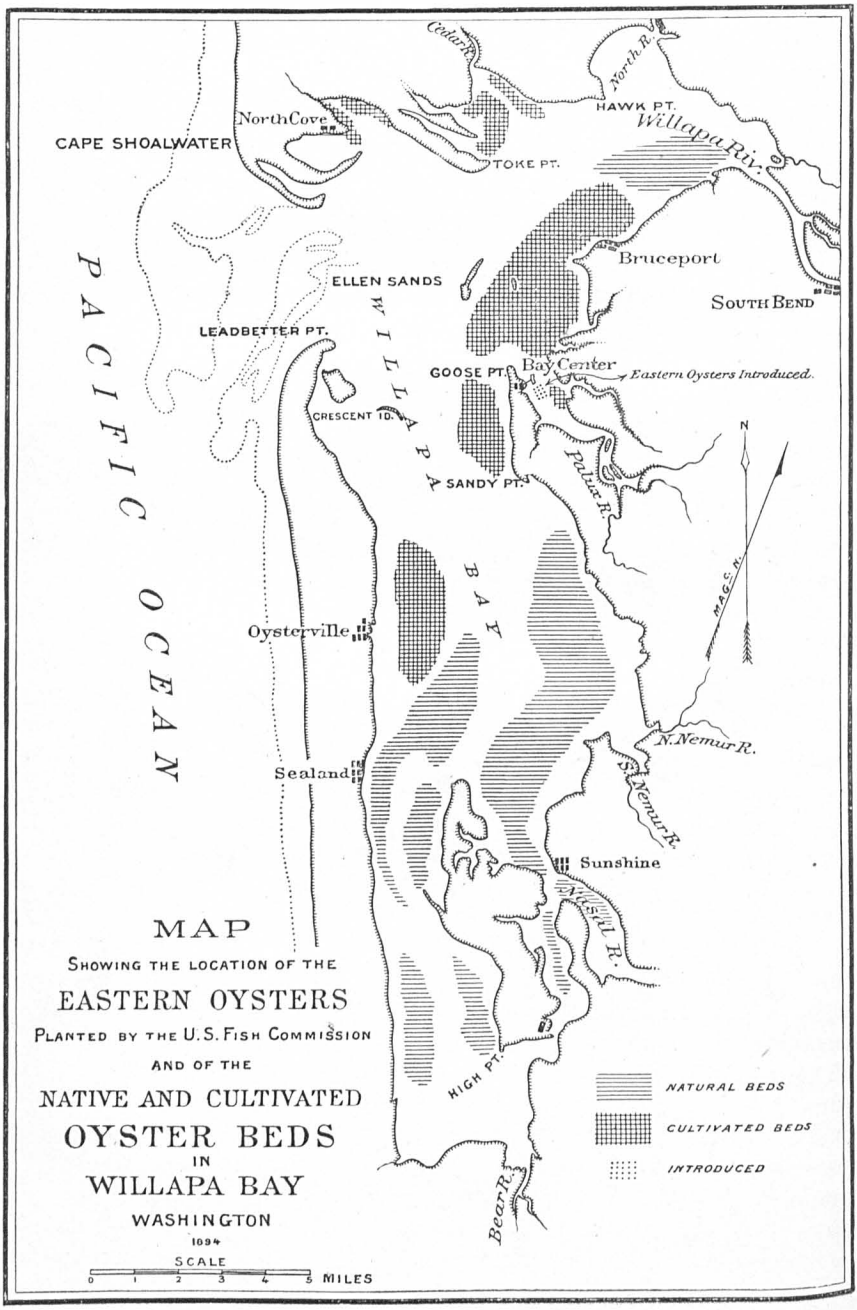
Cedar R.
North R.
HAWK PT.
Willapa Riv.
NorthCove
CAPE SHOALWATER
TOKE PT.
Bruceport
SOUTH BEND
ELLEN SANDS
LEADBETTER PT.
WILLAPA
GOOSE PT.
Bay Center
Eastern Oysters Introduced.
CRESCENT ID.
SANDY PT.
Palix R.
N
MAG. N.
PACIFIC OCEAN
BAY
Oysterville
N. Nemur R.
S. Nemur R.
Sealand
Sunshine
Wash'l R.
HIGH PT.
Bear R.
NATURAL BEDS
CULTIVATED BEDS
INTRODUCED
MAP
SHOWING THE LOCATION OF THE
EASTERN OYSTERS
PLANTED BY THE U.S. FISH COMMISSION
AND OF THE
NATIVE AND CULTIVATED
OYSTER BEDS
IN
WILLAPA BAY
WASHINGTON
1894
SCALE
0 1 2 3 4 5 MILES

3.—THE TRANSPLANTING OF EASTERN OYSTERS TO WILLAPA BAY, WASHINGTON, WITH NOTES ON THE NATIVE OYSTER INDUSTRY.

By C. H. Townsend,

Naturalist, U. S. Fish Commission Steamer Albatross.

During a visit of the late Marshall McDonald, United States Commissioner of Fisheries, to Willapa Bay, Washington, in the summer of 1893, representations in favor of the introduction of the eastern oyster were made to him by persons interested in the cultivation of the small native oysters at that place. Strongly impressed with the desirability of such an importation, the Commissioner promised to authorize the necessary investigations concerning the conditions of the bay and its adaptability for the growth of other species, to be followed by such further action as he might deem advisable to take. Accordingly, in October, 1894, the writer, who had previously made some study of the local oyster industry of Willapa Bay,* was directed to make a further examination of the native oyster deposits found there, and, if possible, select suitable localities for planting the eastern species.

Willapa Bay is the most favorable locality on the Pacific coast for the cultivation of the native oyster (*Ostrea lurida*). This species has always been abundant there, and for many years before its present system of cultivation was attempted was regularly shipped to San Francisco, where it was the only oyster used prior to the introduction of the eastern oyster into the waters of California. Native oysters are taken from the natural deposits with tongs and carefully sorted, the largest being at once marketed and the rest laid out for two or three years upon suitable beds for further growth.

The cultivation of this small oyster constitutes the principal fishery industry of the bay, there being about 350 persons employed, Indians constituting about one-third of the number. Over $66,000 worth of oysters were produced in 1895. The quantity of Willapa Bay oysters consumed annually in the Pacific coast States amounts to about 50,000 sacks, the total acreage of transplanted beds is over 2,000, and the value of small boats and other appliances of the fishery is over $20,000.

* Report U. S. Fish Commission, 1889-1891, Oyster Resources Pacific Coast, pp. 343-372.

Although the quantity of Willapa oysters used in San Francisco has been reduced by the introduction of the eastern oysters, a considerable percentage of the output still finds a market there, many persons preferring the native to the introduced species.

Of the adaptability of the eastern species to the water of San Francisco Bay there is no doubt. Eastern oysters have for the past twenty-five years been brought to California in the form of seed and kept in the bay for three or four years until grown to a large size. It was supposed for many years that, owing to the uniform coldness of the water, there was no natural increase, but an examination of San Francisco Bay in 1890–91 by the writer showed that considerable natural increase had taken place, and more recent inquiry develops the fact that the scattered tracts of naturally propagated oysters were developing into oyster beds, from which a small supply was being gathered annually by boys and others who knew where to look for them. It is altogether probable that the tendency of the acclimated stock is to increase from year to year. There are evidences of natural increase on the beds where the annual supply brought from the Atlantic coast is laid out for growth, but with a gradually developing market for oysters on the west coast and a comparatively limited area over which they could spread and propagate, it seems probable that the present custom of importing seed will have to be continued for many years. If San Francisco Bay were less muddy and more generally supplied with shelly bottom to which young oysters could attach themselves, the establishment of the species would go on more rapidly. Outside of San Francisco Bay the introduction of the eastern oyster has not been attempted on any scale worthy of more than passing notice.

The following extracts from the report previously referred to are of interest in this connection:

In Tomales Bay, Messrs. Weinard and Terry laid out about 17 carloads of eastern oysters in 1875. They remained there only two or three years, until all were marketed or removed to more accessible places in San Francisco Bay. The experiment was not repeated. Captain Lawson, one of the oldest residents upon Tomales Bay, says that these oysters lived and fattened as well apparently as those in San Francisco Bay. They were laid out at Millerton Station, near the southern end of the bay, where some of the stakes used in fencing the bed are still standing. There is perhaps no reason why the extensive mudflats of Tomales Bay should not be used for laying out oysters in the same manner as is done in San Francisco. The bay is nowhere very deep. With two or three good-sized streams flowing into it, the natural conditions ought to prove very similar to those of San Francisco. It is 18 miles long and averages 2 in breadth. There are no signs of the propagation of eastern oysters there, although *Ostrea lurida* is not uncommon.

From correspondents in southern California I have recently learned that eastern oysters are reported as propagating in San Diego Bay. A few years ago a quantity of oysters were placed there, and they still remain in good condition. It is said also that a lot of Mexican oysters, brought in a steamer from Guaymas several years ago, were found to be dying rapidly when the vessel arrived in San Diego Harbor, and were thrown overboard. It is claimed that survivors from this accidental planting are occasionally found. This bay, more than 400 miles south of San Francisco Bay, is much warmer, and it might be that the oyster of the Gulf of California, which

failed to live in the cold water of San Francisco Bay, would be a success in San Diego Bay. The greater part of this bay is shallow and there are extensive mudflats. There are no constant streams flowing into it, though False Bay, immediately north of it, receives San Diego River, a stream which disappears in midsummer.

Humboldt Bay, 200 miles north of San Francisco, is a large and shallow bay that may be found available for oyster-growing when the question of temperature has been studied. By far the greater area of this bay consists of tide lands, exposed at low water. My personal recollection of Humboldt mudflats, visited in 1885, is that they are altogether firmer than those of San Francisco, the bottom being more sandy.

Ballona Bay, near Santa Monica, in southern California, is a small bay where, I am informed, oysters have been placed and found to grow well, but it is not known whether they breed there. A report upon the small bays about Wilmington, near Los Angeles, has already been published by the Fish Commission.

* * * * * * *

Governor E. P. Ferry, of Washington, informed me that he, in company with Colonel Laramie and Mr. William P. Wright, made an experiment in planting eastern oysters near Olympia many years ago. The history of the experiment is lost, but Governor Ferry's recollection of it is that two sacks of oysters were put in Budd Inlet, about 2 miles from Olympia. They were perhaps not properly looked after, as they were soon lost sight of. It was observed, however, that they lived for several weeks. The history of eastern oysters in Willapa Bay is similar; a few sacks only were laid out in the vicinity of Oysterville. They lived as well as those at San Francisco, but no signs of propagation were ever discovered. It was conceded by oystermen that there were hardly enough of them to insure fertilization. This experiment was made several years ago and has never been repeated.

Eastern oysters grown in San Francisco Bay, and thus acclimated to the comparatively cold waters of California, would, if the supply be large enough, constitute a better stock for introduction into other bays of the Pacific coast than oysters newly imported from the Atlantic region. It is probably true, also, that oysters derived from the most northerly localities on the Atlantic coast would be better adapted to Pacific coast bays than those from southerly and warmer localities.

Willapa Bay is situated on the southwest coast of Washington, a few miles north of the mouth of the Columbia River. It is about 25 miles in length, with an average width of 5 miles. On account of extensive shoals and tide flats it was formerly called Shoalwater Bay. Deep navigable channels make nearly all parts of it accessible to large vessels. Its shores are heavily wooded, and many streams valuable for their salmon fisheries flow into it. The most important of the latter is Willapa River, 30 miles in length, smaller rivers and creeks being the Palux, Cedar, Nemur, and Nasal. None of these streams are navigable for more than a few miles above their mouths, and some of them not at all. This part of Washington being decidedly rainy, particularly in winter, the volume of fresh water flowing into the bay is considerable, and it is said that during freshets the waters of the bay are discolored by the inflow of water from the Columbia River. Extensive natural oyster deposits are found along the channels, from the mouth of the Willapa on the north to the extreme head of the bay on the south.

The localities where oyster cultivation is carried on are Bay Center, Bruceport, Oysterville, North Cove, and Toke Point (see accompanying map), no transplanted beds being located in the southern part of the

bay. Oysters for planting are generally derived from the natural deposits in the adjacent channels. North Cove and Toke Point, where natural beds do not occur, are supplied with seed from points as far south as Sealand.

An examination of Willapa Bay in October, 1894, having shown that the tide lands generally had been filed upon or were already under cultivation, it became necessary to consider the deeper waters with reference to their suitability for the eastern species.

Many of the channels where native oysters grow were recommended by resident oystermen as favorable places for depositing eastern oysters, but the danger of leaving such deposits exposed to poachers being admitted, the following localities adjacent to cultivated oyster beds were then considered: Palux Channel, near the village of Bay Center; Willapa Channel, opposite Bruceport, and the channel off Sealand. It is quite possible that the shallow head of the bay will eventually be found to have the highest summer temperature and would therefore afford the most favorable conditions for the propagation of eastern oysters, but its remoteness from the present oyster-growing districts makes it undesirable on account of the lack of such protection as an interested oystering community would afford. The sandy districts near the mouth of the bay are unfavorable, the bottom being constantly shifted by the action of the sea.

Upon examination, Palux Channel seemed on the whole to offer the best conditions. It lies well back of very extensive flats, which would have a tendency to increase the summer temperature; the bottom is firm, and is well supplied with native oysters, while starfish are said to be less numerous than elsewhere. It is within sight of the village, which insures its security against poachers, and has a depth of 8 feet at low water, full security against the winter frosts that injure oysters on shallow transplanted beds.

On October 26, 1894, the J. & J. W. Elsworth Co., of New York, under the direction of the United States Fish Commission, shipped a carload of oysters from New York to South Bend, on Willapa Bay, Washington. It was stated by the shippers that the car would be eighteen days en route, but, owing to fortunate circumstances, the trip was made in thirteen days, the car reaching South Bend on November 7, my own arrival being unfortunately three days later. I arrived on the evening of the 10th, according to instructions received from the Commissioner, and at once examined the oysters, which proved to be in good condition. A number of oystermen from Bay Center had volunteered to transport the oysters on Monday, but not wishing to delay planting them a tugboat and lighter were secured and everything arranged for a start at daylight the next morning (Sunday).

Mr. James Crawford, fish commissioner of Washington, who had been requested to assist in the work, had been looking over the ground. We agreed in favor of the Palux Channel location, and the oysters were accordingly deposited there in good condition at noon on November 11.

There were 80 barrels of oysters in all, collected from the following localities: Raritan Bay, 10 barrels (natural growth); Chesapeake Bay, 12 barrels; Newark Bay, 8 barrels (seed); Prince's Bay, 14 barrels; Keyport, 23 barrels; East River, 13 barrels.

Examining the four or five upper layers of oysters in each barrel as it was opened, a few dead oysters were found and counted, as follows: For the 23 barrels from Keyport, 35 oysters; for the 10 barrels from Raritan Bay, 6 oysters; for the 12 barrels from Chesapeake Bay, 18 oysters, and for the 14 barrels from Prince's Bay, 22 oysters. The Newark and East River lots were in still better condition. A few oysters that were slightly open closed upon being placed in a bucket of sea water, while a dozen or two that we opened were found fresh and well supplied with liquid.

By massing the entire consignment in one locality the chances for fertilization are increased. The tract upon which the oysters were placed, while not measured, is probably about 3 acres in extent. A large representation of the local oystermen were present at the planting, in which they were greatly interested. It was agreed that the entire tract, which lies a short distance south of the Bay Center wharf, be reserved as a bed for eastern oysters, and upon the recommendation of Mr. Crawford, State fish commissioner, the Washington legislature enacted a law protecting these oysters.*

Four months later Mr. N. B. Miller, of the United States Fish Commission steamer *Albatross*, examined this bed by tonging and found its condition to be excellent. State Commissioner Crawford, having tonged up enough to ascertain the general condition of the bed in October, 1895, reported that the oysters were doing well. Very few dead shells were found, while the oysters that were opened were fat and well-flavored. The placing of spat-collectors in the vicinity of this bed is a work that should be arranged for at the proper season.

The good condition of oysters after a year in the waters of Willapa Bay is sufficient evidence as to the suitability of the region for oyster-growing from imported seed, after the method employed at San Francisco. Many cultivators of the native oysters are anxious to try the bedding of eastern seed, but shipping rates at present are so high as to be prohibitory, the freight charges on a carload of oysters (31,200 pounds) shipped by the Fish Commission from New York to Willapa Bay in October, 1894, having amounted to $784.80.

The conditions for the acclimation of this oyster in Willapa Bay seem favorable, the summer temperature of the water being but little colder than in San Francisco Bay, according to our present knowledge of the subject, while the nature of the bottom is such that young oysters have wide tracts of shelly reefs upon which to settle and grow. The protection of oyster beds by closely driven stakes is here unnecessary, the stingray, so destructive to oysters in California waters, not being found here.

* For the laws of Washington respecting oysters, see the writer's report on Oyster Resources of the Pacific Coast, previously quoted.

The following notes on the temperature of Willapa Bay are taken from the writer's first report on the subject:

It is not unlikely that the summer temperature of the extreme southern part of Willapa Bay may be close to that of San Francisco, and that eastern oysters would propagate there. From the shelly nature of the bottom they might be expected to do well, provided the conditions of temperature were similar. It is certain that the native oysters of this bay breed freely at San Francisco. We know nothing as yet about the summer temperature of the water in this bay, except as it is indicated by observations made by the Coast Survey steamer *Gedney* in the northern part. The temperature even there may be higher than the following table indicates, as the observations were all made at 4 a. m., when the temperature is usually lowest, day temperatures being as a rule higher. Ranging, as it does, usually no lower than 60° at 4 a. m. for August and for that part of July covered by the record, it is probable that the temperature would not be lower than 65° for afternoon observations. Assuming a summer temperature of 60° to 65° for that part of the bay nearest the sea, we may reasonably expect to find the water decidedly warmer in those parts of the bay 15 or 20 miles back from the sea. A careful study of the temperature of this locality would, no doubt, yield important information.

Surface temperatures taken at 4 a. m., daily, by the United States Coast Survey steamer Gedney, in Willapa Bay, 1890.

Locality.	Date.	Temp.	Locality.	Date.	Temp.
		°F.			°F.
North Cove	July 26	57	North Cove	Sept. 4	58
Do	27	62	Do	5	58
Do	28	58	Do	6	59
Do	29	61	Do	8	59
Do	30	60	Do	9	56
Do	31	62	Do	15	58
Toke Point	Aug. 1	61	Do	16	59
South Bend	2	65	Do	17	52
Do	3	65	Do	20	55
Do	4	64	Do	23	54
North Cove	5	60	Willapa Bay	24	55
Do	6	61	Do	27	53
Toke Point	7	61	North Cove	29	60
South Bend	10	61	South Bend	Oct. 5	56
Toke Point	12	62	Do	6	56
Do	13	62	Do	8	54
Do	14	63	Do	9	55
Do	15	63	Do	12	54
Do	16	60	Do	13	54
South Bend	17	64	Do	17	52
Do	18	64	Do	18	52
Willapa Bay	19	60	Do	19	54
Sunshine (Nasal River)	20	60	Do	21	52
Sealand	21	61	Sunshine (Nasal River)	23	53
Do	22	62	Do	25	53
Do	23	62	Do	27	54
Do	24	63	Do	29	53
Do	25	62	Do	Nov. 2	56
North Cove	29	62	Do	4	54
Do	30	62	Do	5	52
Do	31	59	North Cove	8	50
Do	Sept. 3	58			

From March 18 to April 5, 1895, Mr. N. B. Miller, of the Fish Commission steamer *Albatross*, was engaged in studying the temperature and specific gravity of the water in Willapa Bay. Commencing on the 18th of March, with the Willapa River at South Bend, about 3 miles above where it enters the bay, temperatures and specific-gravity observations were taken hourly from 7 a. m. until 7 p. m. The specific gravity gradually decreased during the fall of the tide, which is about 10 feet, from 1.0105 at high water at 7 a. m. to 1.0065 at low water at

1 p. m. It gradually increased from this time to 1.0111 at 7 p. m., high water. The temperature was 47° F. On March 19 there was a slight increase in density caused by a strong wind backing the waters of the bay into the river, and the tide did not fall as low as on the previous day. Observations were continued on March 20 at Toke Point, on the north shore of the bay. The specific gravity was much higher than at any other station occupied, being 1.0205 at high water and 1.0141 at low water; temperature 47°. On March 21 the density was 1.0209 at high water, temperature 47°, and 1.0136 at low water, temperature 46°. At Bay Center, opposite the mouth of Palux River, on March 22, the density changed from 1.0182 at high water to 1.0110 at low water; temperature 46°. On March 23 and 24 at the same place, with lower tides, the density was found to be lower. On March 25, in the channel of Palux River, the surface density at low water was 1.0098 and at high water 1.0176. At a depth of 18 feet, high water, the density was 1.0180; temperature in each case 46°.

Before leaving Palux Channel Mr. Miller examined the deposit of eastern oysters I had made there four months before. Eighty-three live oysters were tonged up and only seven empty shells. The condition of the edges of their shells showed them to be growing. At Sealand on March 26 the high-water density was 1.0173, with a temperature of 48°, and on March 27, 1.0152 at low water, increasing to 1.0176 at high water; temperature 48°.

On March 28 at Oysterville the lowest surface density at low water was 1.0164, and at a depth of 35 feet, 1.0165; temperature 49°. At high water the surface density was 1.0178, and at 35 feet the same; temperature 49°. On March 29 the low-water density was 1.0159, temperature 48°; high water 1.0174, temperature 49°.

At Sunshine on March 31 the density decreased from 1.0100 at 8 a. m. to 1.0062 at noon, when it was low water. It then increased to 1.0108 at high water. On April 1 low-water density 1.0062, high water 1.0116, temperature 49°. On April 3 the high-water surface density was 1.0106, temperature 49°, and at a depth of 20 feet 1.0108.

At High Point on April 2 the water was quite fresh, the density being 1.0033, temperature 49°; at high water it was only 1.0084. On April 4 at high water it was 1.0081, at low-water 1.0027; temperature 48°.

Surface observations made from the steamer between Sealand and South Bend showed a low-water density of 1.0148; temperature 49°.

In this work on Willapa Bay observations were as a rule made hourly throughout the day. The specific gravities have been reduced to 15° C. The specimens of water from below the surface were secured with the Sigsbee water bottle.

Record of temperatures and specific gravities.

Date.	Time of day.	Station.	Locality.	Depth.	Temperature of water.	Temperature of air.	Temp. of specimen at time specific gravity was taken.	Specific gravity observed.	Specific gravity reduced to 15° C.	Remarks.
1895.					°F.	°F.	°F.			
Mar. 18	7 a. m.	1	South Bend	Surface.	47	48	47	1.0126	1.0105	High water.
18	8 a. m.	1	do	do	47	48	47	1.0112	1.0101	Ebb tide.
18	9 a. m.	1	do	do	47	50	47	1.0110	1.0089	Do.
18	10 a. m.	1	do	do	47	52	47	1.0108	1.0087	Do.
18	11 a. m.	1	do	do	47	54	47	1.0108	1.0087	Do.
18	12 m	1	do	do	47	53	47	1.0105	1.0084	Do.
18	1 p. m.	1	do	do	48	51	48	1.0086	1.0065	Low water.
18	2 p. m.	1	do	do	48	51	48	1.0088	1.0067	Flood water.
18	3 p. m.	1	do	do	48	48	48	1.0091	1.0073	Do.
18	4 p. m.	1	do	do	48	50	48	1.0104	1.0083	Do.
18	5 p. m.	1	do	do	47	50	47	1.0110	1.0089	Do.
18	6 p. m.	1	do	do	47	48	47	1.0124	1.0103	Do.
18	7 p. m.	1	do	do	47	48	47	1.0132	1.0111	High water.
19	8 a. m.	1	do	do	47	47	47	1.0144	1.0123	Do.
19	9 a. m.	1	do	do	48	48	48	1.0142	1.0121	Ebb tide.
19	10 a. m.	1	do	do	48	49	48	1.0138	1.0117	Do.
19	11 a. m.	1	do	do	48	49	48	1.0134	1.0113	Do.
19	12 m	1	do	do	48	49	48	1.0134	1.0113	Do.
19	1 p. m.	1	do	do	48	49	48	1.0124	1.0103	Do.
19	2 p. m.	1	do	do	47	49	47	1.0122	1.0101	Do.
19	3 p. m.	1	do	do	47	48	47	1.0114	1.0123	Do.
19	4 p. m.	1	do	do	47	48	47	1.0102	1.0081	Low water.
19	5 p. m.	1	do	do	47	46	47	1.0110	1.0089	Flood tide.
19	6 p. m.	1	do	do	47	46	47	1.0116	1.0095	Do.
19	7 p. m.	1	do	do	47	45	47	1.0120	1.0099	Do.
20	8 a. m.	2	Toke Point	do	48	47	48	1.0220	1.0205	High water.
20	9 a. m.	2	do	do	47	47	47	1.0218	1.0197	Ebb tide.
20	10 a. m.	2	do	do	47	48	47	1.0214	1.0193	Do.
20	11 a. m.	2	do	do	47	48	47	1.0210	1.0189	Do.
20	12 m	2	do	do	47	49	47	1.0200	1.0179	Do.
20	1 p. m.	2	do	do	47	51	47	1.0194	1.0173	Do.
20	2 p. m.	2	do	do	47	53	47	1.0180	1.0159	Do.
20	3 p. m.	2	do	do	47	50	47	1.0162	1.0141	Low water.
20	4 p. m.	2	do	do	47	49	47	1.0166	1.0145	Flood tide.
21	8 a. m.	2	do	do	46	47	46	1.0220	1.0198	Do.
21	9 a. m.	2	do	do	46	47	46	1.0224	1.0209	High water.
21	10 a. m.	2	do	do	46	48	46	1.0216	1.0194	Ebb tide.
21	11 a. m.	2	do	do	46	48	46	1.0210	1.0188	Do.
21	12 m	2	do	do	46	50	46	1.0204	1.0182	Do.
21	1 p. m.	2	do	do	46	51	46	1.0194	1.0172	Do.
21	2 p. m.	2	do	do	46	53	46	1.0182	1.0160	Do.
21	3 p. m.	2	do	do	46	52	46	1.0160	1.0138	Do.
21	4 p. m.	2	do	do	46	49	46	1.0158	1.0136	Low water.
22	10 a. m.	3	Bay Center	do	46	45	46	1.0194	1.0172	Flood tide.
22	11 a. m.	3	do	do	46	45	46	1.0202	1.0180	Do.
22	12 m	3	do	do	46	45	46	1.0214	1.0182	High water.
22	1 p. m.	3	do	do	46	45	46	1.0200	1.0178	Ebb tide.
22	2 p. m.	3	do	do	46	45	46	1.0192	1.0120	Do.
22	3 p. m.	3	do	do	46	45	46	1.0174	1.0152	Do.
22	4 p. m.	3	do	do	46	45	46	1.0162	1.0140	Do.
22	5 p. m.	3	do	do	46	45	46	1.0154	1.0132	Do.
22	6 p. m.	3	do	do	46	45	46	1.0132	1.0110	Low water.
23	8 a. m.	3	do	do	46	48	46	1.0180	1.0158	Flood tide.
23	9 a. m.	3	do	do	46	48	48	1.0188	1.0167	Do.
23	10 a. m.	3	do	do	46	52	48	1.0194	1.0173	High water.
23	11 a. m.	3	do	do	46	54	46	1.0194	1.0172	Ebb tide.
23	12 m	3	do	do	46	56	46	1.0192	1.0170	Do.
23	1 p. m.	3	do	do	46	53	46	1.0190	1.0170	Do.
23	2 p. m.	3	do	do	46	53	46	1.0186	1.0164	Do.
23	3 p. m.	3	do	do	46	53	46	1.0172	1.0150	Do.
23	4 p. m.	3	do	do	46	50	46	1.0158	1.0136	Do.
23	5 p. m.	3	do	do	46	49	46	1.0140	1.0118	Do.
23	6.30 p. m.	3	do	do	46	45	46	1.0124	1.0102	Low water.
24	8 a. m.	3	do	do	46	48	46	1.0172	1.0150	Flood tide.
24	9 a. m.	3	do	do	46	48	46	1.0184	1.0162	Do.
24	10 a. m.	3	do	do	46	51	46	1.0188	1.0166	Do.
24	11 a. m.	3	do	do	46	52	46	1.0196	1.0174	High water.
24	12 m	3	do	do	46	55	46	1.0194	1.0172	Ebb tide.
24	1 p. m.	3	do	do	46	56	46	1.0186	1.0164	Do.
24	2 p. m.	3	do	do	46	56	46	1.0182	1.0160	Do.
24	3 p. m.	3	do	do	46	55	46	1.0174	1.0152	Do.
24	4 p. m.	3	do	do	46	53	46	1.0160	1.0138	Do.

Record of temperatures and specific gravities—Continued.

Date.	Time of day.	Station.	Locality.	Depth.	Temperature of water.	Temperature of air.	Temp. of specimen at time specific gravity was taken.	Specific gravity observed.	Specific gravity reduced to 15° C.	Remarks.
1895.					°F.	°F.	°F.			
Mar. 24	5 p. m.	3	Bay Center	Surface.	46	49	46	1.0146	1.0124	Ebb tide.
24	6 p. m.	3	do	do	46	47	46	1.0128	1.0106	Do.
24	7 p. m.	3	do	do	46	47	46	1.0122	1.0100	Low water.
25	7 a. m.	4	Channel, Bay Center.	do	46	48	46	1.0126	1.0104	Do.
25	7.15 a. m.	5	do	do	46	48	46	1.0126	1.0104	Do.
25	7.30 a. m.	6	do	do	46	48	46	1.0124	1.0102	Do.
25	7.50 a. m.	7	do	do	46	49	46	1.0124	1.0102	Do.
25	8.10 a. m.	8	do	do	46	49	46	1.0120	1.0098	Do.
25	12 m	9	do	do	46	51	46	1.0198	1.0176	High water.
25	do	9	do	18 feet		53	46	1.0202	1.0180	Do.
25	12.20 p. m.	10	do	Surface.	46	53	46	1.0198	1.0176	Do.
25	do	10	do	18 feet		53	46	1.0200	1.0178	Do.
25	12.40 p. m.	11	do	Surface.	46	55	46	1.0196	1.0174	Do.
25	do	11	do	18 feet		55	46	1.0200	1.0178	Do.
25	1.20 p. m.	12	do	Surface.	46	56	46	1.0190	1.0168	Do.
25	do	12	do	18 feet		56	46	1.0208	1.0186	Do.
26	12 m	13	Sealand	Surface.	48	57	48	1.0190	1.0169	Flood tide.
26	1 p. m.	13	do	do	48	57	48	1.0192	1.0171	Do.
26	2 p. m.	13	do	do	48	57	48	1.0194	1.0173	High water.
26	3 p. m.	13	do	do	48	56	48	1.0192	1.0171	Ebb tide.
26	4 p. m.	13	do	do	48	56	48	1.0190	1.0169	Do.
26	5 p. m.	13	do	do	48	55	48	1.0186	1.0165	Do.
26	6 p. m.	13	do	do	48	54	48	1.0182	1.0161	Do.
26	7 p. m.	13	do	do	48	52	48	1.0176	1.0155	Do.
27	7 a. m.	13	do	do	49	51	49	1.0175	1.0155	Do.
27	8 a. m.	13	do	do	49	53	49	1.0172	1.0152	Low water.
27	9 a. m.	13	do	do	49	53	49	1.0180	1.0160	Flood tide.
27	10 a. m.	13	do	do	49	53	49	1.0184	1.0164	Do.
27	11 a. m.	13	do	do	49	54	49	1.0186	1.0166	Do.
27	12 m	13	do	do	49	55	49	1.0190	1.0170	Do.
27	1 p. m.	13	do	do	49	56	49	1.0194	1.0174	Do.
27	2 p. m.	13	do	do	49	56	49	1.0194	1.0174	Do.
27	3 p. m.	13	do	do	49	56	49	1.0196	1.0176	High water.
27	4 p. m.	13	do	do	49	55	49	1.0196	1.0176	Ebb tide.
27	5 p. m.	13	do	do	49	53	49	1.0190	1.0170	Do.
27	6 p. m.	13	do	do	49	51	49	1.0184	1.0164	Do.
27	7 p. m.	13	do	do	49	51	49	1.0178	1.0158	Do.
28	7 a. m.	14	Channel, Sealand.	do	49	50	49	1.0180	1.0160	Do.
28	do	14	do	25 feet		50	49	1.0182	1.0162	Do.
28	8 a. m.	15	do	Surface.	49	52	49	1.0180	1.0160	Do.
28	do	15	do	35 feet		52	49	1.0182	1.0162	Do.
28	9 a. m.	16	do	Surface.	49	53	49	1.0174	1.0154	Low water.
28	do	16	do	35 feet		53	49	1.0178	1.0158	Do.
28	9.30 a. m.	17	do	Surface.	49	53	49	1.0174	1.0154	Do.
28	do	17	do	35 feet		53	49	1.0177	1.0157	Do.
28	10.15 a. m.	18	do	Surface.	49	54	49	1.0176	1.0156	Do.
28	do	18	do	35 feet		54	49	1.0178	1.0158	Do.
28	11.05 a. m.	19	do	Surface.	49	54	49	1.0178	1.0158	Do.
28	do	19	do	35 feet		54	49	1.0180	1.0160	Do.
28	1 p. m.	20	Channel, off Oysterville.	Surface.	49	55	49	1.0184	1.0164	Flood tide.
28	do	20	do	35 feet		55	49	1.0185	1.0165	Do.
28	1.30 p. m.	21	do	Surface.	49	56	49	1.0188	1.0168	Do.
28	do	21	do	35 feet		56	49	1.0188	1.0168	Do.
28	2.15 p. m.	22	do	Surface.	49	55	49	1.0192	1.0172	Do.
28	do	22	do	35 feet		55	49	1.0194	1.0174	Do.
28	3 p. m.	23	do	Surface.	49	54	49	1.0194	1.0174	Do.
28	do	23	do	35 feet		54	49	1.0195	1.0175	Do.
28	4 p. m.	24	do	Surface.	49	52	49	1.0198	1.0178	High water.
28	do	24	do	35 feet		52	49	1.0198	1.0178	Do.
29	10 a. m.	25	do	Surface.	48	46	48	1.0180	1.0159	Low water.
29	11 a. m.	25	do	do	48	46	48	1.0182	1.0161	Flood tide.
29	12 m	25	do	do	48	48	48	1.0182	1.0161	Do.
29	1 p. m.	25	do	do	48	50	48	1.0184	1.0163	Do.
29	2 p. m.	25	do	do	48	51	48	1.0186	1.0165	Do.
29	3 p. m.	25	do	do	49	51	49	1.0190	1.0170	Do.
29	4 p. m.	25	do	do	49	49	49	1.0192	1.0172	Do.
29	5 p. m.	25	do	do	49	47	49	1.0194	1.0174	High water.
31	8 a. m.	26	Sunshine	do	49	53	49	1.0120	1.0100	Ebb tide.
31	9 a. m.	26	do	do	49	54	49	1.0114	1.0094	Do.

Record of temperatures and specific gravities—Continued.

Date.	Time of day.	Station.	Locality.	Depth.	Temperature of water.	Temperature of air.	Temp. of specimen at time specific gravity was taken.	Specific gravity observed.	Specific gravity reduced to 15° C.	Remarks.
1895.					°F.	°F.	°F.			
Mar. 31	10 a. m.	26	Sunshine	Surface.	49	54	49	1.0090	1.0070	Ebb tide.
31	11 a. m.	26	do	do	49	53	49	1.0082	1.0062	Do.
31	12 m	26	do	do	49	53	49	1.0082	1.0062	Low water.
31	1 p. m.	26	do	do	49	53	49	1.0086	1.0066	Flood tide.
31	2 p. m.	26	do	do	49	53	49	1.0094	1.0074	Do.
31	3 p. m.	26	do	do	49	52	49	1.0112	1.0092	Do.
31	4 p. m.	26	do	do	49	52	49	1.0122	1.0102	Do.
31	5 p. m.	26	do	do	49	50	49	1.0128	1.0108	High water.
31	6 p. m.	26	do	do	49	49	49	1.0116	1.0096	Ebb tide.
Apr. 1	8 a. m.	26	do	do	49	48	49	1.0126	1.0106	Do.
1	9 a. m.	26	do	do	49	49	49	1.0122	1.0102	Do.
1	10 a. m.	26	do	do	49	49	49	1.0106	1.0086	Do.
1	11 a. m.	26	do	do	49	49	49	1.0092	1.0072	Do.
1	12 m	26	do	do	49	49	49	1.0082	1.0062	Do.
1	1 p. m.	26	do	do	49	49	49	1.0082	1.0062	Low water.
1	2 p. m.	26	do	do	49	51	49	1.0088	1.0068	Flood tide.
1	3 p. m.	26	do	do	49	50	49	1.0092	1.0072	Do.
1	4 p. m.	26	do	do	49	50	49	1.0116	1.0096	Do.
1	5 p. m.	26	do	do	49	50	49	1.0134	1.0114	Do.
1	6 p. m.	26	do	do	49	48	49	1.0136	1.0116	High water.
2	9 a. m.	26	Channel, Sunshine.	do	49	48	49	1.0126	1.0106	Ebb tide.
2	do	27	do	20 feet	.....	48	49	1.0126	1.0106	Do.
2	9.20 a. m.	28	do	Surface.	49	48	49	1.0126	1.0106	Do.
2	do	28	do	20 feet	.....	48	49	1.0128	1.0108	Do.
2	10 a. m.	29	do	Surface.	49	48	49	1.0122	1.0102	Do.
2	do	29	do	20 feet	.....	48	49	1.0126	1.0106	Do.
2	11.10 a. m.	30	do	Surface.	49	49	49	1.0118	1.0098	Do.
2	do	30	do	20 feet	.....	49	49	1.0119	1.0099	Do.
2	12 m	31	do	Surface.	49	51	49	1.0096	1.0076	Do.
3	9 a. m.	32	Channel, High Point.	do	49	48	49	1.0104	1.0084	High water.
3	9.30 a. m.	33	do	do	49	48	49	1.0102	1.0082	Do.
3	10 a. m.	34	do	do	49	50	49	1.0104	1.0084	Do.
3	11 a. m.	35	do	do	49	52	49	1.0096	1.0076	Ebb tide.
3	11.30 a. m.	36	do	do	49	52	49	1.0094	1.0074	Do.
3	12.10 p. m.	37	do	do	49	53	49	1.0090	1.0070	Do.
3	2.30 p. m.	38	High Point	do	48	53	48	1.0054	1.0033	Low water.
3	3 p. m.	38	do	do	48	52	48	1.0054	1.0033	Flood tide.
3	4 p. m.	38	do	do	48	50	48	1.0060	1.0039	Do.
3	5 p. m.	38	do	do	48	48	48	1.0068	1.0047	Do.
3	6 p. m.	38	do	do	48	47	48	1.0082	1.0061	Do.
3	7 p. m.	38	do	do	48	46	48	1.0088	1.0067	High water.
4	8 a. m.	38	do	do	48	49	48	1.0082	1.0061	Ebb tide.
4	9 a. m.	38	do	do	48	49	48	1.0076	1.0055	Do.
4	10 a. m.	38	do	do	48	49	48	1.0072	1.0051	Do.
4	11 a. m.	38	do	do	48	49	48	1.0070	1.0049	Do.
4	12 m	38	do	do	48	50	48	1.0068	1.0047	Do.
4	1 p. m.	38	do	do	48	51	48	1.0060	1.0039	Do.
4	2 p. m.	38	do	do	48	53	48	1.0052	1.0031	Do.
4	3 p. m.	38	do	do	48	53	48	1.0048	1.0027	Low water.
4	4 p. m.	38	do	do	48	51	48	1.0050	1.0029	Flood tide.
4	5 p. m.	38	do	do	48	48	48	1.0064	1.0043	Do.
4	6 p. m.	38	do	do	48	47	48	1.0082	1.0061	Do.
4	7 p. m.	38	do	do	48	46	48	1.0102	1.0081	Do.
5	2.30 p. m.	39	Channel near entrance of bay.	do	49	53	49	1.0168	1.0148	Low water.
5	2.40 p. m.	40	do	do	49	53	49	1.0168	1.0148	Do.
5	2.50 p. m.	41	do	do	49	53	49	1.0170	1.0150	Do.
5	3.05 p. m.	42	do	do	49	52	49	1.0172	1.0152	Do.
5	3.20 p. m.	43	do	do	49	52	49	1.0170	1.0150	Do.