,840	42,743	28,039	6,449	800,427	221,979
			12,925	40,584						
1967	454,641	105,704	33,073	7,690	152,620	35,484	89,097	20,715	742,141	207,274
			12,710	37,681						
1968	365,180	84,904	20,906	4,861	118,272	27,498	140,730	32,720	661,719	197,911
			16,166	47,928						
1969	350,757	81,551	24,132	5,610	198,712	46,201	122,492	28,479	713,045	212,099
			16,952	50,258						
1970	663,455	597,109	25,975	23,378	193,160	173,844	219,987	197,988	1,119,484	1,041,695
			16,745	49,230						
1971	692,515	602,488	29,030	25,255	169,355	147,339	74,074	64,444	978,826	880,251
			13,852	40,725						
1972	751,832	654,094	21,541	18,740	74,014	64,392	28,586	24,870	885,155	788,773
			9,028	26,543						
1973	567,557	652,691	16,928	19,467	128,035	147,240	13,207	8,188	727,057	831,604
			1,148	4,018						
1974	478,633						101,282		770,646	
			2,177							

* California Fish and Game reports of California Marine Catch (or Landings) 1964 — 1973. And, MCALLISTER, 1975.

** Includes landings for Elkhorn Slough: 1964, 8449 lbs.; 1965, 5864 lbs.; 1966, 1978 lbs., and for San Diego: 1972, 154 lbs.

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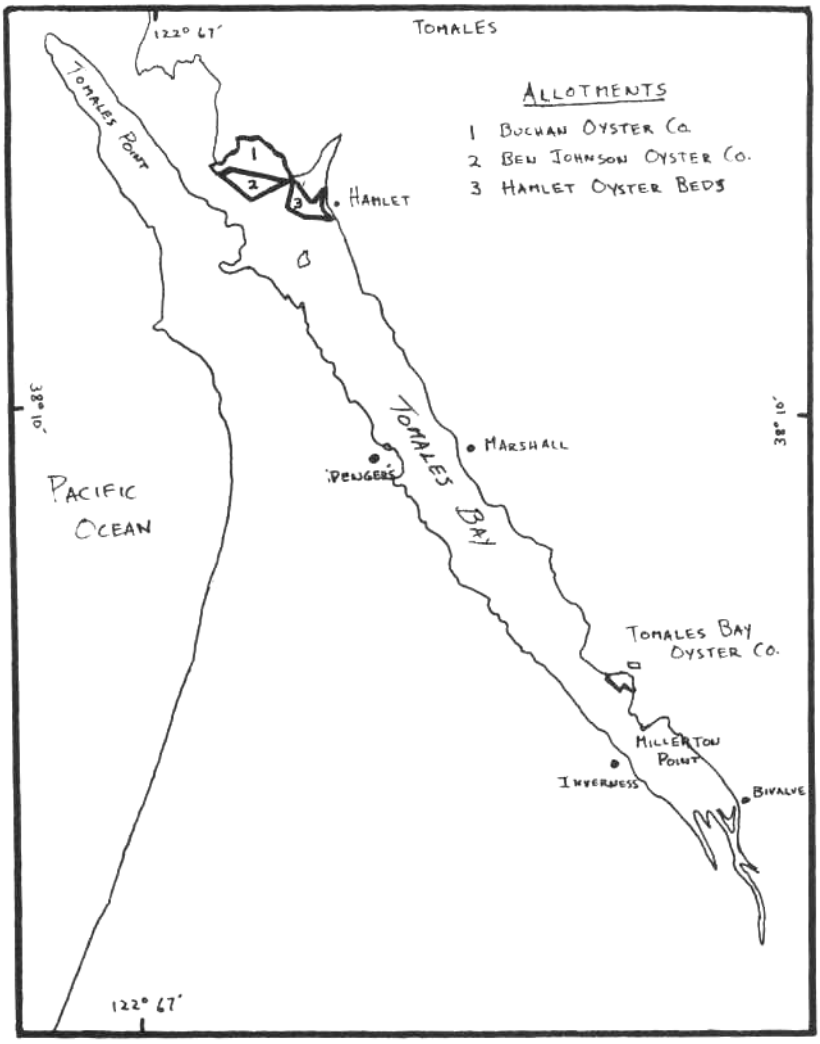

Figure 2. Tomales Bay Oyster Cultivation (modified from Katkansky and Warner 1974; Dahlstrom 1976, pers. comm.).

Pacific oyster culture in Drakes Estero (Fig. 3) has been successful since the mid 1930's (BARRETT 1963). Currently the Charles Johnson Oyster Company has both state allotments for a total culture area of about 1,000 acres (DAHLSTROM 1976, pers. comm.). The methods are approximately ninety percent hanging and ten percent bottom culture (DAHLSTROM 1976, pers. comm.).

The last significant Pacific oyster growing area in the state is in Morro Bay (Fig. 4). Interest in Morro Bay for oyster culture began in 1932 and during the war years Morro Bay was the state's largest producer (BARRETT 1963). Presently the J.R. Johnson Morro Bay Oyster Company is the only producer in the bay. The acreage used is comprised of an 846 acre state allotment (GERDES *et.al* 1974) and sixty acres of city land (DAHLSTROM 1976, pers. comm.). Operations in Morro Bay have historically been concerned only with bottom culturing, but presently experimental stake culture is being conducted.

The following gives an indication of the production figures in present day oyster cultivation. Our observations in Morro Bay, based on planting of seed oysters from a variety of sources, have shown spat counts usually ranging from eight to twenty per shell (cultch) and averaging around ten. The seed oysters are received in case units generally with 800 to 1200 cultch per case; most growers planting about twenty-five cases per acre of bottom. Following a growing period of eighteen to thirty-six months the average harvest per case of planted seeds is ten to twenty gallons of adult shelled oysters. Due to lower predation Morro Bay produces an average of from twenty-five to thirty gallons of oysters per seed case. Experimental results (BLAYLOCK& FAIRFAX 1975, unpublished report) indicate higher production rates yet are possible for bottom cultivation in Morro Bay. The shelled oysters are marketed in gallons containing 100 to 120 oysters and in 10 ounce jars containing five to eight oysters. Using average figures from Morro Bay, of the ten thousand seed oysters per case planted only around three thousand (30%) survive to harvest.

Production for the past decade in California has averaged around one million pounds of meat per year (Table I, Fig. 5) while the value of harvests has risen considerably (Table I, Fig. 6) in the 1970's, decline in production has been evident not only in California, but also in Oregon (DEMORY 1975, pers. comm.) and Washington (WESTLEY 1975, pers. comm.) (Table II, Fig. 5). The prime factor affecting this decline has been the independable source of Pacific oyster seed in past years (DEMORY & WESTLEY 1975, pers. communications; DAHLSTROM 1976, pers. comm.). Japanese sources are unreliable and now contribute less to the fishery (Table III). Seed from other

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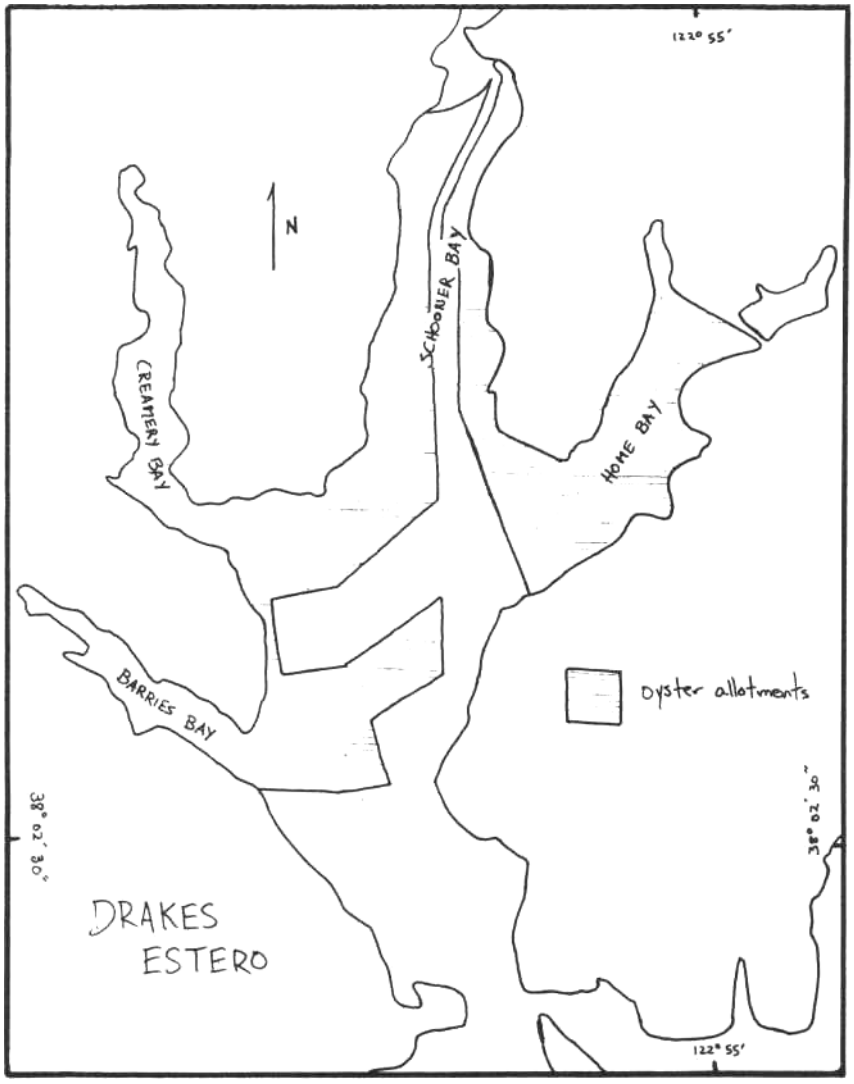

Figure 3. Drakes Estero Oyster Cultivation (modified from Dahlstrom 1976, pers. comm.).

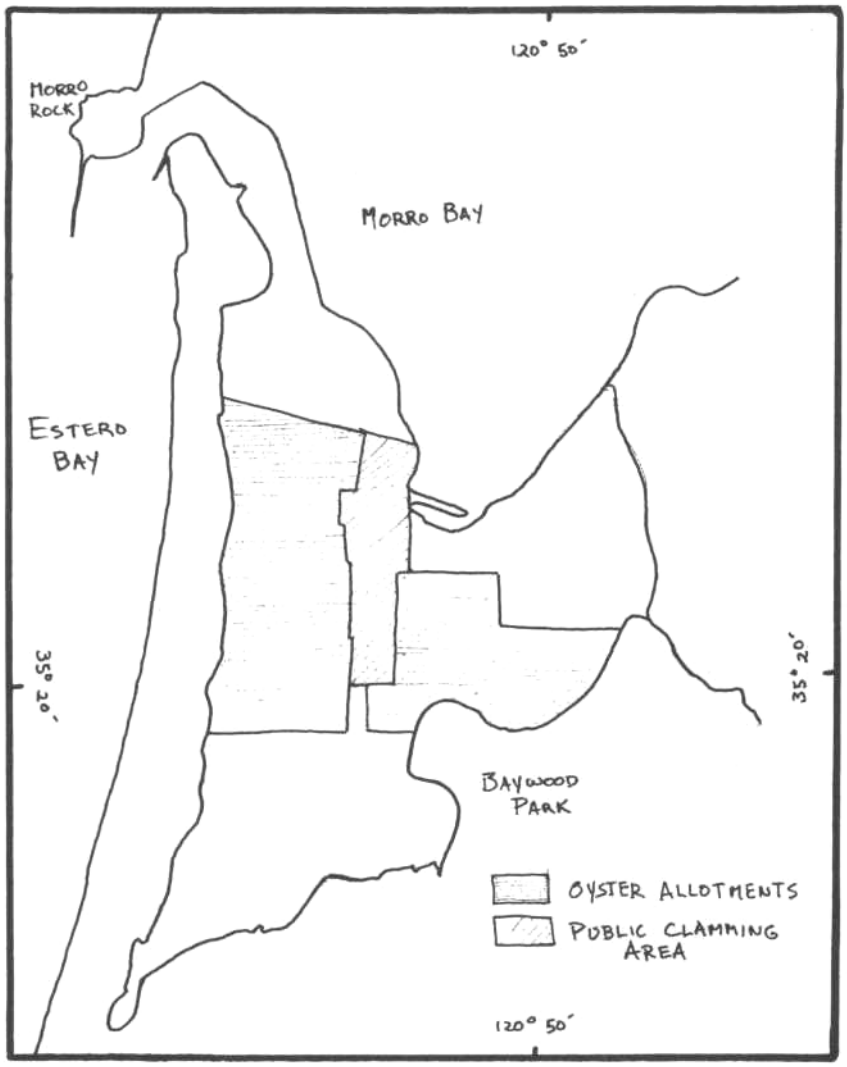

Figure 4. Morro Bay Oyster Cultivation (modified from Gerdes et al 1974; and Katkansky and Warner, 1974).

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TABLE II. Yearly Production From the U.S. Pacific Coast Oyster Industry (in pounds)

Year	California*	Washington**	Oregon +	Total
1964	1,359,647	8,234,396	--	--
1965	1,062,792	7,864,570	--	--
1966	800,427	6,722,750	235,296	7,758,473
1967	742,141	6,490,403	381,728	7,614,272
1968	661,719	6,414,810	573,000	7,649,529
1969	713,045	5,708,373	481,168	6,902,586
1970	1,119,484	6,506,099	307,000	7,932,583
1971	978,826	6,805,168	279,000	8,062,994
1972	885,155	7,309,485	176,000	8,370,640
1973	727,057	5,655,078	198,000	6,580,135
1974	770,646	4,018,840	234,000	5,023,486

* From California Marine Fish Catch (or Landings) 1964 – 1973. Fish Bulletins. California Fish and Game. *And,* McALISTER, 1975.

** From WESTLEY, R. 1975, pers. comm.

\+ From DEMORY, D. 1975 and 1976, pers. comms. No data prior to 1966 available on Oregon oyster production.

Asian countries such as Korea is banned due to disease problems. (DEMORY 1975, pers. comm.). Natural seed production and development of domestic seed hatcheries is increasingly important to the Pacific oyster industry, Washington State seed has been the backbone of the industry in the past few years (DAHLSTROM 1975). British Columbia has also been a source in the past (DAHLSTROM 1975) and has been used in 1976. Commercial quantities of seed from California hatcheries have not been available (EBERT 1973).

California is relatively free of predation problems. Bay ray *(Myliobatis californica)* predation is controlled by fencing with stakes to protect the thinner-shelled young oysters from this pest in problem beds (BARRETT 1963, FREY 1971). Rock crabs *(Cancer antennarius)* and red crabs *(C. productus)* prey on small oysters in some growing areas (BARRETT 1963, FREY 1971). The inspection of all shipments of imported oyster seed and adults by the Department of Fish and Game has been relatively successful in controlling Japanese *Ocenebra japonica* and western Atlantic *Urosalpinx cinepea* oyster drills in the state of California (FREY 1971). Tomales Bay, however, is one location in which oyster drill predation is a significant factor in seed mortality (KATKANSKY & WARNER 1974).

TABLE III. Importation of Pacific Seed Oysters for Planting in California Waters, 1952 – 1975
(standard cases)
(from DAHLSTROM, 1975)

Season	Japan	Origin of Seed Washington	British Columbia
1952 – 53	2,625		
1953 – 54	2,234		
1954 – 55	9,986		
1955 – 56	26,575		
1956 – 57	11,915	5,634	
1957 – 58	13,139	1,617	
1958 – 59	12,460	400	
1959 – 60	7,987		
1960 – 61	9,155		
1961 – 62	8,650		
1962 – 63	11,024		
1963 – 64	10,625		25
1964 – 65	7,627		
1965 – 66	1,180		3,024
1966 – 67	9,328	1,735	
1967 – 68	10,330	2,601	
1968 – 69	11,119	2,164	
1969 – 70	3,184		
1970 – 71	4,851	5,088	
1971 – 72	450	13,252	
1972 – 73		9,520	
1973 – 74	1,330	7,528	
1974 – 75		11,884	

The principle California *Crassostrea gigas* diseases are bacteria, fungi, and protozoans (SNIDERMANN & ROSENFIELD 1967). TAKEUCHI *et. at.* (1960) implicated a gram-negative bacillus in the etiology of mass mortalities of the Pacific oysters from Hiroshima Bay, Japan. Another bacteria is suspected in the "focal necrosis" disease found in seed and adult Pacific oysters on the U.S. west coast (SNIDERMANN & ROSENFIELD 1967).

The fungus *Dermocystidium marinum* has been found to cause emaciation and mortality in Atlantic and Gulf Coast oysters, and has been shown to be transmitable to the Olympia oyster, *Ostrea lurida* (SNIDERMANN & ROSENFIELD 1967). No report has been made of this fungus infecting the Pacific oyster, however.

Minchinia nelsoni, (MSX), a haplosporidan plasmodial parasite caused extensive damage to the east coast industry in the late 1950's. Parasites morphologically quite similar to *M. nelsoni* has been observed in Pacific oysters in Taiwan (SNIDERMANN & ROSENFIELD 1967).

Another parasite found in the Olympia oysters in Washington State and blamed by STEIN *et. al* (1961) is the flagellate protozoan, *Hexamita* sp. This form, while not found in California populations of *Crassostrea gigas,* has been seen in this species from Korea and Taiwan (SNIDERMANN & ROSENFIELD 1967).

Larval trematodes of the genus *Bucephalus* are known to infect oysters (HOPKINS 1954). Prolonged infectations with *Bucephalus* causes a retardation of the growth rate in oysters (MENZEL & HOPKINS 1955 a and b). SNIDERMANN & ROSENFIELD (1967) indicated infection of *Crassostrea gigas* in Taiwan by larval *Bucephalus.*

Prevention of introduction of exotic parasites is a concern of the industry. *Mytilicola orientalis,* a copepod parasitic on Pacific oysters is an example of a parasite introduced to California via seed imports. CHEW *et. al.* (1965) and KATKANSKY *et. al.* (1967) reported that infection with this parasite reduced the condition of the oysters. KATKANSKY & WARNER (1974) however, indicate that this parasite is non-pathogenic and not a factor in mortalities in the Pacific oysters of Morro Bay, Elkhorn Slough, Drakes Estero, and Tomales Bay, although infestation in their studies ran from five to forty percent of the oysters sampled.

KATKANSKY & WARNER (1974) indicated the mortalities at Morro Bay, Elkhorn Slough and Drakes Estero to be quite low (0-14%) according to experimental studies conducted in the locations. Tomales Bay mortalities (7.6-35.7%) were relatively low compared with the figures from Humboldt Bay in the study, and were not considered excessive. A variety of non-pathogenic parasites were observed in these studies however, including *Mytilicola orientalis* an endoparasitic copepod, ancistrocomid ciliates, the peritrichous ciliate *Trichodina,* and encysted cestode plerocercoids similar to *Echeneibothrium.* Cross infection with "microcell disease" did not occur in Pacific oysters held in proximity to infected European oysters (KATKANSKY & WARNER 1974).

Humboldt Bay Pacific oyster mortalities (averaging 30-40% and reaching 56.4%) are more severe than other areas studied by KATKANSKY & WARNER (1974). This report makes speculations implicating the high mortalities with "inclusion cells", high water temperatures, and/or bacterial diseases. While the causes of high mortalities in Humboldt Bay are yet

uncertain, interest in minimizing the mortality figures has become an important concern of the industry throughout the state.

Obtaining higher survival figures for planted seed oysters, in an economically feasible manner, is being approached in a number of ways. Disease resistant varieties of oysters have been found (FREY 1971). EBERT (1973) and KATKANSKY & WARNER (1974) suggests selective breeding of mortality resistant adults in the hatchery is a feasible method of improving the basic stock. KATKANSKY & WARNER (1974) studied the differential mortalities exhibited by seed from various import sources in order to determine the more successful types. Their findings showed significant differences among seed sources.

Inovative methods of cultivation could decrease mortality rates and allow additional improvements in growth rates and quality. KATKANSKY & WARNER (1974) found significantly improved results in rack culture (approx. 20%) mortalities compared with the ground culturing method (approx. 55%). WESTLEY (1975, pers. comm.) reported similar results in experimental combinations of tray and ground rearing in Washington State.

Reversing the declining production trend is primarily a matter of economics. Methods of increasing production have been illustrated by researchers, and the present allotments potentially allow for the use of additional cultivation areas. A stable domestic seed supply is necessary for the fishery to grow, as imports are not always available. Threats to the California oyster industry may exist in the area of pollution, which has shown its effects in the past, but with the enforcement of new laws and regulations new areas may become available for oyster production. Possible problems related to recreational land-water use and increasing population will still remain in some areas preventing or restricting the industry's growth. The industry has, however, been adaptable in the past, and with an increasing interest in the sea for food resources, there seems no reason why oyster mariculture in California will not provide us with this resource in increasing quality and quantity.

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REFERENCES

BARRETT, E.M. 1963. The California oyster industry. *Fish Bull.* No. 123. *California Dept. Fish Game.*

BONNOT, P. 1935. The California oyster industry. *California Fish Game* 21 (1): 65-80.

----------1938. Report of the California oyster industry for 1937. *California Fish Game* 24 (2): 191-195.

BROWNING, B.M. 1972. The Natural Resources of Elkhorn Slough: Their Present and Future Use. *California Dept. Fish Game. Coastal Wetland Series* No. 4. 105 pp. plus appendices.

CHEW, K.K.; A.K. SPARKS and S.C. KATKANSKY 1965. Preliminary results on the seasonal size distribution of *Mytilicola orientalis* and the effect of this parasite or the condition of the Pacific oyster, *Crassostrea gigas. Jour. Fish. Res. Brd. Canada* 22 : 1099-1101.

DAHLSTROM, W.A. 1975. California Shellfish Importation and Planting Report. Mar. Res. Admin. Rep. 75-100. *California Dept. Fish Game.* 5 pp.

EBERT, E.E. 1973. Mariculture in California. Mar. Techn. Rep. No. 18. *California Dept. Fish Game*. 16 pp.

FREY, H.W. 1971. California's Living Marine Resources and Their Utilization. *California Dept. Fish Game.* 148 pp.

GALTSOFF, P.S. 1932. Introduction of Japanese oysters into the U.S. *U.S. Bur. Fish. Fish. Circ.* 12: 1-16.

GERDES, G.L.; E.R.J. PRIMBS and B.M. BROWNING 1974. The Natural Resources of Morro Bay. *California Dept. Fish Game. Coastal Wetland Series* No. 8. 103 pp. plus appendices.

GIGUERE, P.E. 1970. The Natural Resources of Bolinas Lagoon: Their Status and Future. *California Dept. Fish Game. Coastal Wetland Series* No. 3. 107 pp. plus appendix.

HITTELL, J.S. 1882. *The commence and industries of the Pacific coast of North America.* A.L. Bancroft and Co. San Francisco. 819 pp.

HOPKINS, S.H. 1954. The American species of trematode confused with *Bucephalus (Bucephalopsis) haimeanus. Parasitology* 44 : 353-370.

KATKANSKY, S.C; A.K. SPARKS and K.K. CHEW 1967. Distribution and effects of the endoparasitic copepod, *Mytilicola orientalis,* on the Pacific oyster, *Crassostrea gigas,* on the Pacific coast. *Nat. Shell. Assoc. SI* : 50-58.

KATKANSKY, S.C. and R.W. WARNER 1974. Pacific oyster disease and mortality studies in California. Mar. Res. Techn. Rep. No. 25. *California Dept. Fish Game.* 51 pp.

MCALLISTER, R.O. 1975. Statistical Report of Fresh, Canned, Cored and Manufactured Fishery Products for 1974. Circular No. 49. *California Fish Game.*

MENZEL, R.W. and S.H. HOPKINS 1955 a. Effects of two parasites on the growth of oysters. *Proc. Nat. Shell. Assoc.* 45 : 184-186.

---------- . 1955 b. The growth of oysters parasitized by the fungus *Dermocystidium marinum* and by the trematode *Bucephalus cuculus. Jour. Parasit.* 41 : 333-342.

MONROE, G.W. 1973. The Natural Resources of Humboldt Bay. *California Dept. Fish Game. Coastal Wetland Series* No. 6. 160 pp. plus appendixes.

SNIDERMANN, C.J. and ROSEN FIELD 1967. Principal diseases of commercially important marine bivalue Mollusca and Crustacea. *Fish. Bull. U.S. Fish Wildl. Ser.* 66 (2): 335-385.

STEIN, J.E.; J.G. DENISON and J.G. MACKIN 1961. *Hexamita* sp. and an infectious disease in the commercial oyster *Ostrea lurida. Proc. Nat. Shell. Assoc.* 50 : 67-81.

TAKEUCHI, T.; Y. TAKEMOTO and T. MATSUBARA 1960. Hematological study of bacteria-infected oysters. *Rep. Hiroshima Prefect. Fish. Exp. Sta.* 22 : 1-7. (In Japanese).

TOWNSENID, C.H. 1893. Report of observations respecting the oyster resources and oyster fishery of the Pacific Coast of the U.S. *U.S. Burg. Fish. Rep. Comm.* 1889-1891: 343-372. '