DEVELOPMENT AND EROSION HISTORY OF BAYOCEAN SPIT, TILLAMOOK, OREGON

by

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and

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ABSTRACT

Bayocean sand spit lies along the northern Oregon coast approximately 70 miles south of the Columbia River. Work was begun on the construction of a large recreational resort on the spit in the early 1900's. At the outset, the resort appeared to have a promising future. However, a three-year delay in the completion of the railroad to Tillamook created financial instability and lawsuits which continued up to the depression of the early 1930's. There soon followed severe erosion of Bayocean spit leading to its breaching in 1952 and forcing the abandonment of the deteriorated resort. The erosion appeared to have been initiated by the construction and subsequent lengthening of a north jetty to the Tillamook Bay channel. Rapid sand deposition north of the north jetty indicated that the structure had blocked a predominant north to south longshore sand transport, thus depriving the spit of sand and resulting in erosion. Similar occurrences have been documented at other coastal locations. However, analysis of historical shoreline changes and aerial photographs taken in 1971, 1972, and 1973 show that sand eroded from beaches to the north and to the south of the jetty has been transported and deposited immediately adjacent to both sides of the structure. This symmetrical pattern of erosion and deposition on both sides of the jetty indicates a reversing longshore sand transport with a near-

zero net annual drift. The shoreline conditions at Bayocean demonstrate that beach erosion can result from the construction of a jetty transverse to a seasonally reversing longshore sand transport with a near-zero net drift.

DEVELOPMENT AND EROSION HISTORY OF BAYOCEAN SPIT, TILLAMOOK, OREGON

CHAPTER I

INTRODUCTION

Bayocean spit, on the northern Oregon coast separating the Pacific Ocean from Tillamook Bay (Figure 1), has had a long history of beach erosion. Early in the century, work was begun on a large beach resort on the spit. Financial problems caused the decline of the resort, and it was abandoned in 1952 as severe erosion and breaching of the spit threatened the few remaining residents. The erosion was believed to have been caused by the construction of a north jetty to the Tillamook Bay channel. The jetty is thought to have blocked the prevailing north to south littoral sand transport thus depriving Bayocean spit of sand.

The purposes of this study are: (1) to recount the growth and decline of Bayocean Park, the resort development on Bayocean spit; (2) to investigate the erosion of Bayocean spit from the earliest accounts up to the present; and (3) to interpret the erosional and depositional patterns on the spit and neighboring beaches to determine the cause of the severe erosion of Bayocean spit.

Information on the Bayocean Park development and erosion history was gathered from a microfilm study of Tillamook and

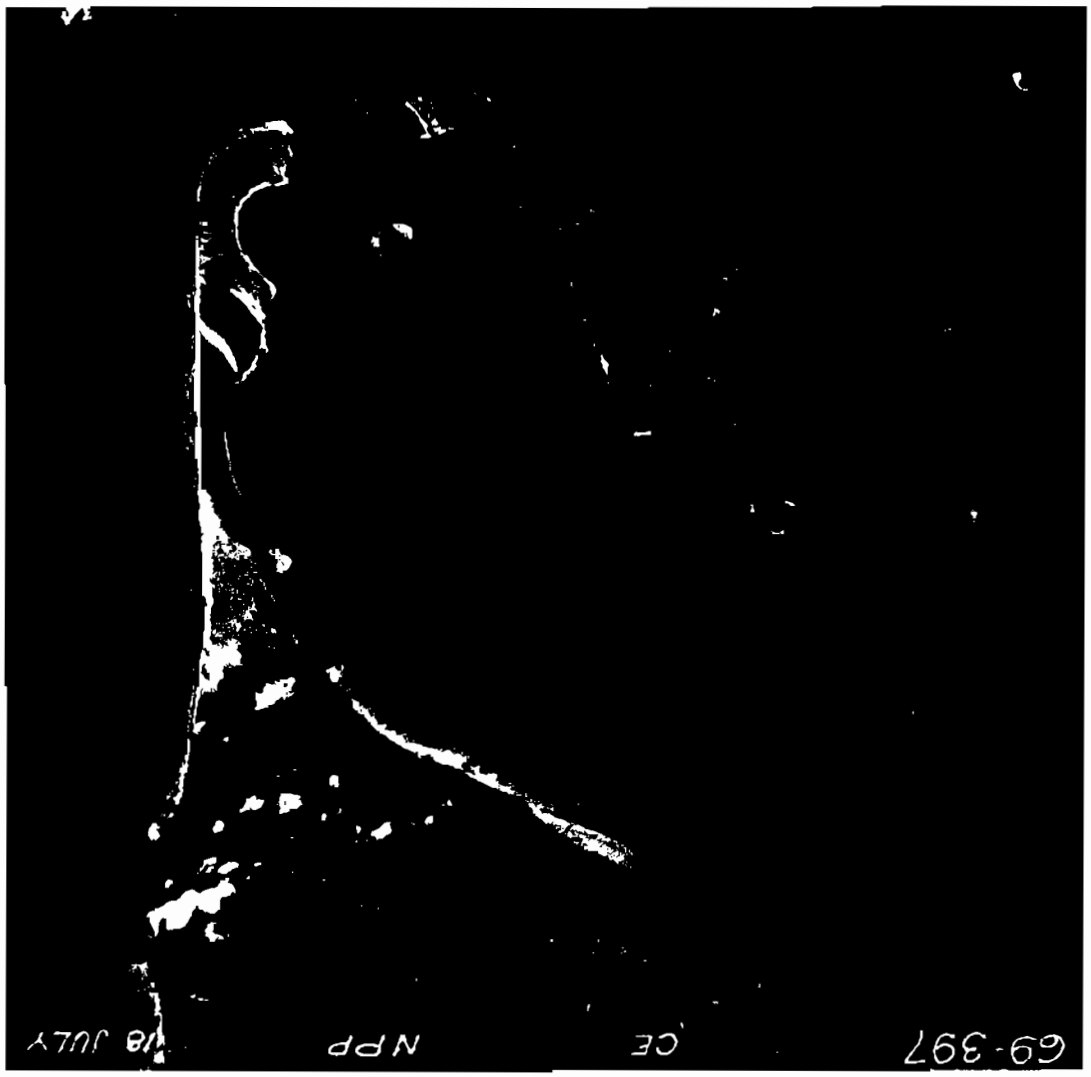


Figure 1. 1969 aerial view of Tillamook Bay and Bayocean spit.

Portland newspapers dating back to the late 1880's. The Tillamook County Clerk and Surveyor provided historic deed records and maps of the resort. The Tillamook County Pioneer Museum, Oregon State Archives, Oregon Historical Society, and Special Collections at the University of Oregon library supplied many early photographs and original documents of the Bayocean resort and subsequent erosion of the spit. Tillamook County Tax Assessor maps served as a valuable source for measuring shoreline recession for selected areas of the spit. The Portland District of the U.S. Army Corps of Engineers provided numerous engineering reports and aerial photographs of the spit taken as far back as 1939. Recent physical changes to the spit were monitored by aerial photography taken in 1971, 1972 and 1973 under contract by Western Aerial Contractors specifically for this study.

CHAPTER II

PHYSICAL SETTING AND LAND USE

Tillamook Bay and its adjoining lowland (Figure 1) are bounded on the east by the Oregon Coast Range, which parallels the coast from the Columbia River south to the Klamath Mountains. The Coast Range varies in width from 25 to 65 miles, locally reaching elevations of 3,000 to 4,000 feet. Baldwin (1964) summarizes the geologic composition of the northern Coast Range as primarily composed of thick submarine volcanic flows, breccias, and tuffaceous sedimentary rock of the Eocene Siletz River Volcanics. This volcanic material is overlain by Tyee sandstone. Many dikes and sills intrude major formations of the Coast Range, forming resistant features.

Much of the seaward side of the Coast Range is composed of Oligo-Miocene sandstones. These sedimentary rocks are the most widespread strata along the northern Oregon shoreline. At points, these sediments are pierced by Tertiary intrusions that form some of the major headlands such as Cape Meares, south of Bayocean spit.

The Hydrographic System

Five rivers flow down the western flanks of the Coast Range and empty into Tillamook Bay; the Miami, Kilchis, Wilson, Trask, and Tillamook rivers. Prior to entering Tillamook Bay, the latter

four rivers converge in the Tillamook lowland, one of the largest lowlands along the northern Oregon coast. The lowland has a soil zone of approximately 6 feet, the uppermost horizon of which is composed of silt nearly 2 feet thick. Below the upper horizon is a mottled clay horizon varying from 3 to 4 feet thick. Cross-bedded gravels underlie the soil zone to a depth of 200 feet. Schlicker et al. (1972) found post-Pleistocene estuarine mud and silt that had been deposited on the lowland prior to the deposition of the flood plain sediments.

The five major rivers have a combined drainage area of 535 square miles and produce combined discharges as summarized in Table 1 (U.S. Army Corps of Engineers, Tillamook Bay, 1970).

Table 1. Freshwater Discharge into Tillamook Bay.

Flow	cfs
Summer average flow	455
Annual winter flood	28,300
2-year Winter flood	58,500
25-year Winter flood	83,200
50-year Winter flood	90,000

Tillamook Bay covers nearly 9,000 acres with a high tide water surface area of 12 square miles and low tide water surface area of 5 square miles. As is the case with most of Oregon's estuaries,

Tillamook Bay is slowly filling with land derived sediments. Moreover, beach and dune sands may be contributed to the bay by littoral and aeolian processes, much as is the case with Yaquina Bay (Kulm and Byrne, 1966). In the case of Yaquina Bay, substantial amounts of sand are being supplied to the Yaquina Bay chiefly during the winter and spring from inland rivers, littoral drift, and nearby dunes. Kulm and Byrne found the rate of sediment deposition in the channel between the entrance of the jetties and the upstream end of the turning basin to be 9.1 inches of sand per year. Thomas Murray and Associates (1972) found a large decrease in depths in the upper and lower Tillamook Bay by comparing old and recent U.S. Coast and Geodetic Survey maps.

Tillamook Bay and Bayocean spit are believed to have been formed from the eustatic rise of sea level and partial drowning of stream valleys. Figure 2 illustrates a geologist's conception of the development of the spit and bay. The late Pleistocene transgression of the sea drowned the lowland and extended up the tributary valleys. The sea's transgression is believed to have initiated a straightening of the shoreline as waves eroded back promontories and beach deposits closed off inlets. Evans (1942) stated that the growth of spits is always in the direction of beach drifting, and that the more material carried forward by the process the more rapidly the spit grows. It appears that Bayocean spit thus evolved and grew from the northward

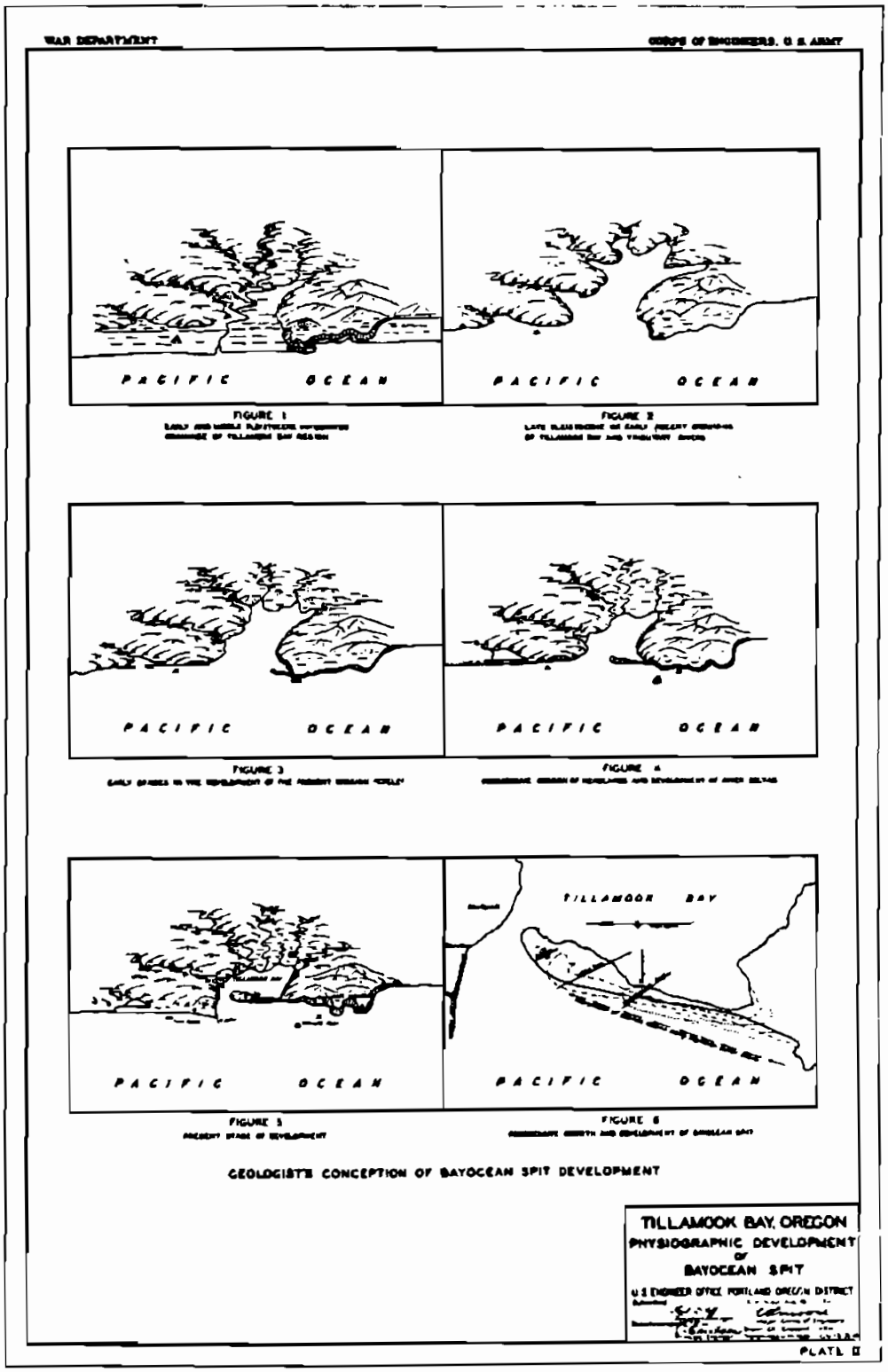


Figure 2. Geologist's conception of Bayocean spit development. U. S. Army Corps of Engineers.

littoral drift and deposition of sediments; however, there presently exists little physical supporting evidence.

Presently, Bayocean spit is approximately 4 miles long and varies in width from 1,000 feet in its midsection to over 3,000 feet at its northern and southern extremes. The south end, in the past much narrower, has been artificially diked and widened. Similarly, the north end has recently been widened by 2,000 feet due to sand accretion south of the new jetty at Kincheloe Point. Elevations vary from a few feet above mean lower low water at the southern end of the spit to 140 feet on the highest dunes located near the midsection. Bayocean's low hummocky surface is typical of most spits that have developed from loose sediments. The surf-borne sands become dried on the exposed backshore where winds accumulate it into small dunes that grow and migrate. Dicken (1961) describes the northern portion of the spit as marked by a low hummocky foredune with a broad sand flat in the interior. Several northwest-southeast trending hummocks are found on the bay side of the spit. The midsection of the spit has a high foredune and a complex of vegetated ridges and swales also trending northwest-southeast. The southernmost area of the spit is broad and flat with sparse grass cover. Dicken (1961) found an embryo of a foredune along some areas of the southern section of the spit indicating dune building on the sand flat.

Vegetation Cover

Nearly the entire spit is covered with vegetation. The densest cluster is found in the midsection where the dominant types are Shore pine (Pinus contorta (Dougl.) and Sitka spruce (Picea sitchensis (Bong.) Carr.) with an undergrowth of European beach grass (Ammophila arenaria (L.) Link.), Kinnikinnick (Arctostaphylos uva-ursi (L.) Spreng.) and Scotch broom (Cytisus scoparius (L.) Link.). In the past, trees extended from their present location in the mid-section of the spit, to its southern limits. The breach in 1952 completely eroded the southern end of the spit and destroyed all of the vegetation. A 75-acre sand flat now occupies the breach site. Plantings of European beach grass, Scotch broom, shore pine and Sitka spruce have been made to stabilize this zone. However, recent photographs of the area reveal little evidence of the planted vegetation, which has experienced repeated washover. The northern section of the spit is covered with grasses, low shrubs and sparsely scattered shore pine which appear to be stabilizing the loose sand.

Climate

Because of its proximity to the Pacific Ocean, the Tillamook area has a marine climate with cool summers and moderate winters. The annual temperature range is from approximately 40°F in January

to 60°F in July and August. Precipitation is predominantly associated with cyclonic activity, with maximum rainfall occurring during the winter months. Over 70 percent of the total annual precipitation occurs during the five months of November through March, and less than 7 percent during the three summer months of June through August. Recorded precipitation at Tillamook for the years 1927-1959 shows an average annual rainfall of 89.33 inches with extremes ranging from 130.29 to 64.62 inches. The month of December typically has the highest monthly rainfall with extremes ranging from 35.78 inches to 4.89 inches. July generally has the lowest rainfall averaging 1.19 inches for the recording period.

The increasing elevations in the Coast Range east of Tillamook effect an increase of annual precipitation. Some of the heaviest rainfall areas in the United States are found in the Coast Range. Figure 3 illustrates the abundant precipitation that annually occurs within the Tillamook Bay drainage basin. The copious winter precipitation provides high runoff and river discharges into Tillamook Bay (see Table 1). Conversely, the relatively dry summers are reflected in low river flows. Responses to the seasonal extremes in precipitation within the Tillamook Bay drainage basin are reflected in the average monthly discharges of the Trask and Wilson rivers (Figure 4).

The interaction of pressure systems within the north Pacific Ocean largely determines the seasonal wind conditions along much of

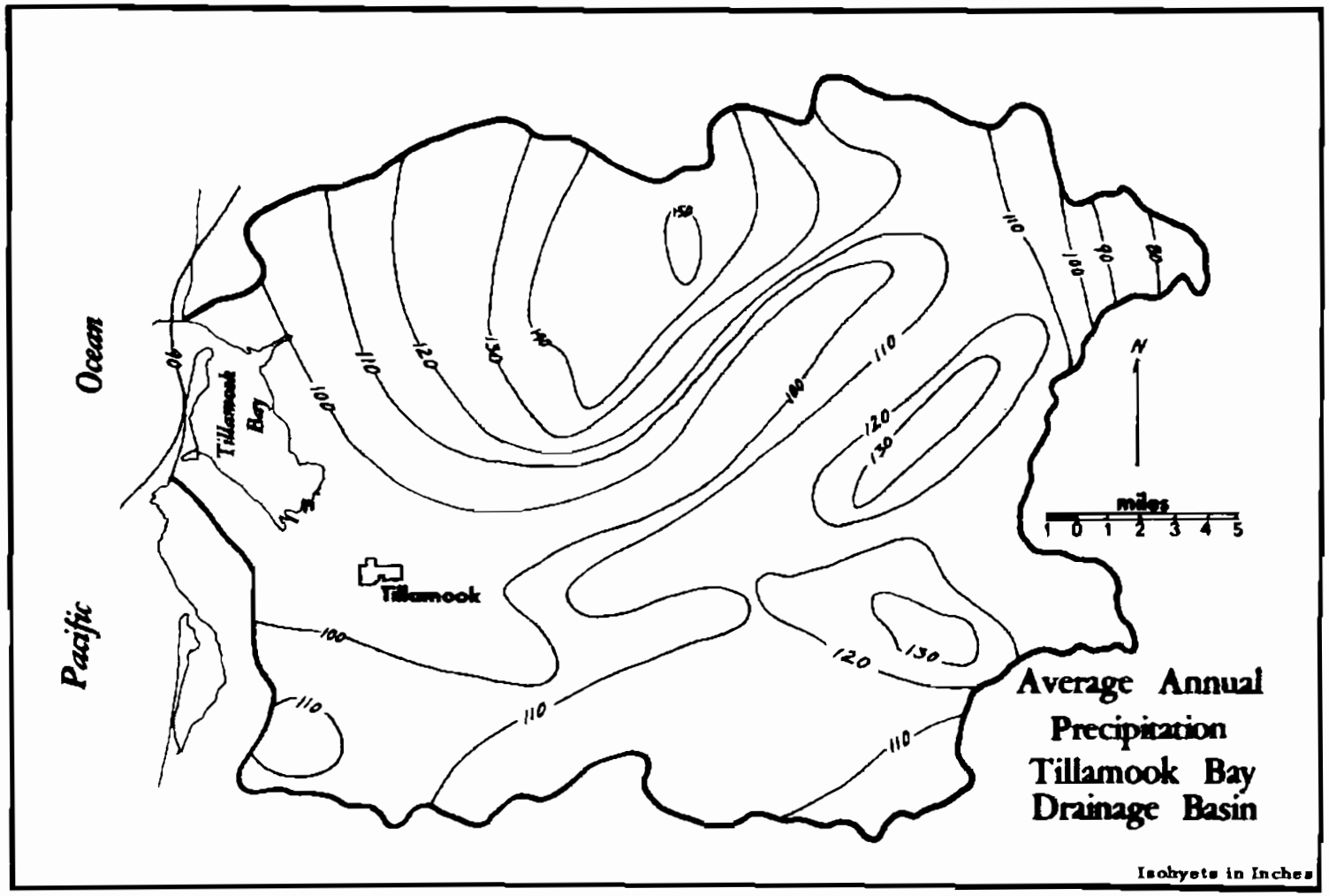
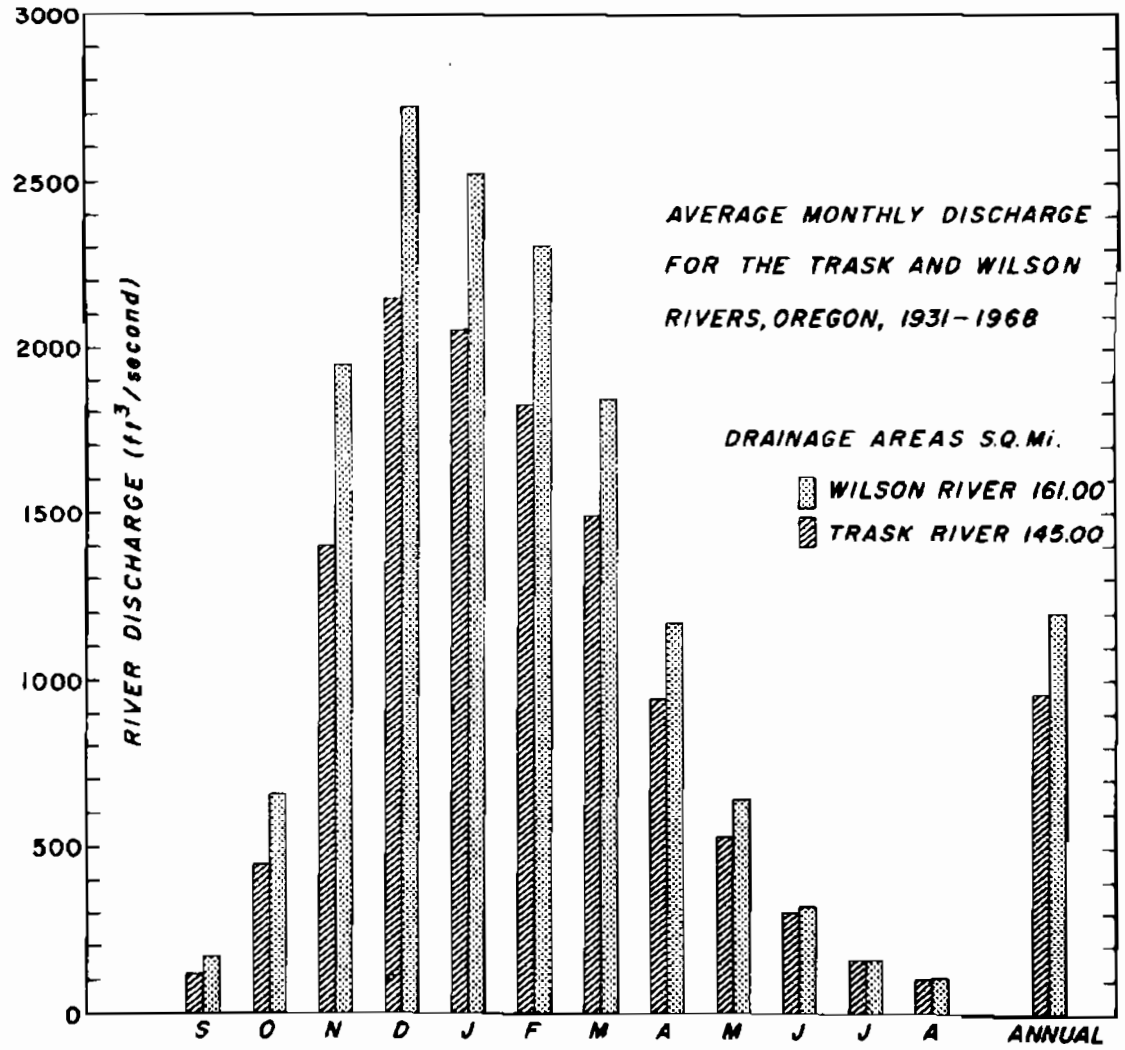


Figure 3. Average annual precipitation of Tillamook Bay drainage basin.



Source: Oregon State Water Res Bd.

Figure 4. Average monthly discharge of the Trask and Wilson Rivers.

the Pacific Northwest coast. Cooper (1958) found north to northwest winds predominating over the nearshore and coastal areas of Oregon during the summer. During the winter, south to southwest winds are most frequent. Bourke (1971) presents wind data for Tillamook gathered from 1943-1945 by the U. S. Weather Bureau. During that period, northwesterly winds dominated in March and May through September; while south and southwesterly winds were most frequent from October through February and April. Thus, Tillamook winds show a six-month seasonal reversal.

Drainage Area and Runoff

The Miami, Kilchis, Wilson, Trask and Tillamook rivers originate in the upper reaches of the Coast Range and flow through forest lands to the coastal lowlands and finally into Tillamook Bay (Figure 5). They have a combined drainage basin area of 535 square miles and an annual combined runoff of 2,849,100 acre feet at an average discharge of 3,500 cfs. Table 2 illustrates the individual characteristics of these rivers.

The generous normal precipitation experienced in the Coast Range and the copious downpours associated with major winter storms generate high potential for flooding in the Tillamook area (Table 1). Recent flooding occurred in January, 1972, December, 1964 and January, 1965. The flooding of January, 1972 was classified as a

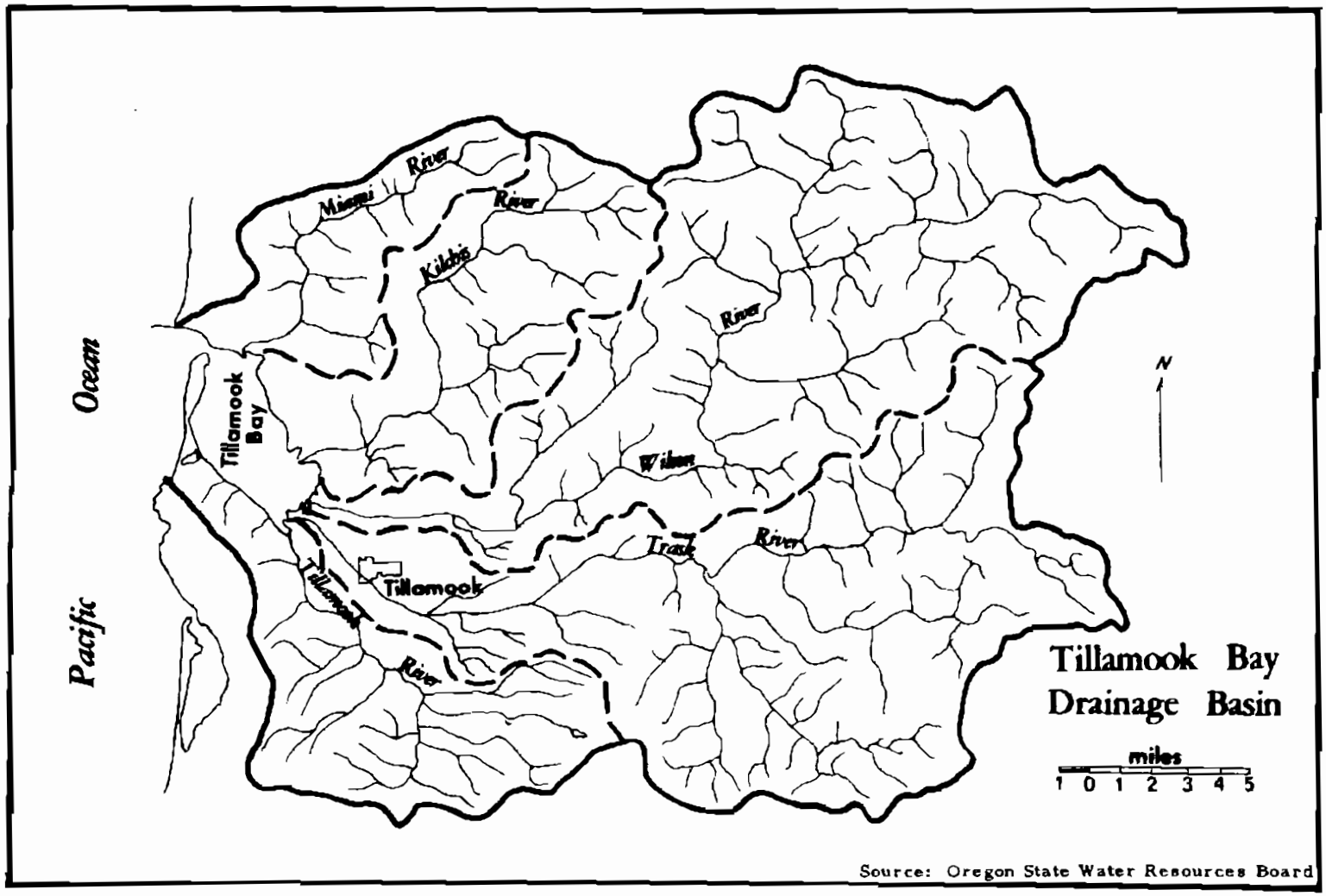


Figure 5. Tillamook Bay drainage basin.

Table 2. Tillamook Bay Drainage Basin Hydrographic Characteristics.

River	Drainage area (sq. mi.)	Average area precipitation (acre feet)	Average annual runoff (acre feet)	Average annual cfs
Miami	36	292,700	213,670	401
Kilchis	67	462,500	381,300	522
Wilson	195	1,210,800	1,047,800	1,428
Trask	176	1,019,130	839,800	1,150
Tillamook	61	344,000	292,500	401

Source: Oregon State Water Resources Board.

100-year flood, meaning that the probability of a flood of such magnitude occurring in a given year is 1 in 100, or 1 percent. The flooding of December, 1964 and January, 1965 was classified as a 70-year flood, or a 1.4 chance in 100 of occurring in a given year. Schlicker et al. (1972) states that contributing to lowland flooding in the area are the following: high tides, strong onshore winds, low permeability of highland soils, siltation of lower reaches of major streams and bays, rapid runoff due to the loss of vegetative cover from the Tillamook Burn, and extensive logging.

Tides

Tides within the 9,000 acre area of Tillamook Bay have the diurnal inequality typical of the Pacific coast. The mean diurnal tidal range within the bay is 7.5 feet. This range is somewhat reduced to a minimum of 5.2 at the extreme southern end of the bay, farthest

from the channel entrance. The U. S. Army Corps of Engineers (1970) has calculated a tidal prism for Tillamook Bay of 2.49×10^9 ft^3.

Tidal current velocities at the channel entrance were measured by the U. S. Army Corps of Engineers (1970) on July 29 and 30 and August 5 and 6 in 1969. Three complete ebb-flood cycles were observed, with the results tabulated in Table 3. The freshwater discharge during the measurements was very low. In order to make proper design requirements for the construction of the south jetty, a flow of 257,000 cfs was used as the combined tidal and freshwater discharge at the strength of ebb during a 50-year flood of 90,000 cfs. The south jetty, which is presently under construction, is designed to allow for a 1,475-foot wide channel entrance that will be nearly self-maintaining to a depth of 18 feet.

The U. S. Army Corps of Engineers is surveying and taking aerial photographs to monitor the effects of the construction of the south jetty on the tidal prism and currents in the entrance and also the effects on erosion of Bayocean spit. Furthermore, the Corps of Engineers is conducting tests with a small fixed-bed hydraulic model of Tillamook Bay with the purpose of studying the interrelationships of jetty spacing, tidal prisms, and regime of the bay.

Sediment is transported into and out of the channel by tidal currents. Some of the material that enters during the time of tidal flood is carried through the entrance and deposited within the bay.

Table 3. Current Velocities Observed at the Channel Entrance to Tillamook Bay.

Date 1969	Observed Maximum Discharge (cfs)	Observed Maximum Average Velocity (fps)	Observed Total Discharge (10^6 ft^3)	Corresponding Range of Tide (ft)	Total Discharge Extrapolated to 7.5-ft Range of Tide (10^6 ft^3)
7/29	-116,000[a]	-4.12	-1638	4.6 F[b]	-2670
7/29	+185,000[a]	+5.81	+2502	6.6 R[b]	+2852
8/5	- 57,000	-2.11	- 621	2.0 F	-2329
8/5	+106,000	+3.65	+1746	4.4 R	+2968
8/5-6	-107,000	-3.62	-1926	6.6 F	-2196
8/6	+ 69,000	+2.62	+1098	4.0 R	+2064
				Average	2513 (57,700 acre-ft) (90.14 mi^2-ft)

[a] - = ebb current and discharges; + = flood current and discharges.

[b] F = falling range of tide; R = rising range of tide.

Source: U.S. Army Corps of Engineers (1970).

The U. S. Army Corps of Engineers (1970) suggests that a considerable portion of that material remains and must be removed by dredging.

Waves and Shore Currents

Winter storms develop in the Gulf of Alaska and eastern Pacific. These storms create winds that circulate counter-clockwise around deep low pressure centers. The storms approach the Oregon coast from the south and southwest driving the sea surface into large waves with significant deep water wave heights of 20 to 30 feet or more; these waves attack the shore from the same direction (Figure 6). In the summer months, lower and longer-period waves arrive at the Oregon coast predominantly from the northwestern quadrant.

One of the most detailed wave studies for the Pacific Northwest was conducted by National Marine Consultants in 1960 and 1961. They employed wave hindcasting techniques to determine seasonal wave conditions. Data were grouped by seasons, winter including the months of December, January and February; spring - March, April and May; summer - June, July, August and September; and autumn - October and November. General conclusions were drawn from the data:

1) The predominant direction from which local seas approached was SW-SSE during autumn and winter and N-NW during spring and summer.

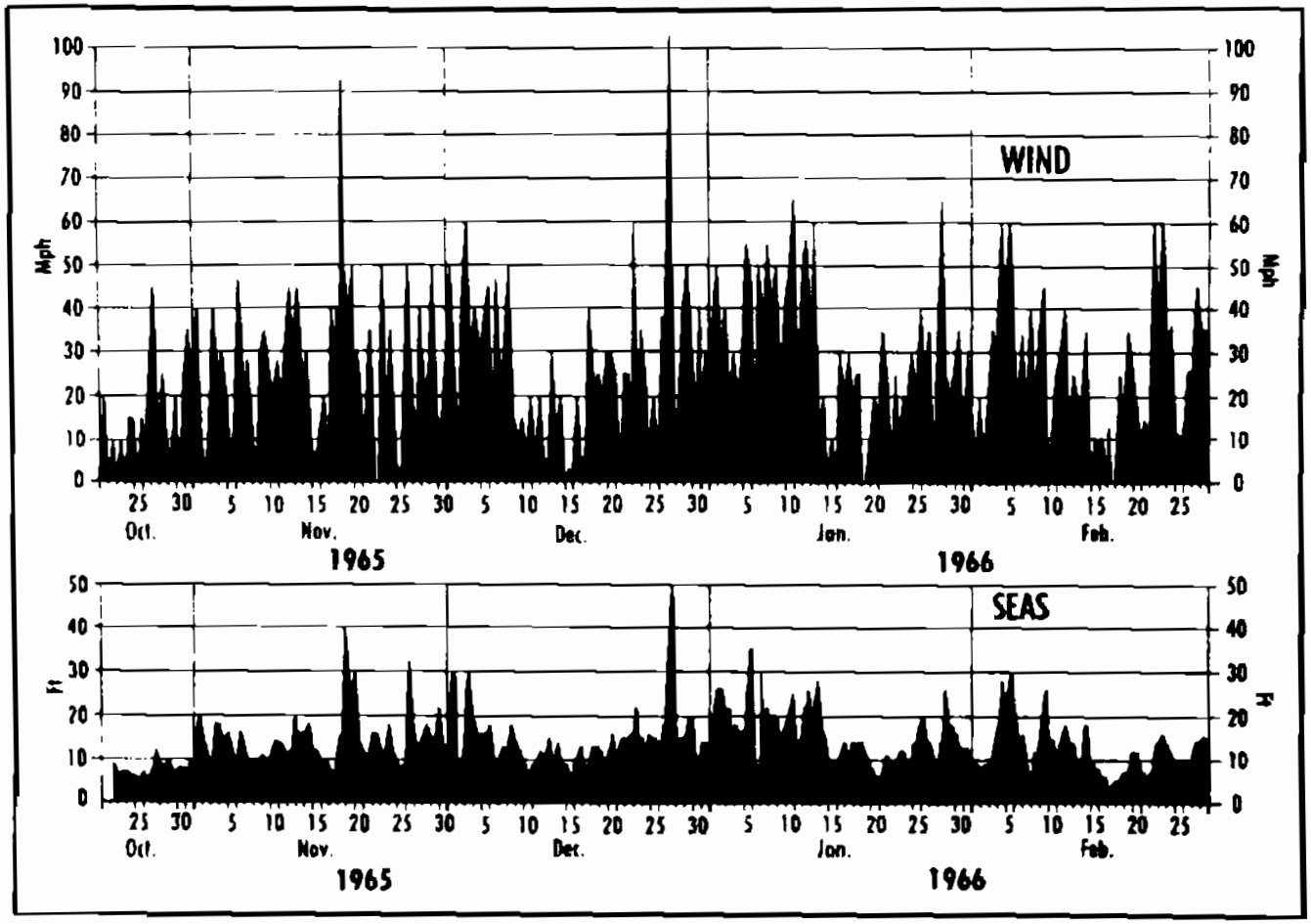


Figure 6. Wind and wave characteristics off the Oregon coast. After Rodgers, 1966.

2) The highest waves, regardless of angle of approach, always occurred in the winter.

3) Throughout the year, the highest waves came from the SW-SSE octant.

Neal et al. (1969) found a similar seasonality to the littoral drift in his investigations off Newport, Oregon. The drift direction from November-December to March is northward, reversing from April to October-November.

The U. S. Army Corps of Engineers (War Dept. Dist. Eng., 1940) conducted monthly observations of currents along the foreshore plunge line of Bayocean spit from May, 1939 to April, 1940, except December. Observations were taken 0.25 and 0.5 miles north of the jetty and along the spit at South Gap and Natatorium Gap. Currents were recorded as flowing to the north or south, parallel to the beach. The average northerly and southerly current velocities at all stations were about one foot per second. From May to November, except June and July, a southerly current predominated; whereas, a northerly current predominated from January to April.

Land Use

Forests occupy nearly 90 percent of the drainage basins that discharge into Tillamook Bay. Large areas of deforestation or clear cutting, however, have exposed the soil surface to increased runoff

and erosion, substantially adding to water-borne sediment loads. Moreover, Tillamook County has experienced large forest fires that have incinerated vegetation, further exposing the soil to rapid water runoff and erosion. The "Tillamook Burns" deforested an estimated 300,000 acres during the years 1933, 1939, and 1945. Approximately 233,000 acres of the burn area lie within Tillamook County, nearly all of which drains into Tillamook Bay. Formerly forested land was laid bare to heavy precipitation and runoff. Soil erosion undoubtedly increased stream sediment loads many-fold and resulted in increased deposition into Tillamook Bay. Reforestation of the "Burn" area began in 1949 and is scheduled for completion in 1973.

Farm and croplands occupy approximately 30,000 acres and are found primarily along the Miami and Tillamook rivers. The major production is in forage crops; however, there is a trend toward intensive agriculture. Earthen dikes have been built along some of the water courses of the lowland to prevent flooding and silt erosion. These dikes are often breached allowing floodwaters to erode valuable topsoil and add to the heavy sediment load of Tillamook County's rivers.

CHAPTER III

EARLY SETTLEMENT HISTORY

One of the earliest observations of Tillamook Bay was given by a passenger aboard Captain Robert Gray's 90-ton sloop, "Lady Washington." On August 14, 1788, the "Lady Washington" crossed the bar and anchored in Tillamook Bay. The following passages are excerpts from the passenger's diary (Bancroft, 1886).

> August 13th, latitude 45°56' at noon; in evening passed a tolerable harbor, with a bar. August 14th, returned to explore the harbor, which, after exploration by the boat, the sloop entered, anchoring half a mile from shore in two and one-fourth fathoms. Murderer's Harbor, for so it was named is I suppose, the entrance of the river of the West. It is by no means a safe place for any but a very small vessel to enter, the shoal at its entrance being so awkwardly situated, the passage so narrow, and the tide so rapid that it is scarcely possible to avoid danger.

Captain Gray thought it likely that here was the mouth of the famous River of the West. Before his departure, he had good reason to name his anchorage "Murderer's Harbor." Here, a group of the ship's company battled with natives and barely escaped with their lives.

The diary, written by this woman passenger, describes the dangers of the bar crossing, and notes only a small vessel may enter. However, it is significant to note that Captain Gray was willing and able to negotiate the bar and channel with his 90-ton sloop. His

crossing indicates that the channel conditions were sufficiently safe in his judgment to allow for passage.

Early Land Claims

In 1867, Webely Hauxhurst claimed the southern part of the sand spit. After his death, the claim was passed on to his wife, Mary Hauxhurst (Tillamook County Deed Records, June 15, 1877). The center and point of the sand spit were claimed respectively by A. B. Hallock and George Elliott on the same day, February 19, 1883 (Tillamook County Deed Records, February 19, 1883).

Hallock named his small holdings Barnegat, after a popular Atlantic coast beach resort (West Shore, 1882). Hallock welcomed tourists to the spit. An early newspaper account states that the spit was frequented by pleasure seekers and that A. B. Hallock had constructed a "Commodious wharf and warehouse here" (Tillamook Herald, May 22, 1891). Hallock also established a post office within his home on the spit near present-day Jackson Gap. The primary purpose of the post office was to serve the Cape Meares Lighthouse (The Oregonian, April 5, 1953).

Ownership of the original claims changed over the following several years. A. B. Hallock died passing ownership to his son, Edward. Following Edward Hallock's death, Annette B. Cotter, Edward's sister, inherited the land. The Elliott property was passed on to Scott Bezerth (Tillamook County Deed Records, February 19, 1883).

Bayocean Resort

While visiting the Tillamook area in the early 1900's, T. B. Potter, president and general manager of the T. B. Potter Realty Company of San Francisco and Kansas City, recognized the recreational potential of the sand spit. An early newspaper account describes Mr. Potter's professional prowess thusly (The Oregonian, June 29, 1970):

> Mr. Potter has the reputation among his friends of never having touched an investment that has not forged to the front, an unqualified success. It is said that his greatest accomplishments are due to the fact that his observations are wonderfully discriminating; that he is quick to grasp opportunities for development and that his subsequent action is quick, well-directed and gets results. It is said of him that he has enabled more people to make more money in suburban realty than any other individual in the United States.

Potter's idea was to establish an elegant resort on the spit which he called Bayocean Park. He put his plan into action by purchasing the Bezerth holdings on May 18, 1907 and the Cotter claim on January 29, 1908 (Olsen, 1937). A deed of dedication and plat map were recorded with Tillamook County on June 29, 1907 (Deed Records Tillamook County, June 29, 1907).

The plat map is an impressive display of approximately 3,000 50 x 100 foot lots with a large block of land mid-way on the spit reserved for the future hotel and bathhouse. Approximately 200 acres of land along the northern seaward side of the spit were to remain as a government reservation (Figure 7).

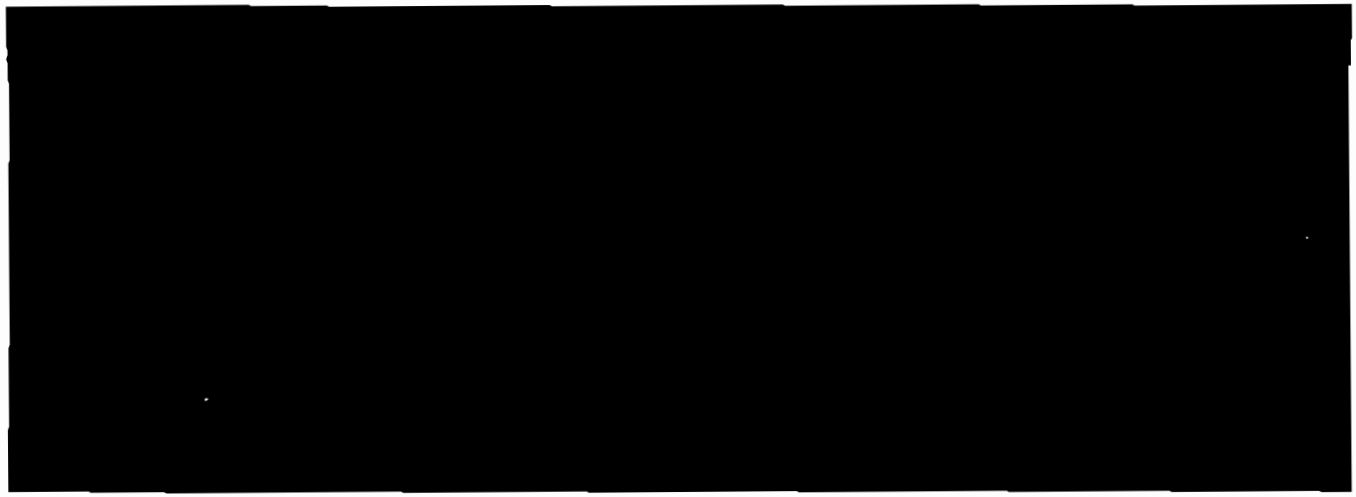


Figure 7. Plat map of Bayocean Park dated June 29, 1907. Courtesy of Tillamook County Surveyor's Office.

The only access to Bayocean Park was by boat; therefore, a pier, pavilion and boathouse were planned mid-way on the bayward side of the spit. Several miles of public streets and boulevards were platted. The principal north and south roads were Bayocean Boulevard, along the seaward margin of the spit, and Bay Street, paralleling the entire bay front. Avenues numbered 1 through 40 intersected the major thoroughfares.

The same day the deed and plat map were recorded (June 29, 1907), a four column article appeared in the Sunday Oregonian detailing the splendor of the planned beach resort (The Oregonian, June 29, 1907):

> This most attractive vacation spot eclipsing all the resorts four tourist travel in Europe, excelling anything on the Atlantic Coast and outstripping the best on the Pacific shores is to be only a bit over a couple of hours ride from the very heart of this city (Portland). E. E. Lytle, who is building The Pacific Railway and Navigation Company's line states that he is under obligation to complete the road next year, and places himself on record by saying that his trains will be able to run to Tillamook Bay in less than two and a half hours from the heart of Portland.

By chance or design, a shorter article appeared in the same issue of The Oregonian (The Oregonian, June 29, 1907) reporting that E. E. Lytle, President of the Pacific Railway and Navigation Company, had inspected the progress of the line from Hillsboro to Tillamook and found the work progressing to his satisfaction. Portlanders' access to Tillamook was limited and time consuming.

Lytle's return trip to Portland took 9 hours and 15 minutes, and was considered a new record for automobile travel (The Oregonian, June 29, 1907). It was clear to the developers that the success of Bayocean Park depended to a large measure upon the completion of Lytle's Pacific Railway and Navigation Company railroad (Olsen, 1937). Lytle fully expected to complete the Portland to Tillamook line by 1908 (The Oregonian, June 29, 1907). By plan, the train would run as far as Bay City. Wharves had been built in Garibaldi and Bay City to accommodate the passenger traffic. At Bay City, Bayocean visitors would then have a 15-minute ferry ride to the resort.

In spite of the depression of 1907, and the lack of a railroad line from Portland, Bayocean Park lots sold readily with prices ranging from $150 to $1800. The high cost of the property was justified on the grounds that improvements such as grading and paving of streets, water lines and sidewalk construction were included in the price.

Bayocean Park was widely advertised to offset its relative isolation from metropolitan centers. Figure 8 is an advertisement from Bonville's Western Monthly believed to have been published in 1909.

The fame of Bayocean spread and in March, 1908 several prominent Spokane, Washington investors visited the development with intentions of investing in the enterprise (Tillamook Herald, March 24, 1908). All of the visitors spoke optimistically about the resort. All

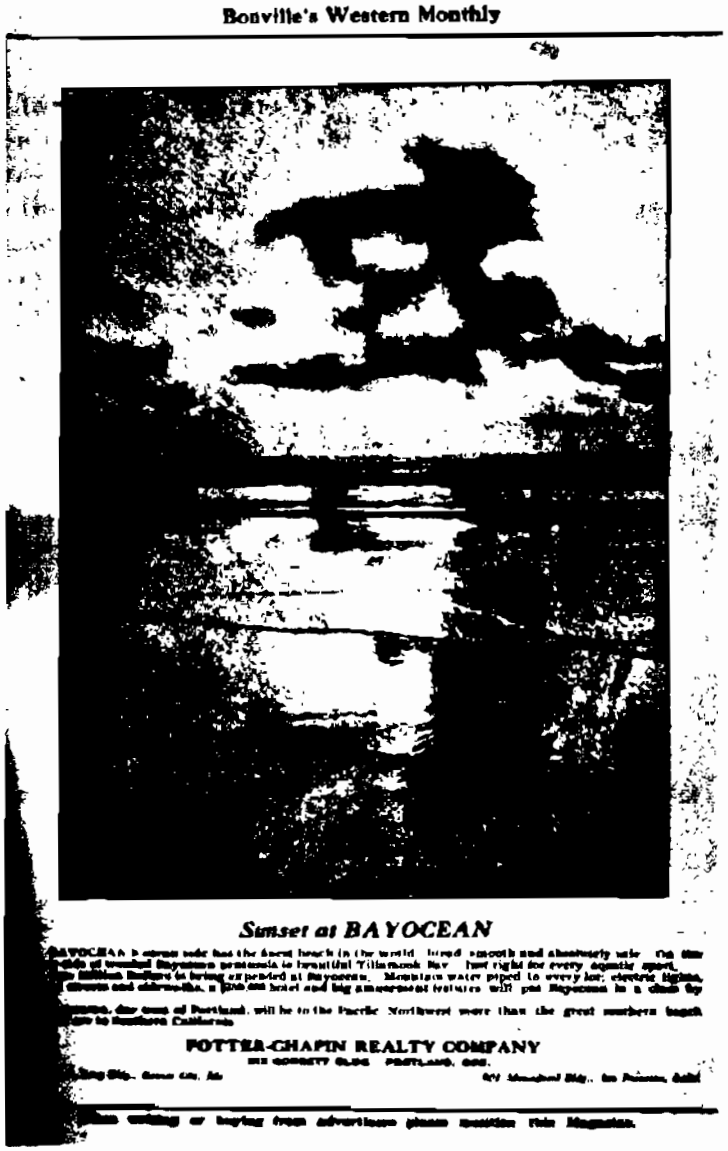


Figure 8. Advertisement for Bayoce an Park. Courtesy of Oregon State Archives.

intended to build bungalows at the resort and live during the summer months. T. I. Potter, one of the party and no apparent relation to T. B. Potter, stated that T. H. Kiser of Portland would take pictures of the resort

> . . . with a large moving picture machine. When these pictures are completed, Bayocean Park will be shown in its entirety. The views will be used for stereopticon lectures in the inland cities throughout the United States, giving the people an opportunity to see the wonderful beauty of Bayocean Park as well as if they were visitors in person (Tillamook Herald, March 24, 1908).

At this same time, Dr. Mott of Salem, one of the investors, announced the purchase of a site for the construction of a heated salt water natatorium. Enthusiasm regarding the future of Bayocean Park grew as developmental plans and prophecies increased.

Channel Improvements

Tillamook was experiencing an economic upswing during 1907 and 1908 as the Bayocean development progressed and E. E. Lytle's railroad grew closer to completion. Moreover, local industrialists, led by the lumber interests, were lobbying state and federal politicians to improve the Tillamook channel and create a deep water port at Tillamook Bay (Tillamook-Headlight, December 31, 1908).

Attempts had been made in the past to appeal to the federal government to construct jetties at the entrance to Tillamook Bay to stabilize the channel passage. Under storm conditions, the channel

was subject to rapid shifts of position up to one mile. One such account was written in local newspapers as told by the Captain of the "Sue H. Elmore," a 131-ton steamer which made weekly runs between Astoria and Tillamook (Tillamook-Herald, December 16, 1909). Tillamook Bay and Bar were surveyed and reviewed several times during the late 1800's and early 1900's. Early Corps of Engineers Reports (1887-1888 and 1898) clearly stated that there was no apparent need to improve the channel entrance (U. S. Congress, House, 1888):

> It is believed that the development of Tillamook Bay commerce is in no way hindered by the present condition of the bar and entrance, in that any vessel that can navigate the bay will find no difficulty in crossing the bar.
>
> Tillamook Bar has always been considered by mariners as one of the safest along the coast on account of its generally uniform depth and position, and no wreck is known to have ever occurred in crossing it.

It appears as though the findings of the Corps of Engineers and the experiences of the captain were opposed. However, in a subsequent report, the Corps of Engineers revised their stand regarding possible channel improvements. The report introduced the possibility not only of a north jetty but a south jetty as well (U. S. Congress, House, 1903).

> After careful study of the map and local conditions, the following project for obtaining 15 feet at mean lower low water is submitted. It involves the construction of a north high tide jetty of rubblestone from the permanent North Head near Green Hill, running seaward in a gentle curve concave to the ebb. This jetty would act partially to prevent the greater part of the sand movement on the north side, but chiefly as a retaining wall to gently control the ebb current and to keep it from spreading out to the north, and to confine it between this jetty and the shoal south sand spit. . . . At

> the same time it would seem desirable to build a shorter high-tide south jetty extending out from Kincheloe Point 4,400 feet from high water mark, to check the cyclic sand movement into the harbor from the south.

The Corps of Engineers appeared to acknowledge the ephemeral positioning of the channel and shoals. However, economics dictated that Tillamook's proximity to the Columbia River's major port facilities and its lack of a railroad severely limited its port potential, thus precluding channel improvements as of 1904.

Tillamook's economic upswing of 1907-1908 prompted another reappraisal of channel improvements by the Corps of Engineers (U.S. Congress, House, 1908). The primary emphasis was a study of the ship traffic at Tillamook Bay in order to determine if the traffic was large enough to warrant channel improvements. Jetty construction was again rejected; however, it "would be reconsidered when Tillamook would receive its long-hoped-for railroad" (U.S. Congress, House, 1908). The thought was that the railroad would increase commerce and shipping traffic for Tillamook Bay, thus justifying the channel improvements.

Bayocean Park 1910-1914

The planned completion of Lytle's railroads in 1908 was central to the developmental plans of Bayocean Park and the desired increase of commerce for Tillamook (The Oregonian, June 29, 1907). The

railroad was not completed in 1908 nor in 1909, delaying developmental plans of Bayocean's investors. In May, 1909, in preparation for the coming of the railroad, a 37-foot launch, "Bayocean" (Figure 9), was inaugurated into the enterprise to shuttle passengers and goods between the resort and the rail lines at Bay City and Garibaldi (Tillamook Herald, May 6, 1909).

Property continued to be sold primarily by an active advertising campaign. During 1911-1912, Potter had a monthly published in Portland called The Surf (Figure 10). Its primary purpose was to tell of news of the resort development. Property exchanges and some improvements continued; however, not at the pace desired, as Lytle's railroad was behind schedule thus delaying the full promotion of the resort. Physical improvements promised to the property owners decreased. Dissent among the property owners began (Olsen, 1937). However, on October 9, 1911, the Lytle railroad at long last reached Bay City (The Oregonian, Jaunary 1, 1912). Bayocean Park took on renewed life. Moreover, with the arrival of the railroad, the Corps of Engineers re-examined and approved the construction of a north jetty to Tillamook Bay channel; however, the question of a south jetty was delayed for future consideration (U. S. Congress, House, 1911).

Tillamook residents and investors grew optimistic with the encouraging developments. Potter had published a 22 page booklet promoting the beauty of Bayocean Park (Bayocean, 1907?). Figure 11

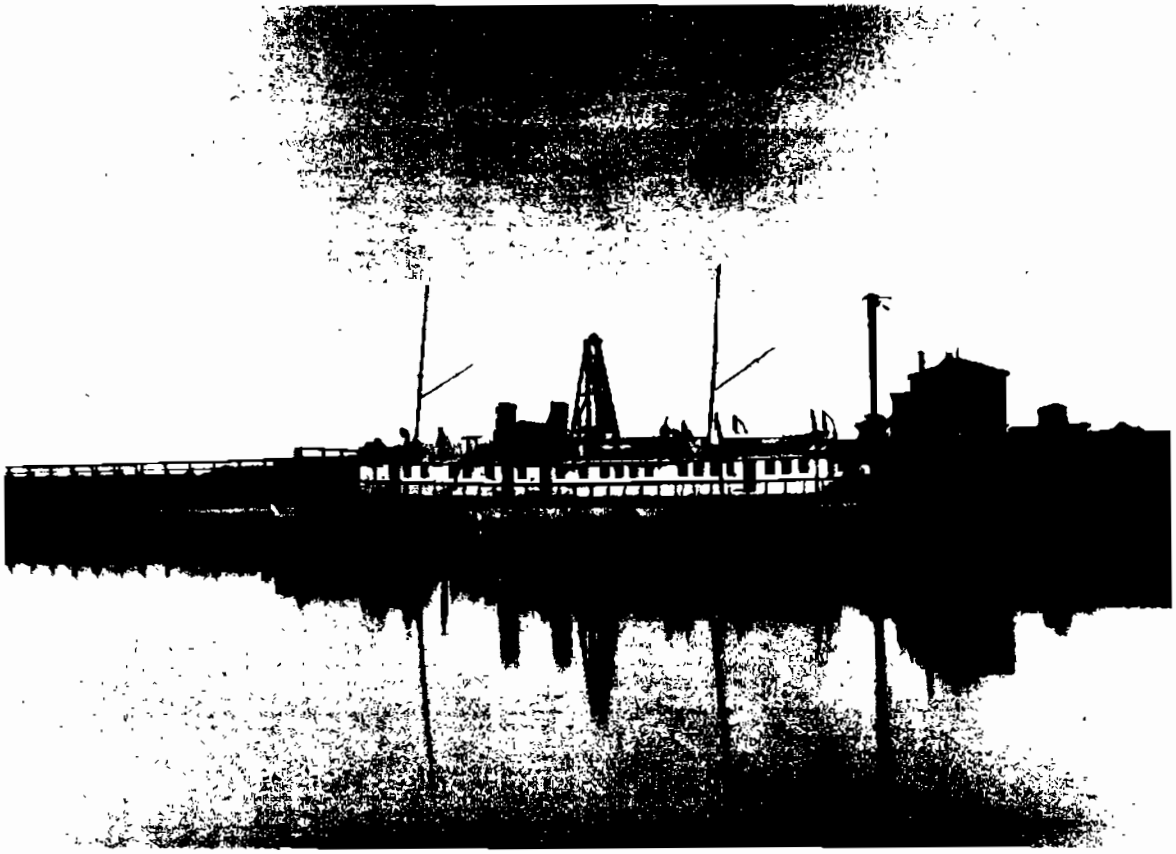


Figure 9. "Bayocean" launch ca. 1910. Courtesy of Oregon Historical Society.

BAYOCEAN, OREGON, JANUARY 1, 1912

1912 **Foreword** 1912

HE Christmas has come and gone, and it is to be hoped that it was a merry one for all.

The New year has arrived, it looks to us like a healthy youngster and we are [illegible] our share in seeing it grow thru its youth, [illegible] age.

[illegible] this will be as always, the giving of unthoughts that come from knowing it. The [illegible] this spot will appeal to others as it has appealed to us.

The development of Bayocean, as planned and [illegible] carried out to the last detail, means that city will [illegible] comparing favorably with Atlantic City, N. J.

The environments of Bayocean, natural and [illegible] are unequaled; it logically becomes the natural [illegible] for those seeking health, for those desirous of [illegible]

[illegible] DIRT FLYING AT BAYOCEAN

Street Work For December Ahead of November

The streets of Bayocean as seen by the visitors who have been there before, will be one big surprise on the next trip.

Chief Engineer Lockwood, with Supt. M. J. O'Donnell, have seriously been doing things in December.

High Street is now graded in its entirety and is ready for paving.

That portion of Pine Street from Block 56 to 60th Avenue is also in the urbo condition.

Alder Street is another on which the gradeps have finished with their part of the work, and as it looks now one of the beauties of this therefore appeal to all who have seen it.

Clark Street is well under way and shows completion of grades from Alder to 9th Avenue.

[illegible] BAY CITY TO HAVE MODERN FACTORY

Bayocean Extends Glad Welcome

BAY CITY, Or.—A car of new machinery has arrived for the Central Door & Manufacturing Company and a crew of men is busy installing it. The additional machinery places the equipment of the factory in such position that a strong bid for business can be made. W. M. Hennek, manager of the company, returned last week from a business trip to Portland, where he secured the additional machinery. While there he interested Portland capital in the enterprise. The factory will begin operations soon after the first of the year with a large force of men.

STILL ANOTHER BOAT FOR BAYOCEAN.

[illegible]

Figure 10. Publication of Surf. Courtesy of Bert Webber. "What Happened at Bayocean--Is Salishan Next." YeGalleon Press, 1973.

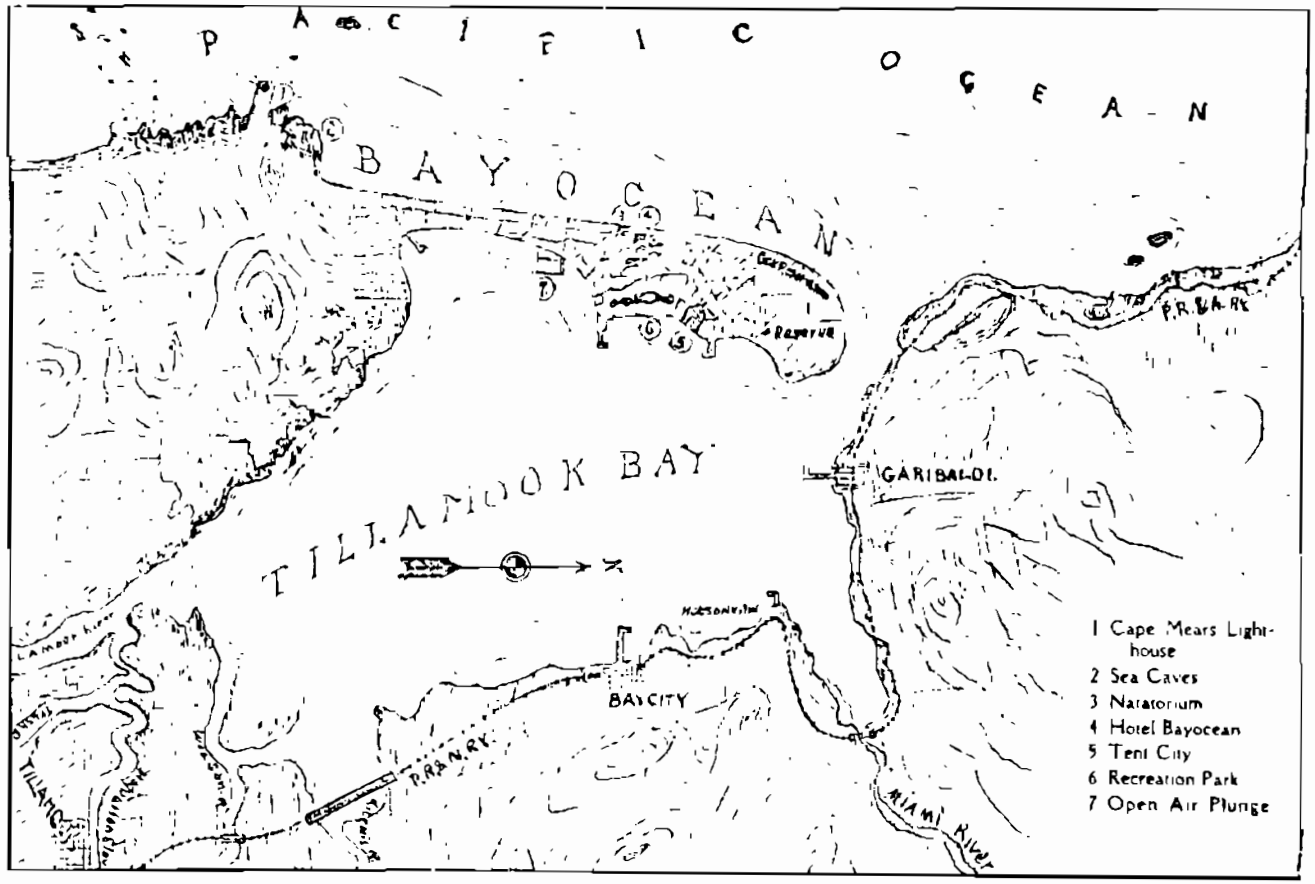


Figure 11. T. B. Potter's map of Bayocean Park and vicinity as taken from Bayocean (1907 ?).

is a map taken from the booklet. The map illustrates the locations of the major attractions of the spit, the P. R. & N. rail lines to Bay City and the Bayocean Park docks. T. B. Potter's predictions about the attractiveness of the resort illustrate the vigor of this promotional campaign (Bayocean, 1907?):

> These natural attractions should of themselves be sufficient to draw the tourists from all parts of the world, but in addition we are expending over one million dollars in high grade improvements, and when completed we challenge the world to produce another such resort as Bayocean.

The arrival of the railroad finally allowed the scheduling of an official opening of the resort for June 12, 1912 (Olsen, 1937). Photographs of the resort taken at its high point of development illustrate its attractiveness. Wide sandy beaches were backed by stable vegetation-covered foredunes (Figure 12). The large salt water natatorium was constructed mid-way on the spit, at the base of the foredunes (Figure 13). Upon the foredune and near the natatorium was the 40-room Bayocean Hotel (Figure 14). Other humble yet adequate temporary bungalow housing and tents were available to the visitor. Many large private vacation homes and permanent residences were scattered throughout the park (Figure 15). A pamphlet prepared about 1913 provided the following information about the resort (Bayocean Park Resort, 1913?):

> The natatorium is a 136-foot tank of artificially heated salt water.

Figure 12. Wide sandy beach along Bayocean spit ca. 1910. Courtesy of Pioneer Museum, Tillamook.

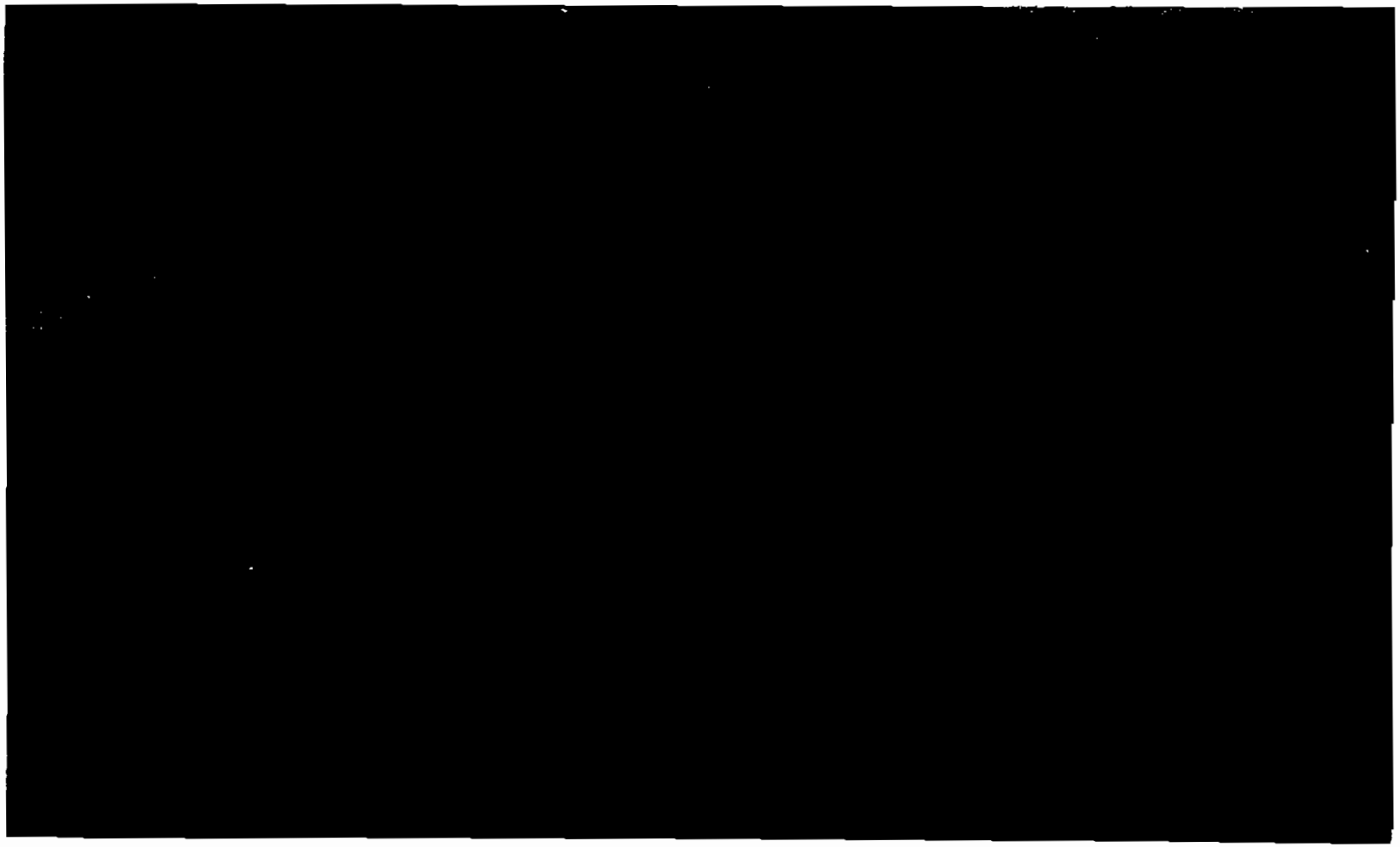


Figure 13. Natatorium on the beach at Bayocean ca. 1910. Courtesy of Pioneer Museum, Tillamook.

Figure 14. Bayocean Hotel and natatorium on the beach. Courtesy of Pioneer Museum, Tillamook.

Figure 15. Residence on Bayocean spit ca. 1910. Courtesy of Oregon Historical Society.

> There are: a dance hall, bowling alleys, billiard tables, tennis court, a big hotel parlor, 40 furnished bungalows, meant for 3-4 persons, with electric light, inside toilet, and running water, at $14 per week (10 days for $18.50; two weeks for $22.50). Also, 10 tents, furnished and equipped like the bungalows, for $9.50 per week (10 days, $15).
>
> Round trip tickets on P. R. & N. line $5.67 good from Friday to Monday.

Construction of the North Jetty

In June, 1914, work commenced on the construction of the north jetty to the channel entrance of Tillamook Bay. Rock for the jetty was quarried near the Miami River and hauled by train 7 miles to the jetty site (Tillamook Herald, December 1, 1914). The 5,400-foot long jetty projected straight seaward from the base of the hills on the northern side of the channel. The essentially straight structure with a slight southward curve at its terminous has a crest height of approximately 16 feet above mean lower low water. The north jetty was completed in October of 1917, utilizing a total of 429,000 tons of stone at a total construction cost of $766,000 (War Department District Engineer, 1940).

Decline of Bayocean Park

All outward signs pointed to the future prosperity of Tillamook and Bayocean Park; however, as time passed, the comparative prosperity and improvements to the resort were apparently not

sufficient as there were numerous complaints by investors. In 1914, complaints from land holders and investors grew (Olsen, 1937). The complaints culminated in charges that the enterprise was bankrupt; a petition was instituted for a receiver (The Oregonian, December 11, 1914). Affidavits were filed by H. L. Chapin, general manager of the T. B. Potter Realty Company, citing that there was no cause for a receiver to be named, as the assets of the company were far in excess of the liabilities. Chapin submitted as evidence that 1,648 lots had been sold for $890,336 and of this amount $573,000 had been paid; that net assets were $929,172 (The Oregonian, December 11, 1914). Although the Chapin evidence appeared convincing, the plaintiff's evidence was strong enough that the judge appointed a receiver. S. B. Vincent was appointed receiver with three members of each opposing faction to work with him (The Oregonian, December 11, 1914). Another suit occurred in 1917 when dissatisfied stockholders im the Bayocean Natatorium Company, a stockholders' enterprise organized to construct the natatorium, charged the T. B. Potter company with fraud in an alleged misrepresentation of the value of property of its share of stock in the natatorium corporation (The Oregonian, September 20, 1917).

Years of litigation followed receivership and claims of fraudulent practices. The newspaper accounts of the alleged practices on behalf of T. B. Potter undoubtedly downgraded the creditability of the

T. B. Potter Realty Company and value of Bayocean Park property. Improvements to the resort came slowly. The depressed resort was in operation; however, its isolation from the automobile during an era of road building and increased auto access to other resorts further depressed Bayocean Park (Olsen, 1937).

The long litigation which clouded the affairs of the Potter Company appeared to be nearing settlement when, in 1926-1927, a group of Tillamook residents were reviewing the requirements established by the court for assuming the assets of the T. B. Potter Company's Bayocean holdings. The court's requirements obligated new owners to construct a good road from Tillamook to Bayocean by April 1, 1927 and spend at least $100,000 " in general improvements and in straightening out the affairs of the Potter Company" (The Oregonian, June 3, 1926).

F. D. Mitchell, a long time resident and investor in Bayocean Park, had long recognized the need for a road link to Tillamook if the resort were to establish economic viability. His attempts to induce public officials to aid in road building met with disappointment. Mitchell and his wife assumed the responsibility for completing a road. In July, 1926, they succeeded in their self-imposed task and completed a portion of a dirt and plank road to the resort (The Oregonian, July 18, 1926).

In July 1927, a revival of the deteriorating resort appeared

imminent as the road had been constructed and the group of Tillamook residents, recently organized under the name of the Tillamook-Bayocean Company, has assumed the entire assets of T. B. Potter's Bayocean Park holdings (The Oregonian, July 13, 1927):

> The acceptance of the court's terms for the settlement of the delinquent taxes and the agreement to build a road of market standard into Bay Ocean brings that resort, once the pride of Tillamook County's beaches, with its paved streets, huge natatorium and attractive summer homes and hotel a renewed bright outlook.

The optimism was short-lived as the stock market crash and depression of 1929 halted all hopes for revival of the resort. One by one, the cottages were abandoned, the hotel closed and numerous other structures were vacated (Olsen, 1937).

Depression

Bayocean spit and resort remained essentially dormant from 1929 to 1933. Discussion was opened in 1933 for the construction of a south jetty. The proposed jetty would create a channel of 22 feet depth at mean low water through the bar and a turning basin 20 feet deep at mean low water (Tillamook Herald, February 23, 1933). Local interest was generated in support of the proposal. However, it appears that funds for the south jetty were diverted to the rehabilitation of the north jetty which was in need of repair after 13 years of weakening by wave and tidal activity. The north jetty was also extended

300 feet for a total length of 5, 700 feet (War Department District Engineer, 1940).

The depression did bring some interesting news regarding Bayocean Resort. In 1934, two or three families and several single men, drifters and products of the depression, obtained permission to move into the deserted Bayocean Hotel (The Oregonian, April 11, 1935). Recognizing the possibilities of their surroundings, they organized a communal living group, calling themselves The Artisans Cooperative Community. Work among its members was divided equally, men doing fishing and gardening, women cooking and housework, children doing small chores. The colony found a market for some of their seafood products (The Oregonian, October 6, 1935). The efforts of the group came to the attention of Washington, D. C. The Federal Emergency Relief Administration granted the colony $3, 900 to purchase fishing equipment and building materials. They were also given possession of a government owned 65-foot cutter docked at Astoria. With the new cutter the group planned to fish for tuna far off the Oregon coast (The Oregonian, October 6, 1935). The colony appears to have flourished for a short period of time and then departed. No mention of the colony was found following the 1935 reports.

One final glimmer of hope was presented to the investors of Bayocean Park when in 1936 the Wilson River Highway was opened

providing easy automobile travel between Tillamook and Portland (The Oregonian, December 6, 1936). The report states that the hotel, which the Artisans' colony had taken occupancy of two years earlier, was totally gone, "now nothing remains but a gapping foundation and stark reminder of what had been" (The Oregonian, December 6, 1936). Property owners were warned that real estate men had been approaching the investors with discouraging reports about the resort and following with offers of small sums of money to assume ownership. The 1936 newspaper account clearly illustrates the deterioration of the resort. A 1932 photograph of the undermined sidewalk fronting the natatorium is one of the first illustrations of erosion damage to resort structures (The Oregonian, December 6, 1936).

Summary

The historical evidence suggests that T. B. Potter did have grand designs for his Bayocean Park Resort. However, the success of his plan required quick and easy access for city dwellers to the resort via the planned railroad to Tillamook. Potter did what he could to offset the three-year delay with the rail line's completion. He advertised widely and even transported Portlanders by boat to Bayocean. It appears, however, as though his efforts were inadequate. Funds for promised resort improvements dwindled as sales

lagged. The ensuing years brought court actions and further decline until the depression of 1929 ended all hope for the ill-fated Bayocean Park Resort.

CHAPTER IV

EROSION AND PHYSICAL CHANGES TO BAYOCEAN SPIT

The decline of Bayocean Park up to the decade of the 1930's appears to have occurred as a result of poor developmental planning and the effects of a severe depression. Further deterioration of the resort and spit itself is believed to have begun as waves began to erode the spit, eventually undermining and destroying some of the large structures at Bayocean Park.

Early Erosion

It is difficult to assess when noticeable erosion began on the spit. A discrepancy exists between Corps of Engineers reports and accounts of the residents. The Corps of Engineers maintains that not until 1930 was erosion of the foredune noticeable and not until 1937 did its rate of retreat become a threat to the residents of the spit (War Department District Engineer, 1930). This account conflicts with another statement made several pages later in the same publication in which the Corps explains that a total of 11 houses had either been destroyed or moved since 1927 (War Dept. Dist. Eng., 1940). This latter declaration indicates that the threat to residents began in 1927 rather than 1937 as reported earlier in the same document. Moreover, the U. S.

Army Corps of Engineers reports storm damage to Bayocean spit in 1908, 1909, 1915 and 1920 (War. Dept. Dist. Eng., 1939). An exhaustive attempt to substantiate this information was unsuccessful.

Residents of Bayocean Park contend that there was no erosion or property loss prior to 1932 (see Appendix, p. 136 and 140). They maintain that erosion of the spit began following the rehabilitation and 300-foot extension of the north jetty in 1932-1933. Photographs of 1932 and 1936 of the natatorium published in The Oregonian (December 6, 1936) show the progress of its erosional destruction. In 1932, the sidewalk fronting the structure was undermined and nearly gone. By 1936, the seaward portion of the structure had been undermined, weakening the walls and causing the roof to fall in. Figure 16 is an undated photograph of the natatorium taken sometime between the first onslaught of erosion in 1932 and the roof destruction in 1936. The sidewalk is totally destroyed and erosion was beginning to undermine the building itself. The photos of the natatorium destruction clearly show that erosion was not only threatening, but destroying structures on the spit prior to 1937.

Dicken (1961) reports that a resident of the spit used stakes at an unknown location to mark the progress of erosion for a period of 7 years, 1926-1933. He found that the rate of retreat of the foredune was an average of 1 foot per year from 1926 to 1931. The rate increased markedly to 6 feet per year during 1932 and 1933, coinciding with the 300-foot lengthening of the north jetty.

Figure 16. Wave action undermining Bayocean natorium ca. 1930. Courtesy of Bert Webber. "What Happened at Bayocean Spit--Is Salishan Next?" YeGalleon Press, 1973.

Figure 17. Wash at Jackson Gap, Bayocean spit, looking west showing broken water main, January 6, 1939. Courtesy of U.S. Corps of Engineers.

The Corps of Engineers maintained that the north jetty construction and subsequent lengthening had little impact upon Bayocean spit. They countered the residents' claims with geomorphological evidence that the Oregon coast is undergoing a recessional change without the influence of man-made structures and that erosion may be normally expected anywhere on the coast (War Dept. Dist. Eng., 1940).

It is clear that the north jetty had trapped large amounts of sand and caused a rapid seaward advance of its northern shoreline (Figure 36, p. 94). It is difficult to assess whether the 300-foot extension to the north jetty reached some critical length depriving the spit of littoral sands, thus initiating its rapid erosion in 1932-1933. The problem is, there exists very little information regarding erosion of the spit prior to 1932-1933. The absence of published erosion information suggests: (1) that little noticeable erosion had been occurring prior to 1932; (2) erosional destruction to the abandoned buildings such as the natatorium had been occurring but met with little concern.

Within a few years of its completion, the north jetty had trapped an estimated 6,000,000 cubic yards of sand to the north of the structure (War Dept. Dist. Eng., 1930). The concensus among the residents was that the littoral sands were prevented from reaching the spit and replenishing winter losses. They also believed that the jetty initiated added currents and offshore eddies which aided erosion of Bayocean spit (The Oregonian, February 19, 1939b).

A 1939 Corps of Engineers report does acknowledge the possibility of a deflecting effect of the north jetty upon littoral sands (Huff, 1939). The report hypothesizes that southward drifting littoral sands may have been deflecting beach sands into deep water where they were lost to Bayocean's beach and nearshore. Depth changes offshore from Bayocean spit indicate sand losses and offshore deepening (Figure 18). From 1885 to 1939, the 3-fathom contour migrated an average of 1,500 feet closer to Bayocean's shoreline (War Dept. Dist. Eng., 1940). Greater nearshore depths allow waves of increased energy to approach the shore with less shoaling, refraction, and energy loss. A greater concentration of wave energy in the nearshore zone would allow for increased beach erosion potential.

The apparent increased erosion rates of 1932-1933 alarmed the residents of Bayocean Park. They proposed that the construction of a south jetty would afford protection to the spit as well as benefit navigation in the channel (The Oregonian, February 19, 1939b; War Dept. Dist. Eng., 1941). Their reasoning was that a south jetty would trap sand to the south along Bayocean's beach front and replenish sand losses. Moreover, the suspected offshore currents created by the north jetty would be driven farther out to sea preventing the erosive effects of offshore eddies. The Corps of Engineers countered, explaining that they believed a south jetty would create only local accretion south of its land connection and would be of no value to the protection

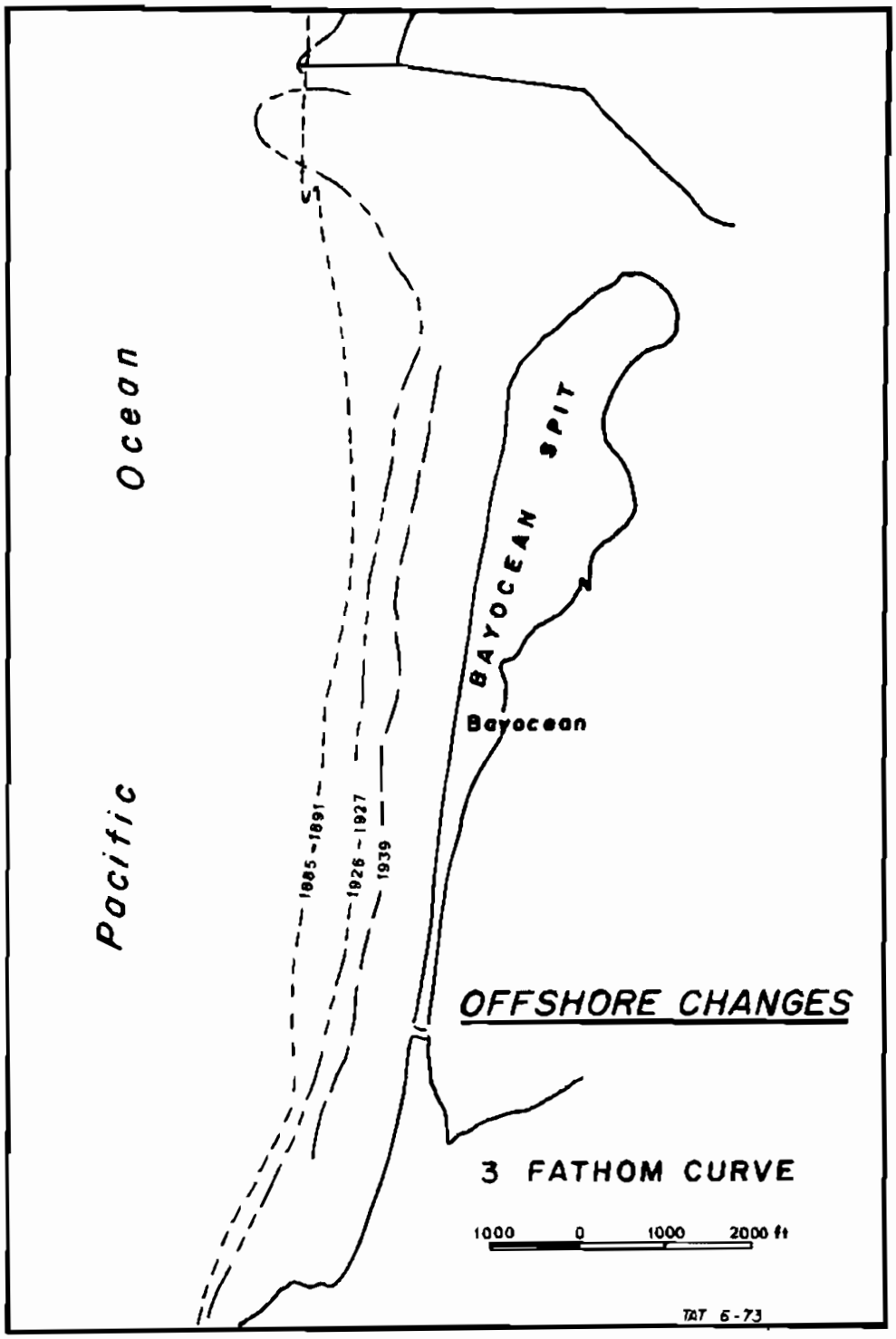


Figure 18. Depth changes offshore Bayocean spit 1885-1939. U.S. Army Corps of Engineers.

of the inhabited portion of the spit (War Dept. Dist. Eng., 1941).

Erosion - 1939

Erosion along much of Bayocean's beach occurred through the late 1930's. Erosion during the winter of 1939 was particulary severe and caused considerable damage. On January 3, 4 and 5, 1939, a severe storm and high tide combined to lash the spit. The Headlight Herald (January 5, 1939) details the destruction:

> At Bay Ocean, the ocean carried huge timbers, rocks and debris out onto the highway, blocking it in many places. Water poured through the gaps. . . water poured through in a torrent, digging a new deep furrow, carrying great boulders weighing a ton or more. . . . Further on, at the second opening, the surf pounded along the beach tearing through, bearing huge trees and rocks with it, the gap there becoming a part of the ocean at high tide leaving a drop of nine feet to the concrete road, leading to Bay Ocean City.

The gaps discussed in the newspaper account are found along the narrow southern neck of the spit (Figure 19). Two were awash with waves carrying debris and gravel into Tillamook Bay. The largest washover, Jackson Gap, was about 50 feet wide and 7 feet below the general ground level (Figure 17). Natatorium Gap had also been awash. The natatorium which stood on the seaward side of the gap had been totally destroyed (Figures 20 and 21). Considerable damage was done to the paved road along the foredune between Cape Meares and Bayocean Resort. The road's surface was littered with debris washed in by the high waves (Figures 22 and 23).

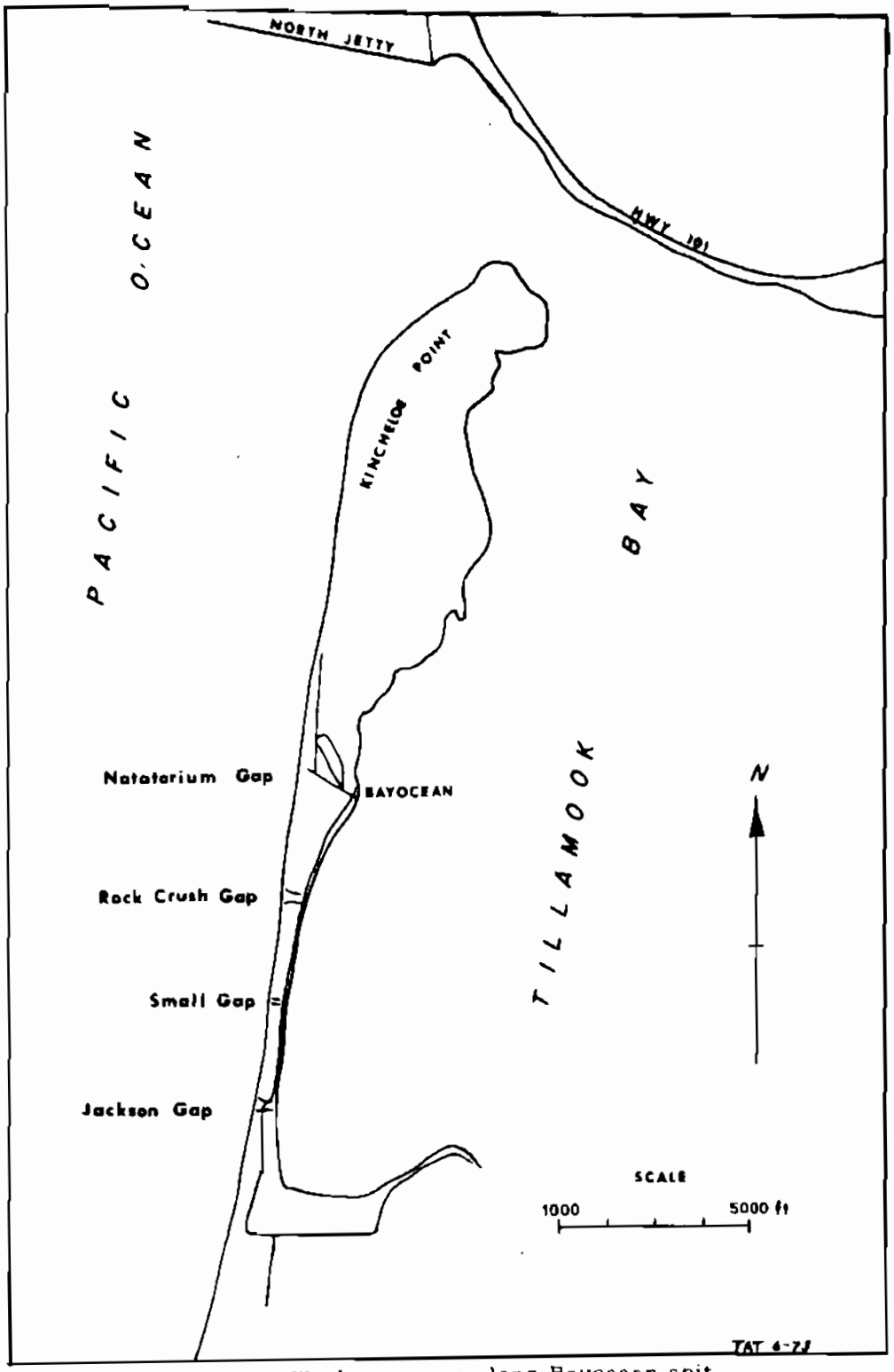


Figure 19. Washover gaps along Bayocean spit.

Figure 20. Looking south at Bayocean natatorium ca. 1915. Olsen, 1937.

Figure 21. Looking north at remains of Bayocean natatorium ca. 1940. Pioneer Museum, Tillamook.

Figure 22. Drift and debris at Bayocean Park. January 4, 1939. U.S. Army Corps of Engineers.

Figure 23. Drift and debris on the road to Bayocean Park. January 4, 1939. U.S. Army Corps of Engineers.

Subsequent high tides and storms in January and February of 1939 continued the destruction (The Oregonian, February 19, 1939b). During the winter of 1939, maximum recession of the top of the foredune bank was 25 feet, with an overall of 7.3 feet for the entire spit (War Dept. Dist. Eng., 1940). In the Village of Cape Meares, wave action had cut deeply into the clay seacliff, later causing a slide of 150 feet long making a 60-foot indentation in the cliff.

Sandbag, wood and concrete bulkheads had been built at various times to protect local areas along the foredunes; none withstood the onslaught and erosive action of storm waves. Nor did these various structures remain in place long enough to be considered at all effective in retarding the erosion rate in the area which they were intended to protect (War Dept. Dist. Eng., 1940).

The conclusion of the 1939 erosion saw four houses undermined and destroyed, nine houses were in precarious positions, and six had been moved back from the foredune. The natatorium had been completely destroyed (War Dept. Dist. Eng., 1939). There still remained approximately 30 dwellings at Bayocean, ten of which were permanently occupied. There were two small stores and an auto camp with 35 cottages located mid-way on the bay side of the spit. The 1940 population was 32 permanent and approximately 150 peak population during the summer (War Dept. Dist. Eng., 1940).

The destructive erosion of January 1939 initiated much concern and fear, not only among residents and investors in Bayocean Park but also Tillamook citizens. The fear was not only of further erosional destruction but also of possible breaching of the spit. A breach in the spit would allow sand and gravel to enter the bay, covering shellfish beds, and would permit wave activity to disrupt shipping and flood low farm lands (Tillamook Herald, February 19, 1939b). A group of concerned citizens organized the Bayocean Erosion Committee (Appendix, p. 133). Their stated purpose was:

> To devise ways and means of securing protection against ravages of Pacific Ocean now going forward at Bayocean on the west shore of Tillamook Bay, which if let go will ultimately merge the ocean and bay following which certain destruction impends for all lowlands adjacent to bay which will include towns of Garibaldi, Bay City and eventually the City of Tillamook.

Figure 28a (p. 71) is a mosaic of vertical aerial photographs of Bayocean spit taken May 8, 1939. The winter storms of 1939 had eroded much of the foredune of the spit and washed over the spit at Natatorium Gap (1) and Jackson Gap (2). The fear was that the narrow sand ridge would continue to erode and weaken while washovers widened and deepened the gaps, eventually breaching the spit. Figure 24 is a low oblique aerial view of the spit taken from a position inland of Cape Meares. The arrow points to lighter colored beach sands washed through the gaps and into the bay during former storms. The barren eroded seaward face of the foredune in 1939 is sharply

Figure 24. Aerial view of Bayocean spit, looking northerly from Cape Meares. Tide +6.6 feet. July 20, 1939. U.S. Army Corps of Engineers.

contrasted to the pre-erosion vegetated seaward face of the foredunes about 1910 (Figure 12).

A shoal area nearly one square mile in area is often marked by the wave activity within the channel entrance to Tillamook Bay (Figure 25). The most severe waves are often formed at the seaward projection of the shoal just south of the end of the north jetty. The shoal is bounded on the north and south by relatively deeper channels with less wave activity. Both channels are believed to be formed by ebb and flow tidal currents. Both are plotted on USC and GS chart Figure 25; however, aerial photos taken of the spit over several years show the south channel is an ephemeral feature.

Bayocean Boulevard, the main access road to Bayocean Park, was cut along the narrow sand ridge (Figure 26). At Jackson Gap, the road descended and turned bayward within the gap. Beyond the gap, the road continued northward to the park. Use of the gap as a convenient turning point for the road may have increased its vulnerability to widening and deepening as the passage of vehicles would prevent vegetation growth and sand accumulation. The road should have avoided use of the gap. The road should have descended the ridge south of Jackson Gap and have been diked along its bayward margin. Sand stabilizing vegetation should have been planted within the gap to trap all beach-derived sand.

Figure 25. 1971 U. S. Coast and Geodetic Survey chart.

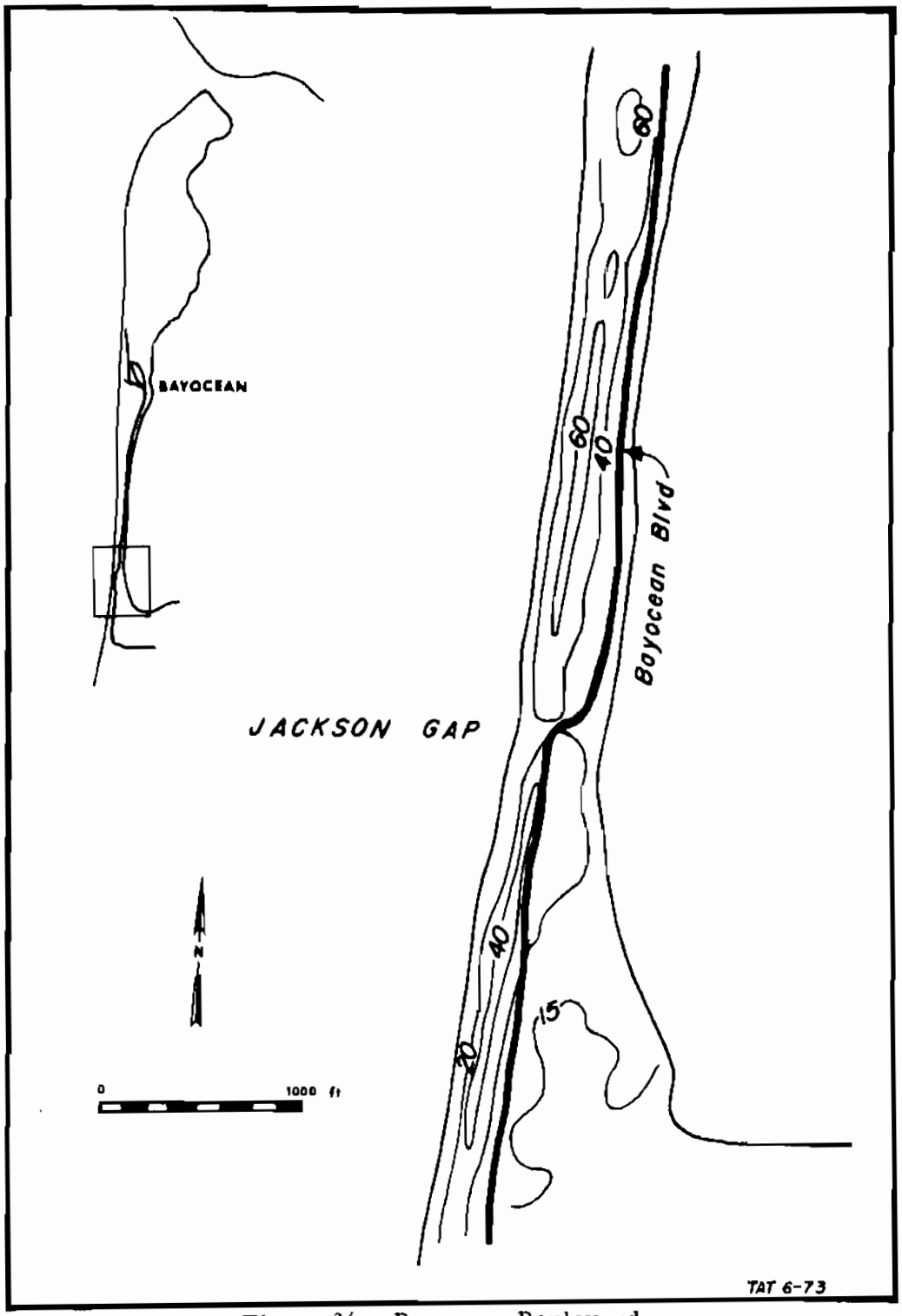


Figure 26. Bayocean Boulevard.

Erosion - 1940 to 1948

In January, 1940, winter storm waves continued to gnaw at the spit and widen the gaps cut by the preceding year's storms. A newspaper account details the conditions on the spit (The Oregonian, January 28, 1940):

> The cuts made across the peninsula a year ago are being deepened and widened by the water of the ocean passing through, and the higher parts of the peninsula are being cut out continuously. More of the residences on the ridge have been endangered as to require their abandonment and others soon will be, at the rate of erosion.

The Bayocean Erosion Committee appealed to state and federal representatives and, in one case, the President of the United States, for emergency assistance (Appendix, p. 140). Unfortunately, they received little support.

The U. S. Army Corps of Engineers prepared at least three research reports regarding erosion of Bayocean spit between 1939 and 1940. The largest and most comprehensive research report was prepared August 26, 1940, entitled "Report on Beach Erosion Studies, Tillamook Bay, Oregon." The report suggested four courses of action to retard the erosion (War Dept. Dist. Eng., 1940):

(1) Construction of a short south jetty to check the movement of longshore drift from Bayocean spit into the bay and afford storm wave protection to the channel and lower bay;

(2) Construction of a full length south jetty to more positively check

the flow of longshore drift into the channel, better control the channel, and provide greater depths for navigation over the bar;

(3) Construction of a groin system throughout the length of the spit to preserve and trap beach sand;

(4) Construction of a south entrance to the bay. The existing jetties would be allowed to deteriorate and close the present channel entrance. A new channel entrance at Jackson Gap would be stabilized by north and south jetties. It was hypothesized that such an improvement would result in accretion along Bayocean spit and eliminate storm damage at the present channel and north end of the bay as Cape Meares would provide better protection from storm driven southwesterly waves.

The war years postponed work by the Corps of Engineers on the Bayocean erosion problem; however, erosion continued (Table 4).

Table 4 shows that from 1939 to 1946 erosion was concentrating on the narrow sand ridge between Natatorium and Jackson gaps while the bank at station 146 along the northern one-third of the spit accreted.

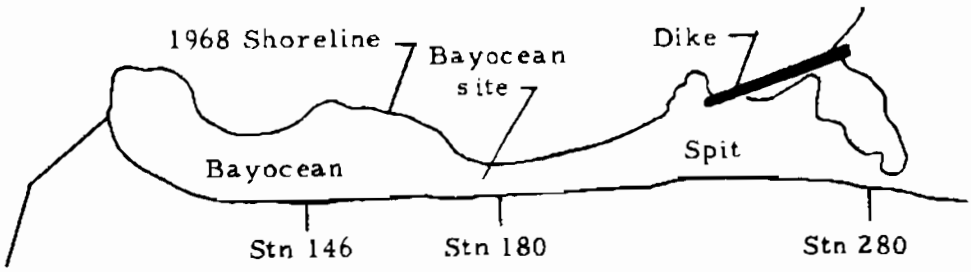
Figure 27 graphically illustrates the recession of the seaward face of the foredune by a series of surveyed cross-sections. The surveys were taken May, 1939, September, 1939, May, 1940 and January, 1946 at points along the beach shown in the inset map of Figure 27. From May, 1939 to January, 1946, the foredune receded along the entire length of the spit where a pronounced vegetated

Table 4. Top of Bank Changes[a]. Amount of Accretion (+) or Erosion (-) (feet per year), 1939-1971.

Period	Station 146	Station 190	Station 280
1939-1946	+ 4	- 4	- 8
1946-1957	- 4	-34	-60
1957-1962	- 4	-28	-10
1962-1967	-24	-15	- 8
1967-1971[b]	-35	-15	(no data)

[a]Source: U. S. Army Corps of Engineers, National Shoreline Study, Columbia-North Pacific Region, Washington and Oregon (1971).

[b]Source: U. S. Army Corps of Engineers. Shoreline Changes Map, Bayocean Peninsula (1971).



Location of Survey Stations

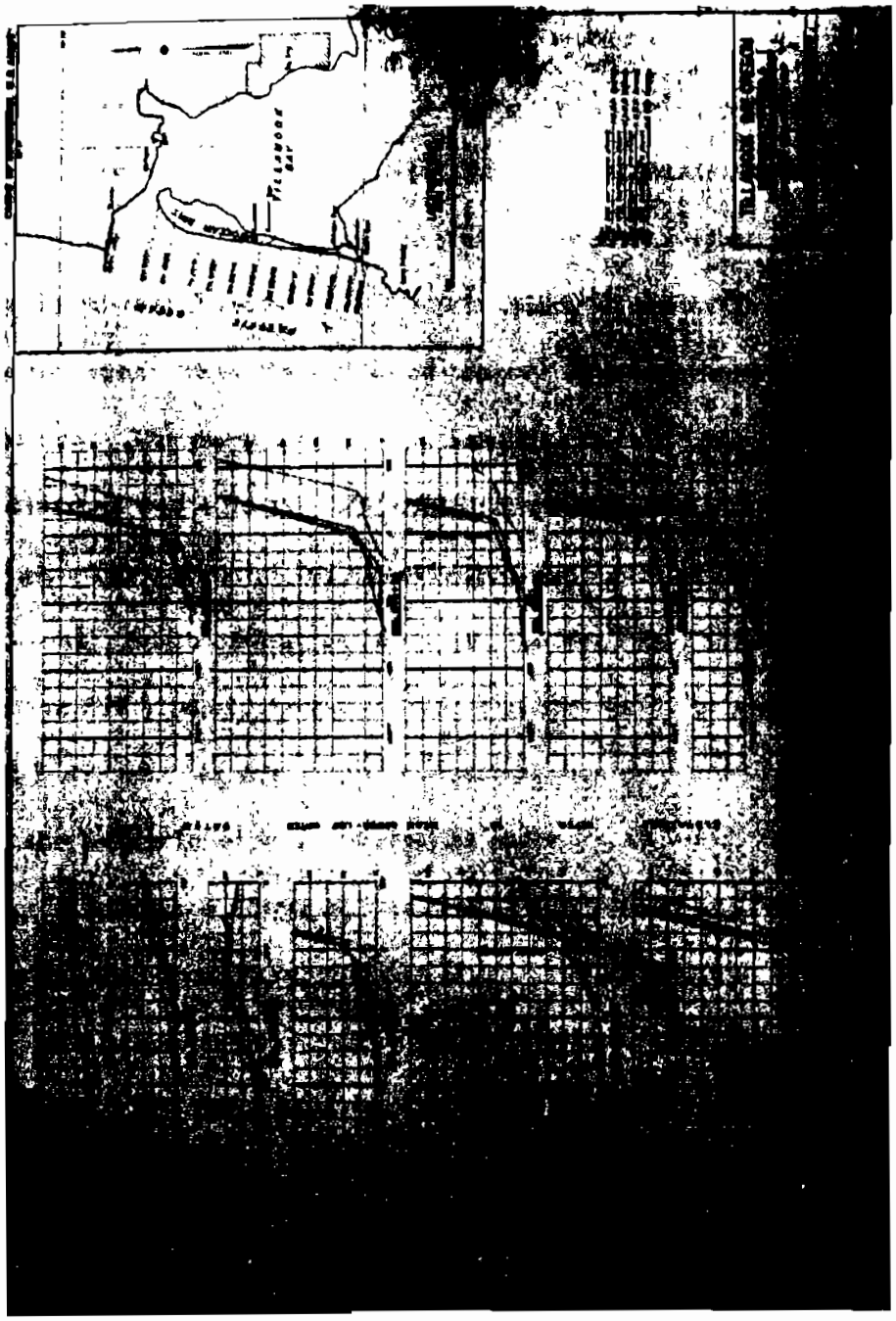


Figure 27. Bayocean beach cross-section changes 1939-1946. U. S. Army Corps of Engineers.

foredune existed. North of station 159 + 94, the foredune bank lowered to a series of low profile berms rounding Kincheloe Point; it was here that shoreline accretion was surveyed between 1939 and 1946. Relatively small amounts of erosion were measured at station 159 + 94 and to a lesser extent at station 180 + 00, recession of the foredune increased abruptly to approximately 50 feet at station 200 + 00 and nearly 90 feet for station 220 + 00. Many of the major structures of the Bayocean Park Resort were located between these two survey stations. The most severe erosion attack from 1939 to 1946 occurred to stations 240 + 00 and 260 + 00 located mid-day on the narrow sand ridge. The foredune scarp retreated over 100 feet during the 7-year interval. South of station 260 + 00, the erosion decreased to 50 feet at station 280 + 00; 20 feet and 30 feet respectively at stations 200 + 03 and 310 + 08. At many of the stations, not only did the seacliff retreat but the beach level was lowered as much as 10 feet.

Two minor points of interest are exhibited by the cross-sections. The erosion from May, 1939 to May, 1940 at stations 200 + 00 and 280 + 00 accounted for nearly half of the total cliff recession from 1939 to 1946. The cross-sections also show that in all but one station, the foredune cliff has retreated parallel to its former slope angle. At station 260 + 00 the retreat from 1940 to 1946 became subparallel as the erosion likely destroyed the crest of the sand ridge and its stabilizing vegetation, thus changing the angle of slope.

A survey and report were authorized by a resolution adopted September 16, 1946 by the Committee on Rivers and Harbors of the House of Representatives. The Corps of Engineers' report (Dept. of Army Corps of Engineers, 1946) reviewed conditions at Tillamook Bay and Bayocean spit and discussed the four possible courses of action to retard further erosion of the spit which had been enumerated in the 1940 report. The opinion of the Corps of Engineers with respect to the suggested improvements was:

(1) That the construction of either a short or full length south jetty would result in impounding of sand south of the jetty, but neither improvement would have an appreciable effect on the shorelines south of Natatorium Gap;

(2) The construction of a system of groins and bulkheads would be an undertaking of such magnitude as to preclude any possible justification;

(3) That the construction of a south entrance to the bay would be expensive and unnecessary from the standpoint of navigation.

The Corps of Engineers made it clear that it was not going to undertake any projects to retard further erosion to the spit.

Although the shoreline evidently continued to erode through 1946, the perception of any immediate increased erosion danger among some individuals had apparently declined since 1939. A 1947 newspaper report optimistically describes hopes for the revival of the resort (Headlight Herald, September 7, 1947):

> Judging from the way people are buying property at Bayocean it will not be long before most of the desirable and usable lots which the County has long carried on the books for taxes will be back on the tax rolls as an asset to the County as well as the taxpayers. The old belief that Bayocean has been carried out to sea is being exploded and the more hardy souls who take time to look around and see what an enormous pile of sand is still to be washed away to eradicate Bayocean have come to the conclusion that it will be a long time if there is any further erosion at the rate that has been eroded in the past.

The optimism for a revival of the resort was again held only briefly as one year later, Tuesday, November 2, 1948, a storm lashed the spit. The gaps along the narrow sand ridge were again awash with waves pouring into Tillamook Bay. Two new gaps were cut through the narrow sand ridge approximately mid-way between Jackson Gap and Natatorium Gap (Figure 19). The largest newly formed gap, Rock Crusher Gap, was about 250 feet wide (The Oregonian, November 7, 1948b). The erosion of the gaps undermined roads and severed the waterline. Storm, wind and high waves reappeared Friday, November 5, 1948 to further erode the spit and isolate its 80 residents from the mainland. Food and water were ferried to the residents. Saturday, November 8, 1948, city engineers restored water service by attaching fire hoses to each side of the broken pipe and suspending it over the large gap (The Oregonian, November 8, 1948b). The following week storms battered the spit and endangered the aerial waterlines. Emergency preparations were made in the event the residents of the spit were isolated (The Oregonian, November 25, 1948e). A telephone cable was installed so the residents had some

means of rapid communication with the mainland. January 2, 1949, a major article on Bayocean spit appeared in The Oregonian entitled "A Queen Dies: Victim of Time and Tide" (The Oregonian, January 2, 1949). It appeared as if the residents and investors of Bayocean finally had to acknowledge the downfall of Bayocean spit.

Breaching of the Spit

The 1939 fears of the spit's breaching became a reality on November 13, 1952 (The Oregonian, November 23, 1952b). Storm waves aided by high tides penetrated the gaps, weakened and finally destroyed a 4,000 foot long segment of the narrow sand ridge (Figure 28c). At high tide the water-filled breach was nearly three-quarters of a mile wide. At low tide the break became several smaller channels, the largest about 500 feet wide with a water depth of 6 feet. The ebb and flow of subsequent tidal periods deepened and widened the breach (The Oregonian, November 23, 1952b). Eight residents remained on the spit through November; in December two more residents were evacuated leaving the total resident population of Bayocean at six (The Oregonian, January 18, 1953). The breach severed all communication between Bayocean and Tillamook, save by boat. A system of bonfire signals was established between the residents on the spit and the Coast Guard at Garibaldi in the event of an emergency (The Oregonian, January 18, 1953).

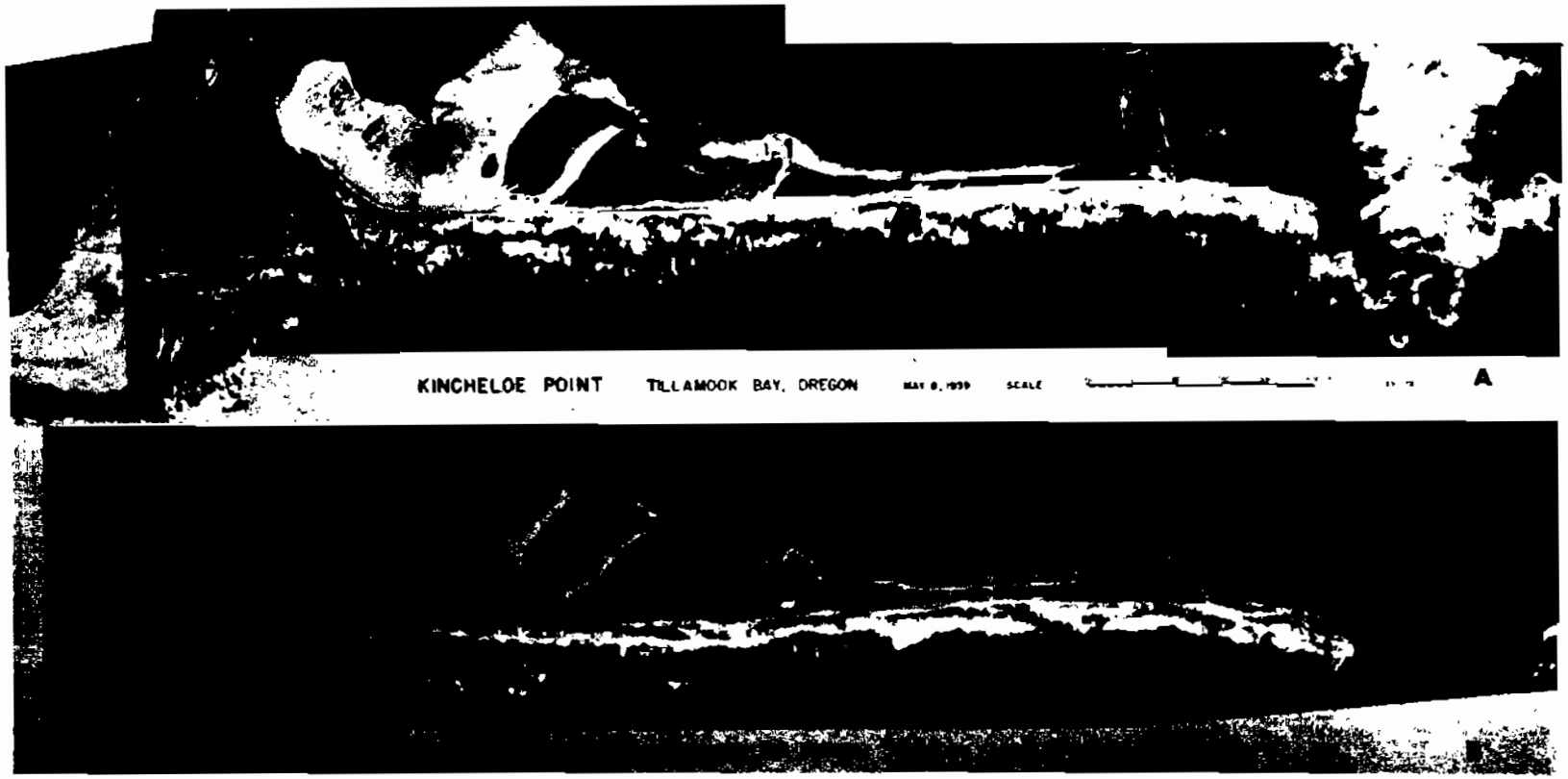


Figure 28 a, b. Aerial photos of Bayocean spit May 6, 1939 and September 26, 1945. U.S. Army Corps of Engineers.

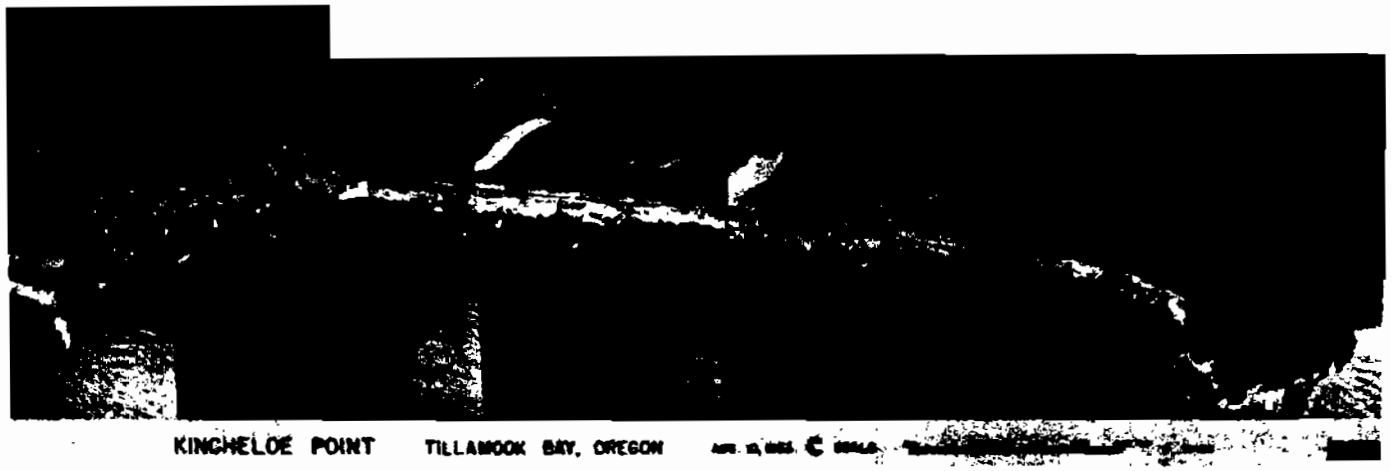


Figure 28 c, d. Aerial photos of Bayocean spit August 10, 1953 and August 27, 1955. U.S. Army Corps of Engineers.

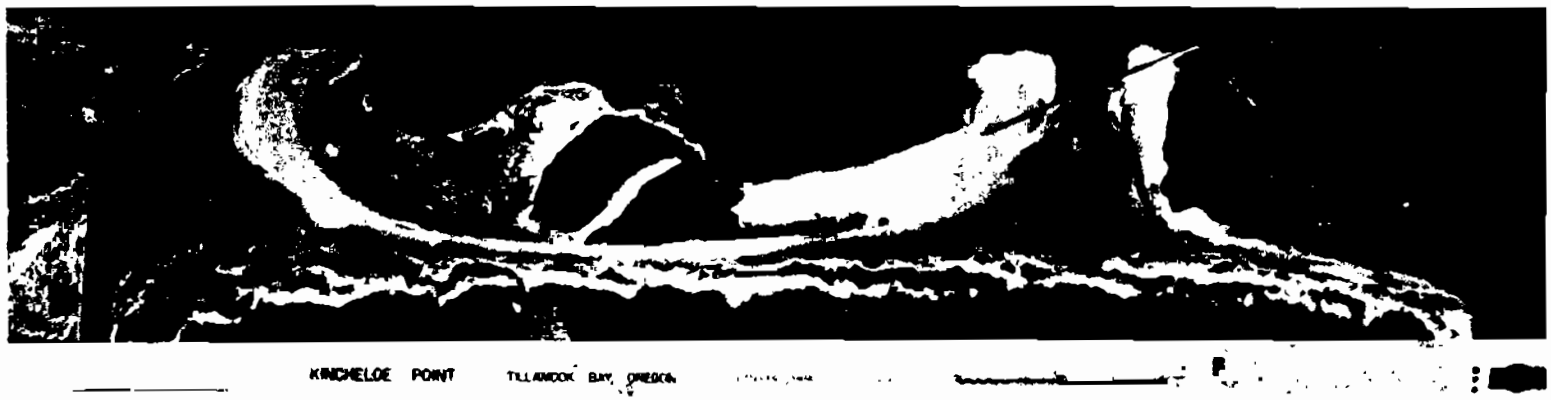


Figure 28 e, f. Aerial photos of Bayocean spit April 4, 1956 and October 1, 1956. U.S. Army Corps of Engineers.

Succeeding high tides and storms during the following several weeks continued to widen the newly created breach to nearly one mile, undermining several houses in the vicinity (The Oregonian, November 23, 1952b, December 23, 1952b, January 23, 1953c; Headlight Herald, December 18, 1952b). Brown (1958) describes some of the consequences of the breaching:

> With the loss of the protection against wind and wave action formerly afforded by the peninsula, the entire bay area was subjected to damage. During high tide, waves rolled through the break and spread out in a fan-shaped pattern. This action produced a troublesome surge action at both the south and north end, operations at the log-booming grounds had several log rafts broken up each winter. At the south end, levees along the lower reaches of the tributary rivers were weakened by the additional wave wash and threatened with complete failure or over-topping by salt water due to the increased tidal range and surge effect. Sand carried in by storm waves soon covered over one-third of the approximately 3000 acres of tide-lands leased for oyster beds. A natural channel along the east side of the bay was shoaled to such an extent that rafting of logs could be accomplished only during the higher tides each day. The major portion of the tidal flow entered and departed through the new entrance. With the loss of scouring current action through the improved entrance, the remaining "island" portion of the peninsula spread to the north and northwest, threatening to choke off the federal nevigation channel along the north side of the bay.

Inspection of Figures 28c, d, and e reveals the rapid growth of the sand plumes within Tillamook Bay and the well-defined channel that resulted from the breaching of the spit. The rapid infilling of sand into the bay initiated fears among the Tillamook residents of lowland flooding (Headlight Herald, December 4, 1952a). Comparison of Figures 28c with 28d and e shows significant progradation of the

Kincheloe Point shoreline from August, 1953 to April, 1956. Following the break in the spit, Kincheloe Point extended by accretion of sand and gravel to the north and northwest, narrowing the usable channel to not over 150 feet at low tide (U.S. Congress, Senate, 1952). The shoreline progradation probably resulted from decreased tidal scour and subsequent sand deposition as the breach assumed a large part of the tidal action (The Oregonian, January 8, 1953a). Figure 29 illustrates the major shoreline changes to Bayocean spit resulting from the breaching. As the sand plumes within the bay grew from 1953 to 1956, the shoreline adjacent to the breach receded significantly.

Diking of the Breach

Funds were made available in December, 1952 to the Corps of Engineers for field surveys and an economic study of the breach problem (The Oregonian, December 19, 1952a). The survey and study resulted in a $1,500,000 proposal to dike the breach. The plan called for a rock and sand fill to connect a point east of Cape Meares with the townsite of Bayocean (The Oregonian, September 25, 1953g). A federal agency is not empowered to spend money for the protection of private property. Therefore, Colonel T. H. Lipscomb, with a tone of urgency, recommended the following benefits from the closure of the breach: (1) preservation of existing navigation facilities; (2) saving of future maintenance expense; (3) protection of remaining oyster beds

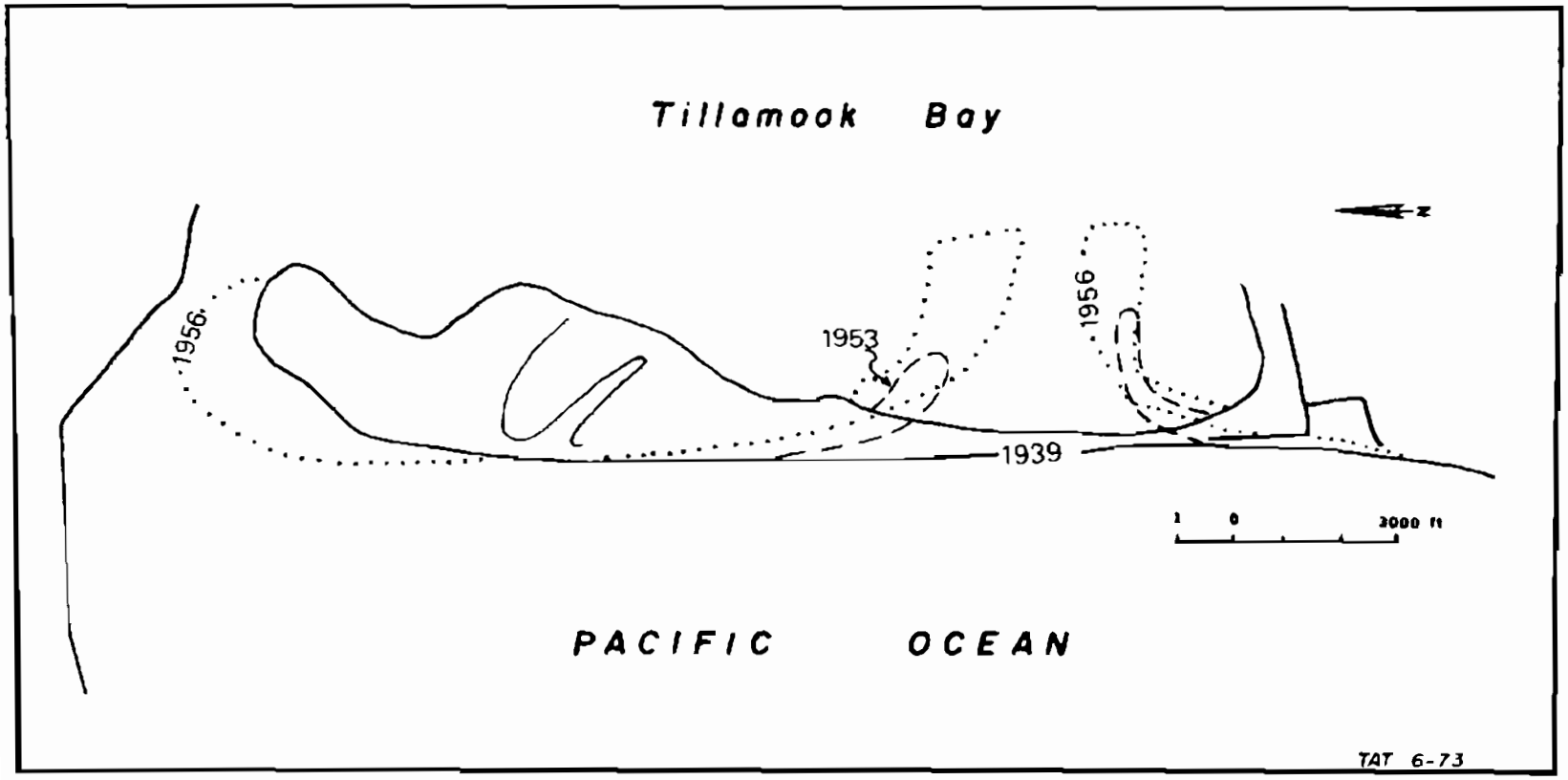


Figure 29. Major shoreline changes resulting from breaching of Bayocean spit.

and agriculture lands; (4) general benefits, including recreational advantages (U. S. Congress, Senate, 1952).

In November, 1953, the Corps of Engineers board of review for rivers and harbors rejected the emergency action to close the Bayocean breach (The Oregonian, November 21, 1953h). Two months later, however, they reversed their decision and approved construction of a $1,775,000 dike to close the breach (The Oregonian, January 22, 1954). Further conditions contingent to the approval were that Tillamook Bay interests furnish without cost all land, easements and rights of way necessary for the construction. Moreover, local interests had to contribute 15 percent of the construction costs, an estimated $250,000. Final design studies and preparation of contract plans were begun in the fall of 1955 with the intention of awarding the contract in the spring of 1956 (The Oregonian, February 28, 1956a). It was realized that the closure of the breach had to be completed in one summer season, for a partially completed dike would be severely damaged by winter storms. The alignment of the rock dike was set back from the beach line of Bayocean spit (Figure 28f). It was anticipated that the pocket in the shoreline formed by this setback would fill chiefly by erosion material from Bayocean spit and to a lesser extent by material moving northward from Cape Meares. With the pocket filled, it was expected that a more or less uniform shoreline would be reestablished forming a protective sand beach in front of the

dike. Figure 33a, b and c (p. 87-88) show that this assumption proved to be correct.

Materials for the construction of the rock dike were locally available. Basalt riprap of sizes up to 5 tons was available from quarries at Cape Meares, armor stone of 2 to 5 tons size from a quarry on the Trask River. A relatively soft, friable sandstone was available from the ridge along the bay southeast of the site. Easy access encouraged use of this material capable of withstanding wave action for several seasons. The fine sand dredged from the north end of the dike site provided an adequate foundation material. The dredge site is visible in Figure 28f approximately 4,000 feet north of the dike's northern terminus. Figure 30 is an aerial view taken in 1955 of the remaining Bayocean Park buildings which occupied the southern end of the breached spit. Construction of the dike and necessary sand fill required razing of the structures. By October, 1956 (Figure 28f) virtually all signs of the former resort had been destroyed. Some difficulty was experienced with engineering the closure; however, in the fall of 1956, the closure was accomplished. Holland beach grass was planted in November, 1956 to stabilize the sand fill to the north and northwest of the dike (Brown, 1958).

Immediately following the closure of the breach, commercial fishermen reported marked increases in tidal velocities in the navigation channel and rapid erosion of sand bars which had been building

Figure 30. 1955 aerial photo of breach. U.S. Army Corps of Engineers.

inside the bay since 1952 (Brown, 1958). Sand filling of the former embayment seaward of the dike has progressed as shown in Figures 33a, b, and c. At times, high waves are able to wash into Biggs Cove; however, this appears to offer little immediate danger.

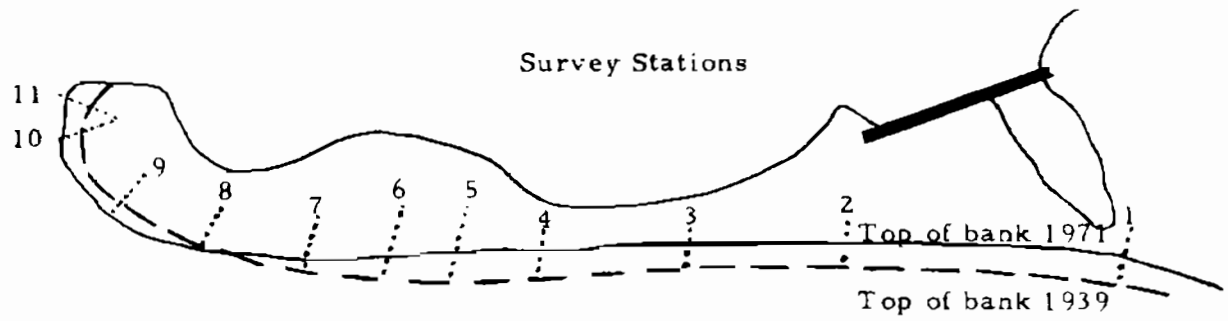
Recent Erosion

Since the 1956 closure of the beach, erosion has continued along much of the seaward face of Bayocean spit. The U. S. Army Corps of Engineers has periodically surveyed the spit's shoreline changes. An abbreviated tabulation of their surveys is presented in Table 5. For cross reference purposes, station numbers 4 and 6 in Table 5 coincide with stations 146 and 190, respectively, for Table 4. Erosion has continued unabated save at station 2 where progradation of the shoreline occurred following the dike construction. Rapid rates of erosion are occurring north of the former breach site along a mile long stretch of the spit's mid-section. The continuing rapid rates or erosion at station 4 has raised some concern as it is the narrowest part of the spit, most subject to future breaching. The Corps of Engineers foresees the average rate of -15 feet per year declining as sand accretes south of the new south jetty, constructed from 1969-1971, slowing the erosion process (Figure 32). The shoreline retreat at the Village of Cape Meares south of Bayocean spit has been ascertained from Tillamook County Assessor maps (Figure 31). The 1953 shoreline was

Table 5. Bayocean Shoreline Changes, 1939-1971.

Station:	11	10	9	8	7	6	5	4	3	2	1
Total	+330	+230	+360	+100	-260	-464	-460	-550	-650	-890	-510
Average ft/yr	+ 11	+ 7	+ 11	+ 3	- 8	- 14	- 15	- 17	- 20	- 27	- 16

Source: U. S. Army Corps of Engineers (1971).



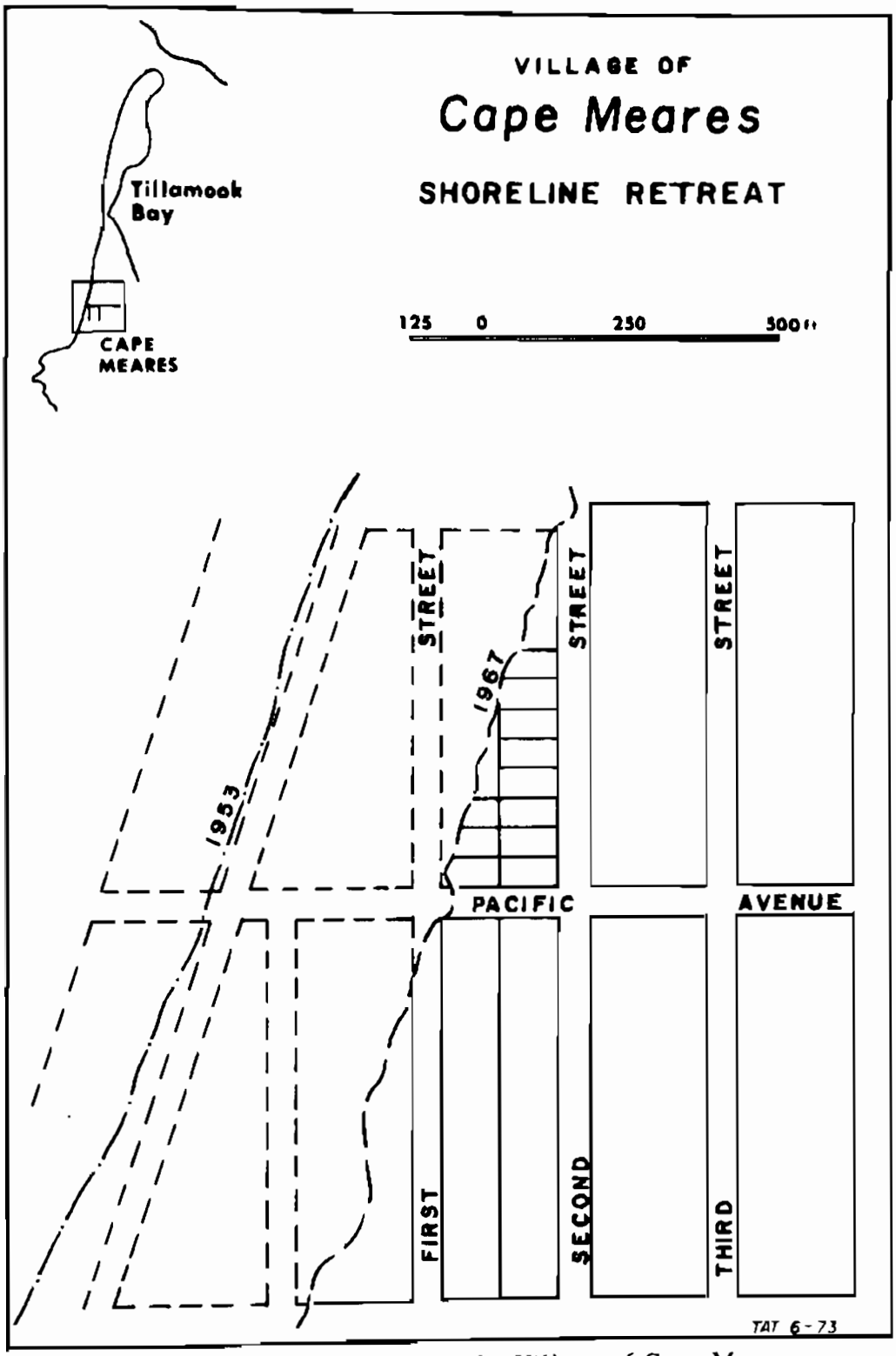


Figure 31. Shoreline retreat at the Village of Cape Meares.

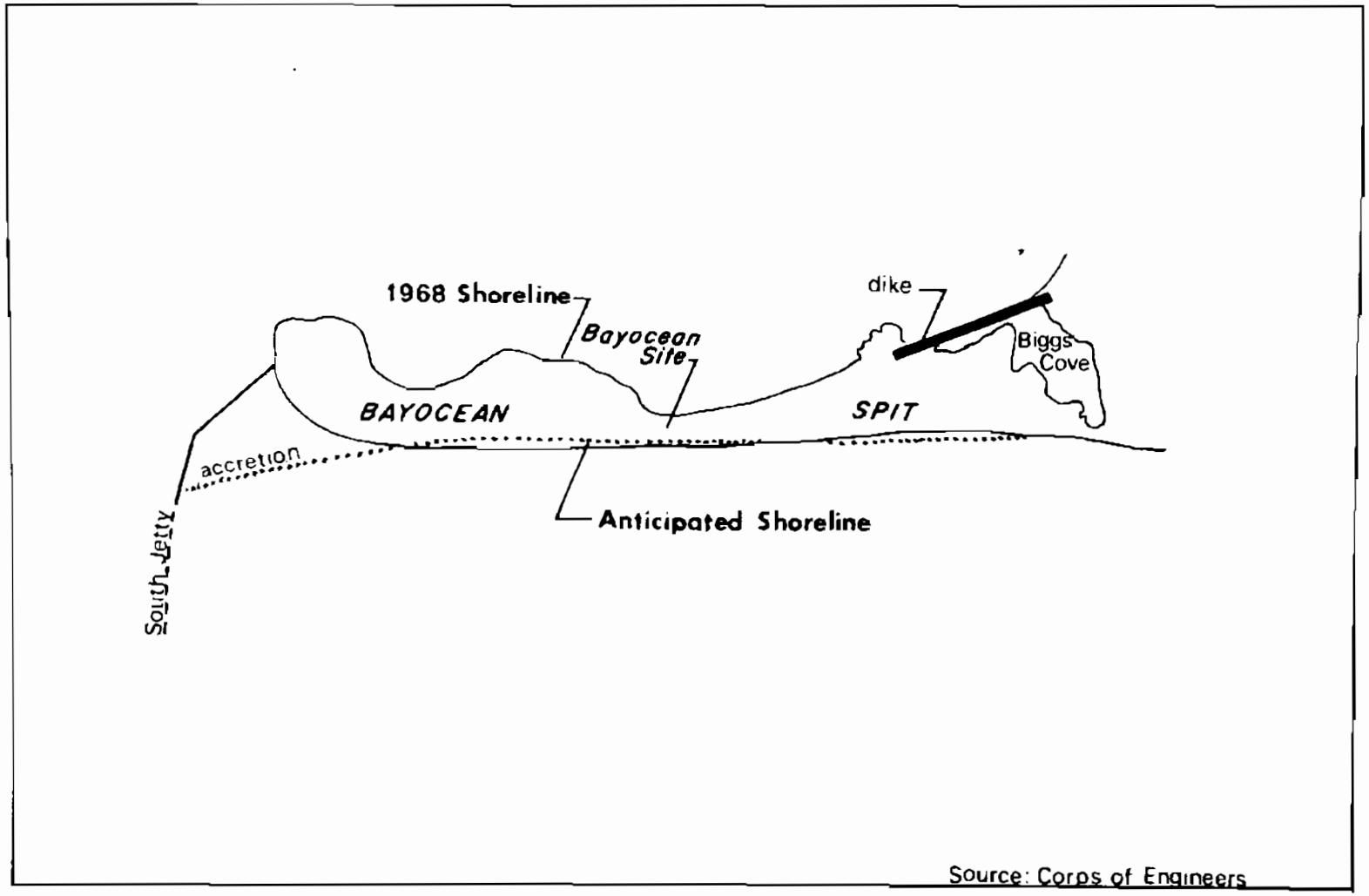


Figure 32. Anticipated shoreline change to Bayocean spit.

plotted on the assessor maps by Tillamook County officials. Since 1967 additional retreat has totaled approximately 10 feet.

South Jetty

The United States Coast and Geodetic Survey maps for 1904 through 1971 illustrate the growth of shoals within the channel entrance to Tillamook Bay. Figure 35 (p. 92) illustrates that the shoals extend northwesterly from Kincheloe Point with a small intervening channel. The shoals migrate within the channel entrance causing increased wave activity and turbulence. Winter conditions are most severe as southwesterly storm waves break over the shoals making the entrance impassable for periods ranging up to 10 days (U. S. Congress, Senate, 1965). The vessel delay has forced cancellation of water carrier service; moreover, the unpredictable channel conditions discouraged many fishing boats from basing at Garibaldi. As a result, Tillamook Bay suffered a decline in water-borne transport and fishing activities (U. S. Congress, Senate, 1965).

The hazardous channel conditions which developed prompted renewed consideration for construction of a south jetty at the channel entrance to Tillamook Bay. Construction of a 3,700-foot long jetty westerly from Kincheloe Point was commenced in April, 1969. As the construction progressed it was recognized that the large shoal the jetty was designed to contain extended well beyond the proposed length

of the jetty; the jetty had to be lengthened for more complete protection within the channel. Work is now underway to extend the south jetty by 2,830 feet to a total length of 6,525 feet with a projected completion date of October, 1974.

It can be expected that the south jetty will modify the local water currents and drift of sand on the beach at Bayocean spit. The Corps of Engineers predicted the following impacts of the south jetty upon the spit (U.S. Congress, Senate, 1965):

> It is believed that a south jetty at the entrance to Tillamook Bay would have a general beneficial effect on the shoreline between the jetty and Cape Meares, 6 miles to the south. Sand would be moved into the shadow of the jetty by northward littoral transport due to the draw of the inlet, thus causing accretion for a short distance south. The jetty would eliminate or greatly reduce the continuing loss of material into the inlet and consequently should have some beneficial effect on the shoreline south to Cape Meares. This effect would be accretion for a short distance south of the jetty and a decrease in the erosion rate within that area south to Cape Meares.

The Corps of Engineers maintains that the south jetty will create a beneficial straightening of the Bayocean shoreline as demonstrated in Figure 32 with continued erosion in some zones and deposition in others. As illustrated, the beach near survey stations 146 and 190, which lie approximately 7,500 feet and 11,500 feet, respectively, south of the south jetty, will likely continue to experience erosion as this zone supplies sand to the accreting beach immediately south of the south jetty.

Figures 33a, b, and c illustrate the very rapid accumulation of sand that occurred in 23 months during the first phase of construction of the south jetty from April, 1969 to June, 1971. Accretion appears to be continuing at a declining rate as shown in the aerial photographs for the two-year period, November, 1971 to February, 1973 (Figures 34a, b, and c). The August, 1972 photo reveals greater sand accumulation, typical of the summer period. More comparable are the November, 1971 and February, 1973 shorelines under winter conditions. Omitting some tidal and seasonal variations to the shoreline, the beach immediately south of the jetty has accreted approximately 400 feet seaward from November, 1971 to February, 1973.

In summary, it appears that the south jetty will continue to impound sands to the south and cause a progradation of the beach. Erosion will probably continue along the narrow midsection of the spit and will require continued surveillance.

Erosion and Deposition Summary

Figure 35 represents mean lower low water shoreline configurations of Bayocean spit taken from United States Coast and Geodetic Survey charts for 1867, 1904, 1920, 1932, 1949, 1960, 1965, and 1971. Very little change occurred between 1867 and 1904; however, between 1920 and 1932 erosion is indicated by the narrowing of the southern sand ridge. The retreat of the shoreline along the southern

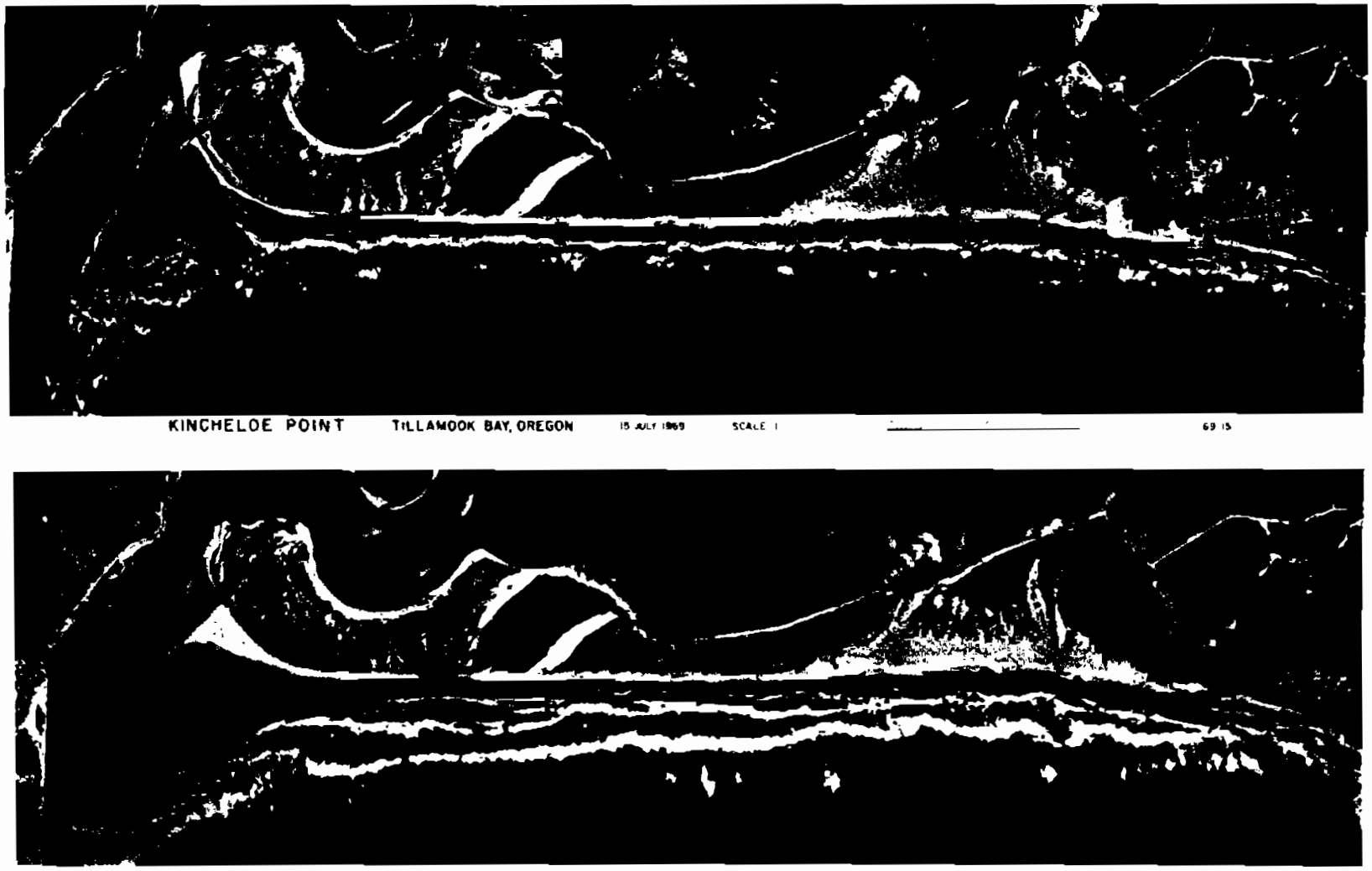


Figure 33a,b. Aerial photos of Bayocean spit July 15, 1969 and April 13, 1970. U.S. Army Corps of Engineers.

Figure 33c. Aerial photo of Bayocean spit June 30, 1971. U.S. Army Corps of Engineers.

Figure 34a. Aerial photo of south jetty November 23, 1971.

Figure 34b. Aerial photo of south jetty August 30, 1972.

Figure 34c. Aerial photo of south jetty February 6, 1973.

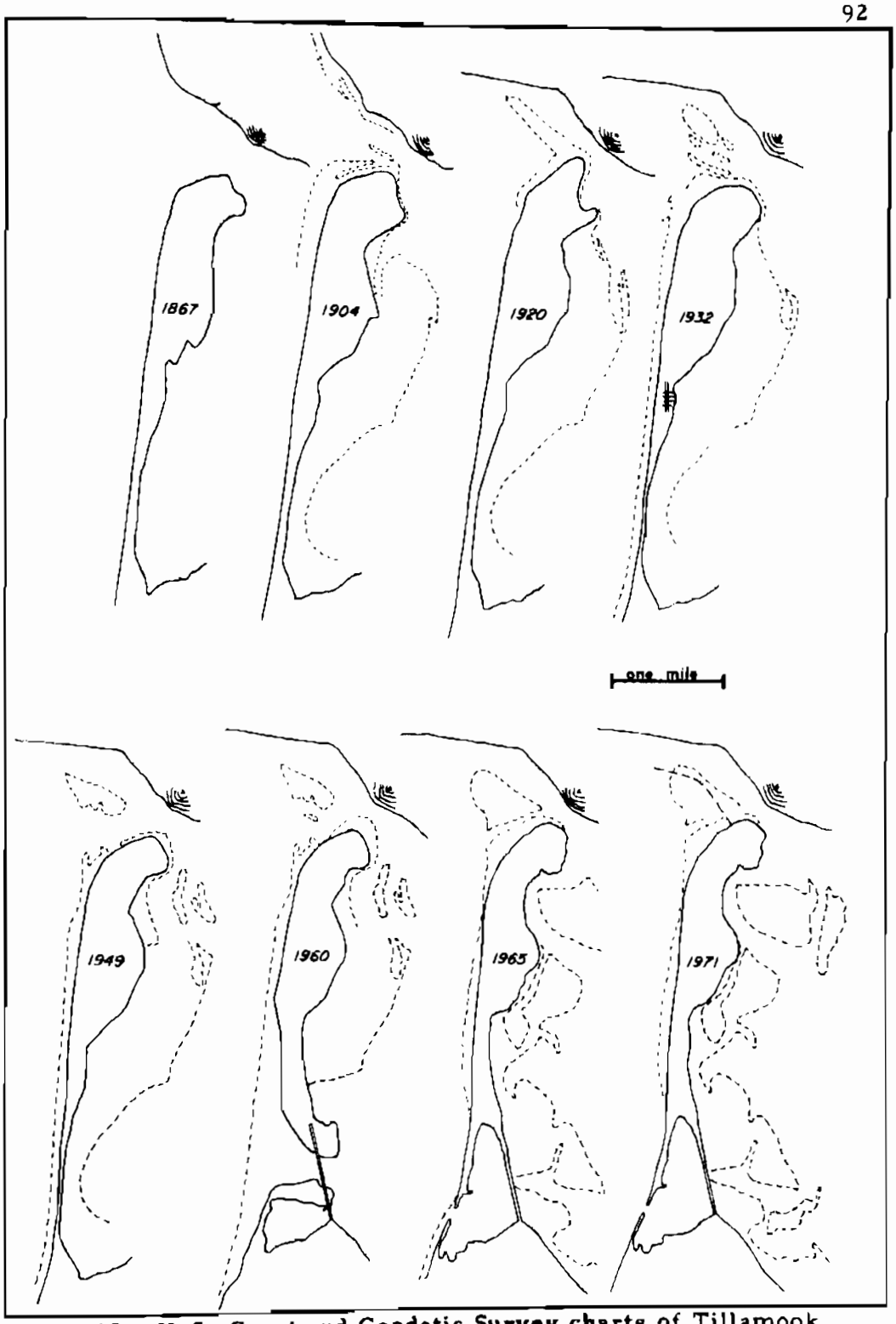


Figure 35. U.S. Coast and Geodetic Survey charts of Tillamook Bay 1904-1971.

end of the spit between 1920 and 1932 supports the Corps of Engineers claim that erosion of the spit began prior to 1932-1933 lengthening of the north jetty. Only the northern part of the spit was revised in the 1949 survey. This is unfortunate, for the shoreline is known to have retreated significantly between 1932 and 1949. The 1960 and 1965 charts show the diked breach and subsequent filling and formation of a new shoreline west of the dike. Finally, the 1971 chart shows no revision since 1965 except for the projected position of the south jetty from Kincheloe Point.

The construction of the north jetty resulted in the rapid progradation of the shoreline to the north and west (Figure 36). The shoreline prograded approximately 2,500 feet seaward within 3 years of its completion in 1917 (U. S. Army Corps of Engineers, 1970). It is subsequently receded as the jetty deteriorated and became less of a barrier to littoral drift. The shoreline again advanced after the jetty's 1933 restoration and 300-foot extension. By 1940, the shoreline had prograded seaward a total of 3,200 feet; since that time it has remained relatively stable.

Figure 37 represents shoreline changes to Bayocean spit as taken from 1939 and 1973 aerial photographs. Most of the seaward face of the spit has retreated several hundred feet since 1939. The most severe recession has occurred where the former narrow sand ridge connected Bayocean to Cape Meares. The breach destroyed nearly a

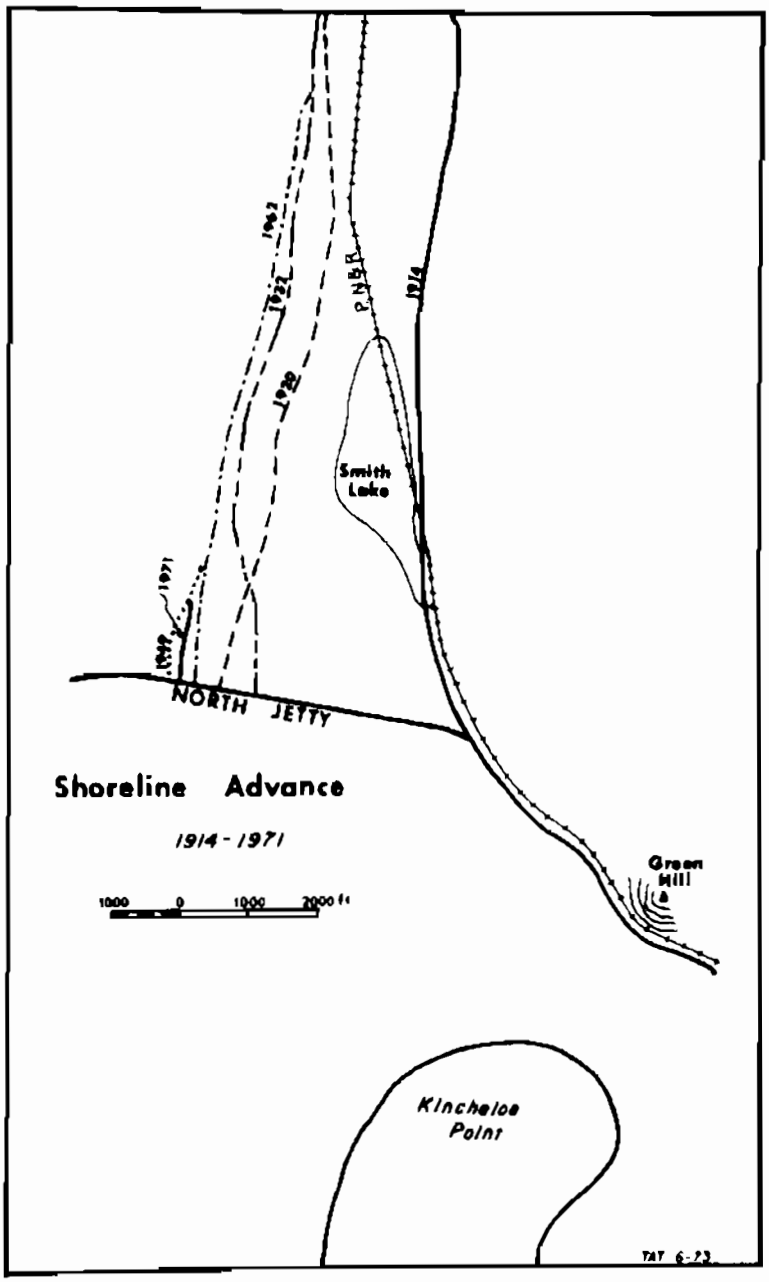


Figure 36. Shoreline advance north of north jetty.

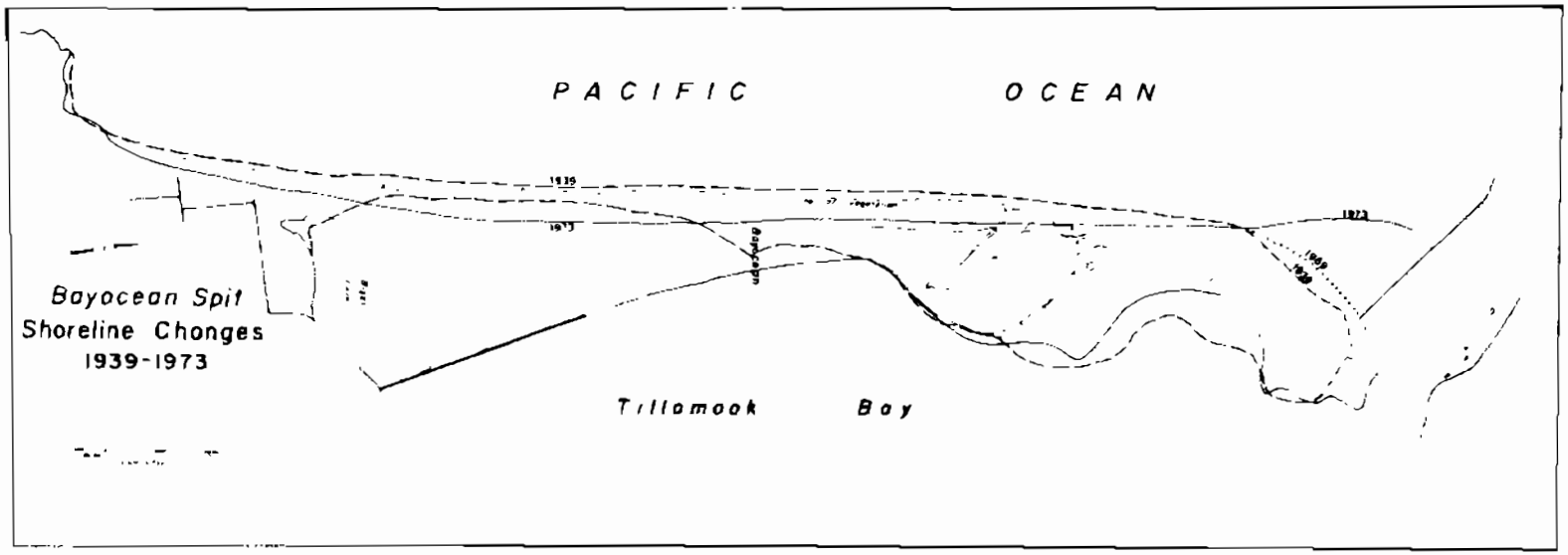


Figure 37. Bayocean spit shoreline changes 1939-1973.

mile long stretch of the ridge. The diking of the breach and subsequent formation of a new shoreline repositioned the entire southern part of the sand spit 800 to 900 feet east of its 1939 location. Some people still hold claim and pay taxes on land formerly located on the narrow sand ridge. Their claims are now several hundred feet seaward of the present shoreline (Tillamook County Tax Assessor maps). The northward facing seacliff of Cape Meares appears also to have retreated between 500 and 100 feet during the 34-year period (1939 to 1973). Very recently, rapid shoreline progradation has occurred south of the new south jetty at Kincheloe Point. The shoreline adjacent to the jetty has advanced over 2,000 feet since 1969. The shoreline will probably advance even farther as the jetty is lengthened.

CHAPTER V

INTERPRETATION OF EROSIONAL AND DEPOSITION PATTERNS

The purpose of this chapter is to identify and attempt to explain the erosional and depositional patterns that have developed along Bayocean spit and neighboring beaches. Historical shoreline changes presented in the previous chapter will serve as the primary evidence. Sedimentary sources and losses to Bayocean spit and neighboring beaches will be identified and, where possible, quantified to account for the major areas of beach erosion and deposition. Figure 38 is a schematic representation of sedimentary sources and losses to the spit and adjoining beaches. Such a "budget of sediments" is an application of the approach of Inman and Bowen (1966) who assessed various sedimentary contributions and losses to the nearshore zone in the area of Point Arguello, California.

Budget of Sediments for Bayocean Spit

Figure 38 illustrates the major potential sediment sources and losses to Bayocean spit. Potential sediment sources include: landslide and headland erosion, and fluvial discharge. Major sediment losses are erosion to Bayocean spit, deposition in Tillamook Bay, and trapping by jetties. The identified sediment sources and losses to Bayocean spit will be discussed in order of the above presentation.

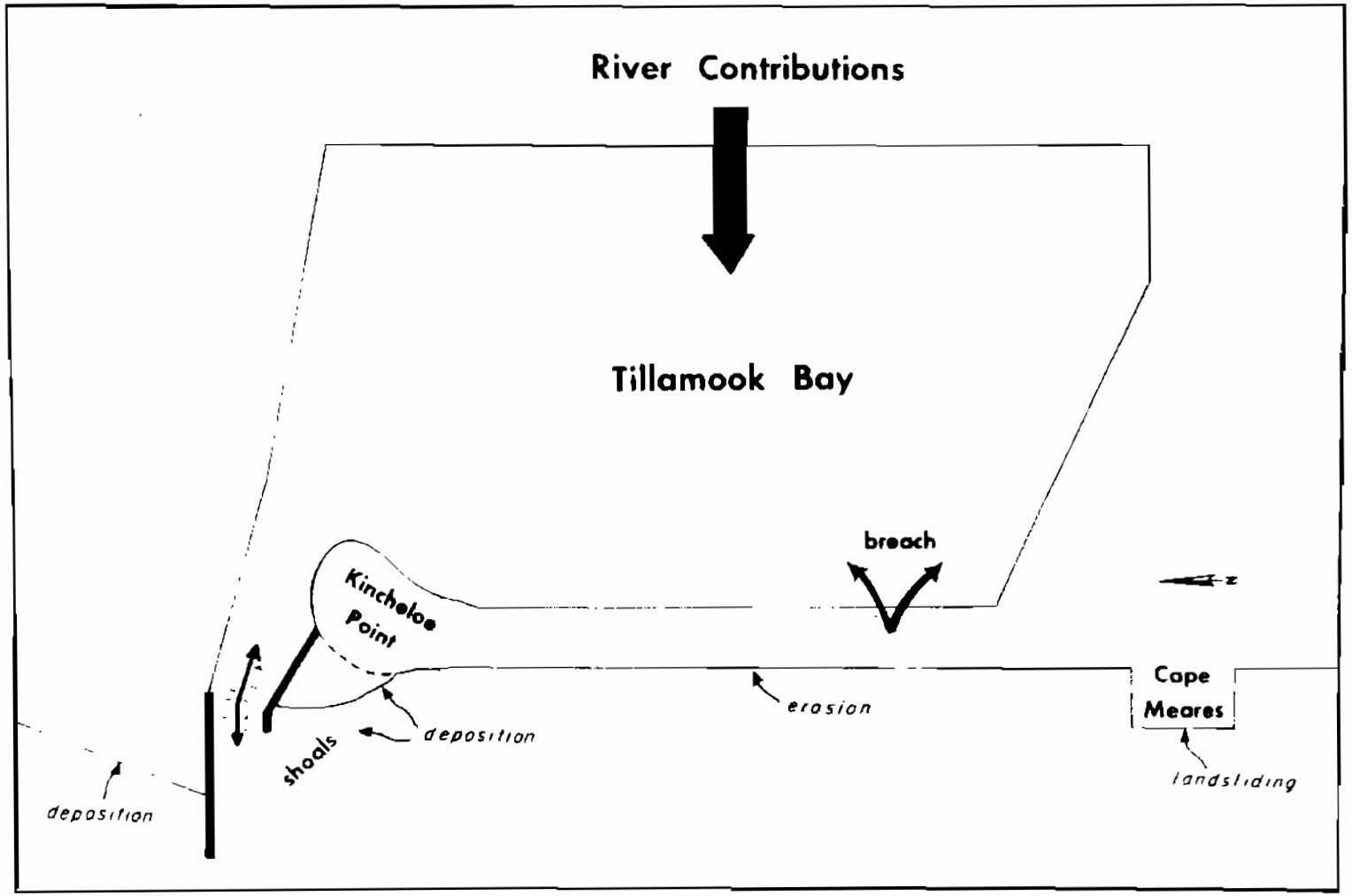


Figure 38. Sediment sources and losses to bayocean spit.

Sediment Sources

Landslide and Headland Erosion. Cliff erosion and landsliding at Cape Meares south of Bayocean spit appear to serve as sources of littoral sediments. Cape Meares is a 350-foot high promontory composed of basalt capped with terrace sands. The relatively slow but continual erosion of Cape Meares can be seen where areas of instability--soil creep and debris fall--contributes sediments to the surf below. The U. S. Army Corps of Engineers (War Dept. Dist. Eng., 1940) conducted a petrographic analysis of beach sediments north and south of Cape Meares to determine the effectiveness of the Cape as a source of Bayocean beach sediments. On Bayocean spit, roughtly 20 to 25 percent of the minerals comprising the beach and bottom drill samples were minerals common to basaltic rocks. Thus, at least one-fifth to one-quarter of Bayocean sediments have been derived from basaltic sources. The U. S. Army Corps of Engineers (War Dept. Dist. Eng., 1940) concluded that Cape Meares, because of its proximity, is the largest source of basaltic minerals. Twenhofel (1946) analyzed beach sands along much of Oregon's coast. He also suggested Cape Meares as the source of basaltic boulders and cobbles comprising the beaches north of the Cape and at Bayocean spit.

Figure 39 outlines a large landslide on the north side of Cape Meares. Aerial photos for 1939 and 1955 showed no advance of the

Figure 39. 1972 aerial view of landslide north of Cape Maeres. U.S. Army Corps of Engineers.

toe of the slide along the beach suggesting that movement did not begin until after 1955. Conversely, 1965 and 1972 aerial photos clearly illustrate mass movement onto the beach. Schlicker et al. (1972) discuss the landslide:

> A major landslide is located on the north side of Cape Meares. The slide is more than 300 feet long and 1000 feet wide; the elevation of the head of the slide is about 400 feet above mean sea level. The toe of the landslide is on the beach and erosion of the toe is rapid and continual. During the summer of 1971, a segment of the beach rose about 30 feet as a result of rotational uplift at the toe. The block was completely eroded by autumn.

At the toe of the slide, trees lean 20 to 30 degrees seaward indicating the ground movement. The landslide is undoubtedly contributing much sedimentary material to the littoral transport.

Fluvial Sediment Discharge. Among the largest potential sediment sources for Bayocean spit are the fluvial sediments carried down the five major rivers that empty into Tillamook Bay. The Langbein and Schumm (1958) method for estimating the sediment discharge was employed to quantify this sediment source. Langbein and Schumm (1958) correlated the effective annual precipitation to drainage basin areas throughout all the climatic regions of the United States (Figure 40). The effective precipitation eliminates that part of the total precipitation which is lost through evaporation and transpiration. Several studies have shown that sediment yield per unit area decreases with increasing drainage area, resulting from flattening

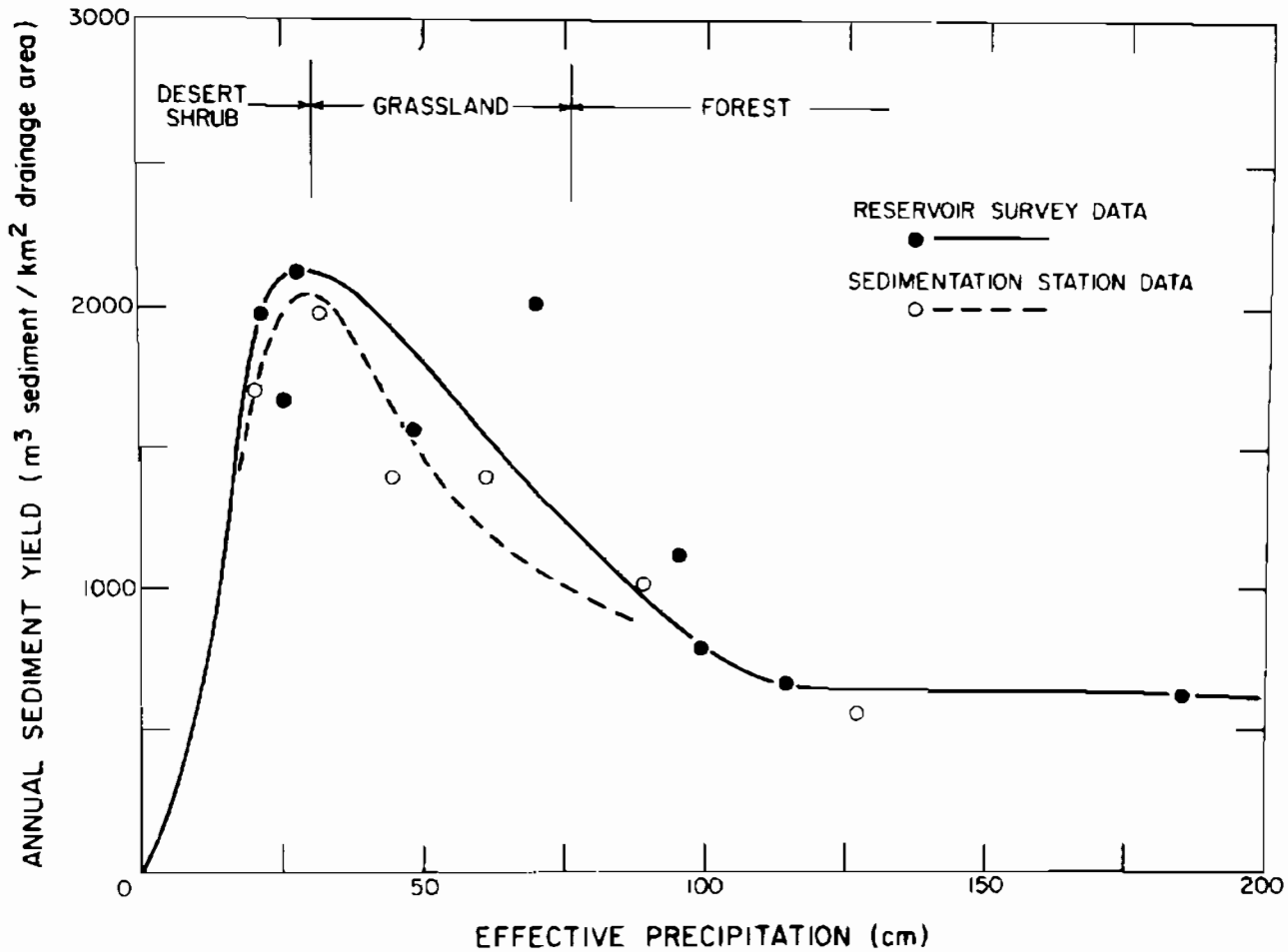


Figure 40. Climatic variation of sediment yield. After Langbein and Schumm, 1958.

gradients and lower probability that an intense storm will cover the entire drainage area. The curves of Figure 40 have been normalized to a drainage area of 100 kilometers utilizing the results of Brune (1948) which show that the sediment yield is inversely proportional to the 0.15 power of the drainage area. In application, this effect of drainage must be taken into account. For example, if the drainage area of the river in question is 750 square kilometers, then the sediment yield rates by Figure 40 must be divided by the factor $(750/100)^{0.15} = 1.35$ to obtain the proper yield rate for the area. Each point shown in Figure 40 represents an average of from 5 to 38 individual correlations grouped according to effective precipitation. The averaging has the effect of removing some of the variability due to differences in geology, degree of cultivation and vegetation type and distribution. The "Tillamook Burns" which occurred within the drainages of the rivers emptying into Tillamook Bay probably increased the rate of sediment discharge. However, in the absence of direct fluvial sediment discharge measurements, the effect of the "burn" is extremely difficult to quantify. Table 6 presents the annual amounts (yd^3) of sediment discharge as for a 115 cm effective precipitation and 650 m^3/km^2 annual sediment yield predicted by the Langbein and Schumm method for each of the five rivers that empty into Tillamook Bay.

Table 6. Drainage Basin and Sediment Yields.

River	Drainage Area (mi^2)	Annual Sediment Yield (yd^3/year)
Miami River	36	79,200
Tillamook River	61	125,500
Kilchis River	67	136,000
Wilson River	195	337,400
Trask River	175	308,600
Total	534	986,700

It is generally agreed that many of Oregon's estuaries are filling with river discharged sediments (Appendix, p. 144). Sediments that would otherwise supply sand to beaches and littoral currents are trapped within estuaries. Undoubtedly, some part of the fluvial sediments, primarily fine suspended sediments, does flush out to sea by tidal forcing. However, soon to be discussed, it appears that a large fraction of the sand-sized sediments remains within the estuary. The potential source of fluvial sediments to Bayocean spit and neighboring beaches appears to be lost, as much of the sediment is trapped within Tillamook Bay.

Sediment Losses

Tillamook Bay. Comparison of U. S. Coast and Geodetic Survey charts for 1869 with present day charts indicates shoaling within the

bay. The primary sediment contributions probably are from the major rivers that discharge into Tillamook Bay. There is, however, some indirect evidence suggesting that the bay is filling also from beach sands migrating through the channel entrance into the northwestern part of the bay with additional aeolian contributions. Such evidence indicates that Tillamook Bay acts as a "sink" for both fluvial and marine sediments. Avolio (1973) has found very well sorted sand covering over 1 km^2 of the northwestern part of the bay (Figures 41 and 42). The presence of very well sorted sand extending from the channel entrance into the bay suggests the movement of beach sand into Tillamook Bay. Avolio (1973) conducted X-ray diffraction analyses of the heavy mineral fractions for selected stations at the northern end of the bay extending from the Miami River on the east to the channel entrance on the west. Figure 43 shows the diffraction patterns with the top representing the Miami River assemblage and the bottom two patterns, beach and older dune samples collected from the northern end of Bayocean spit. The three intervening patterns are from east to west, respectively, top to bottom. The most easterly bay sample shows a marked resemblance to the Miami River sample, whereas the westerly samples indicate the influence of the beach and dune sands. Avolio (1973) concludes that Tillamook Bay is receiving sediment infill not only from the rivers but also from the ocean.

Yaquina Bay, approximately 50 miles south of Tillamook Bay,

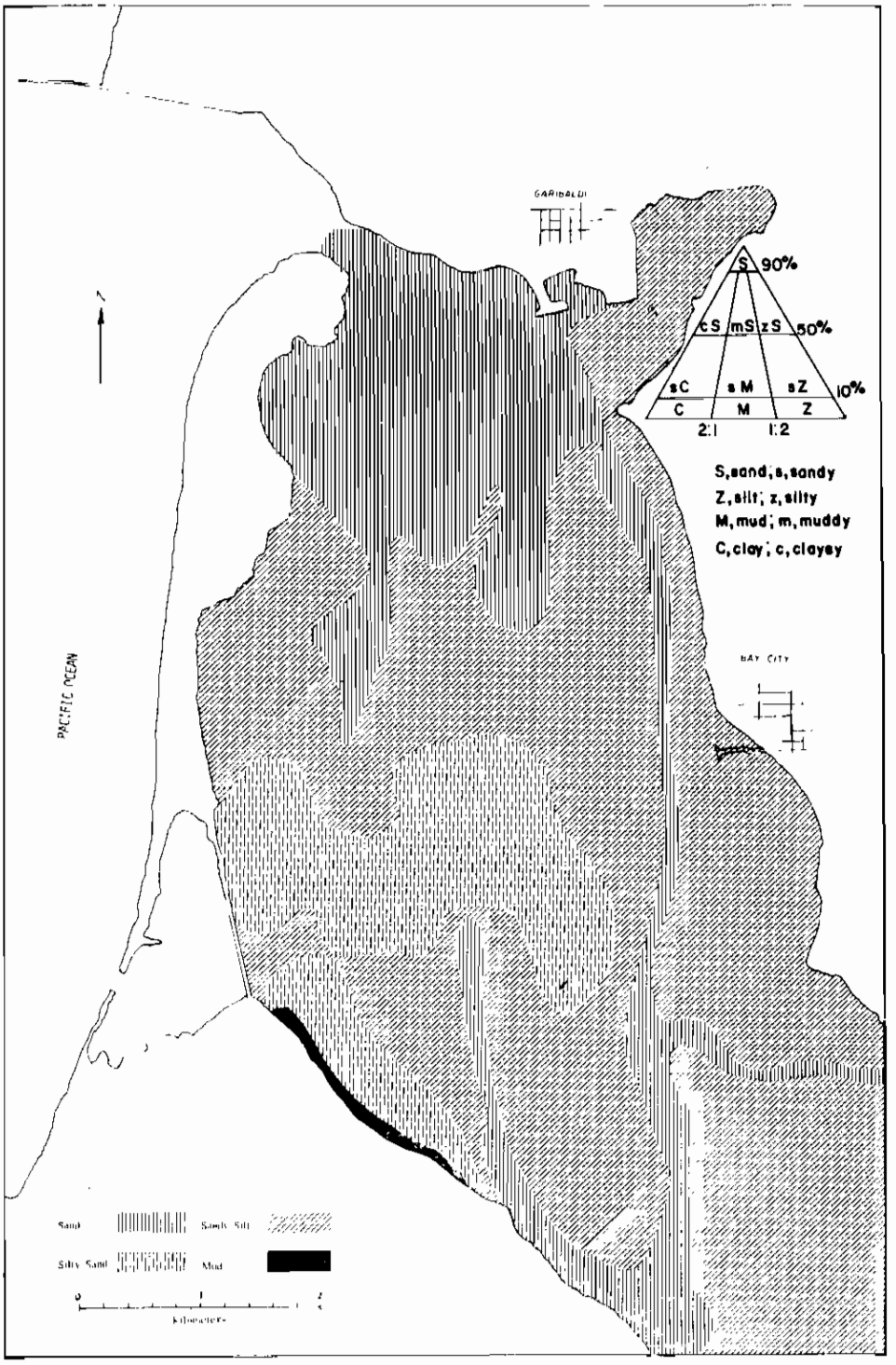


Figure 41. Distribution of sediment type in Tillamook Bay. Avolio, 1973.

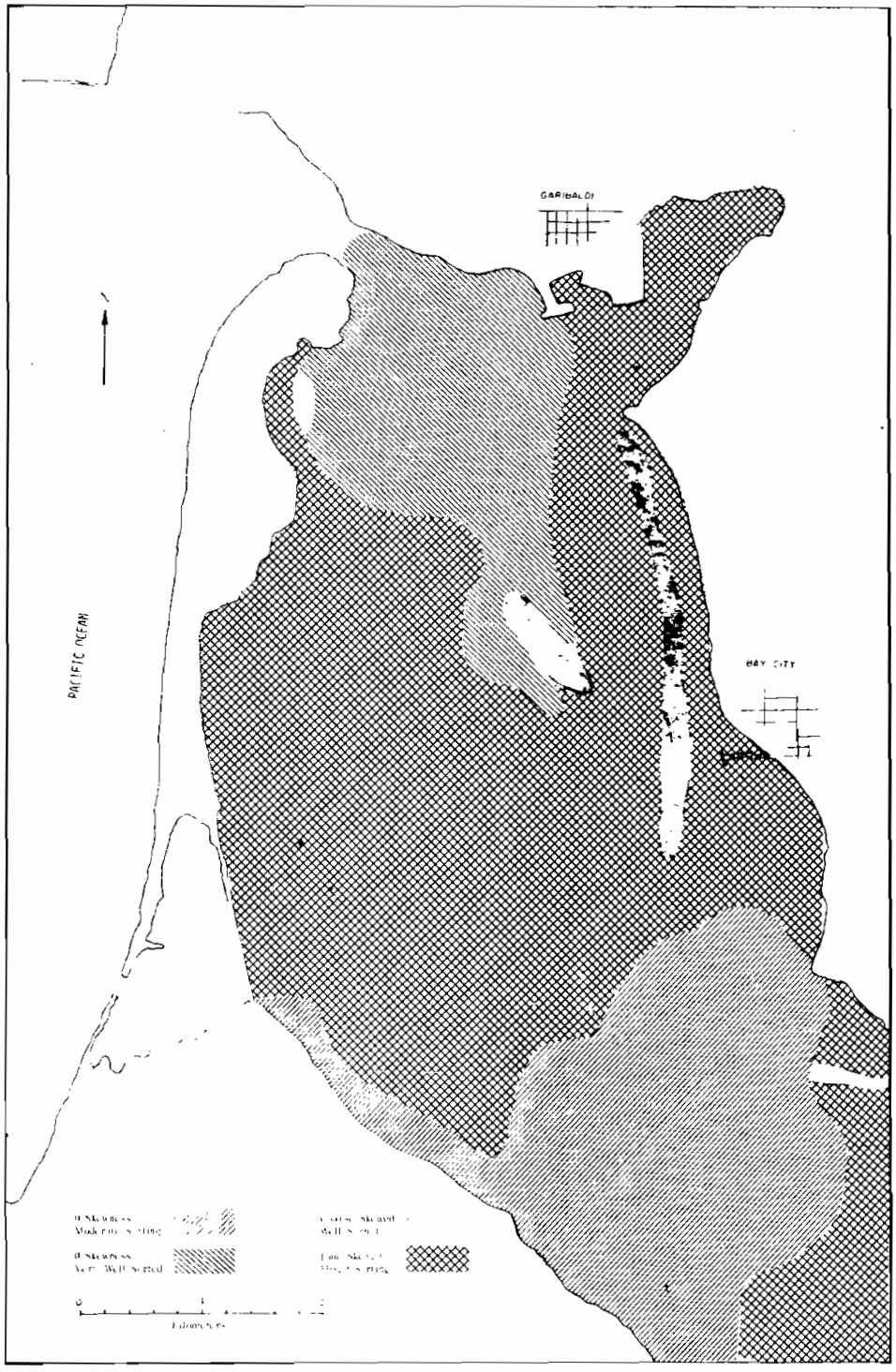


Figure 42. Distribution of skewness and sorting of sediments in Tillamook Bay. Avolio, 1973.

Figure 43. X ray diffraction "fingerprints" of heavy mineral samples from the northern part of Tillamook Bay. The easternmost locations are at the top and westernmost at the bottom. Avolio, 1973.

was found by Kulm and Byrne (1966) to be a "sink" for fluvial and marine sand-sized sediments. At Yaquina Bay, beach sand enters the bay through the channel when the bay assumes a two-layered system. A two-layered system is achieved when a boundary layer develops within the water with fresh water overlying a salt water wedge. Denser sea water flows upstream along the bottom to replace the salt water carried downstream at the halocline by the fresh water. The condition occurs during the winter and spring with increased precipitation and terrestrial runoff. The two-layered system increases bottom current velocities flowing from the ocean into the bay, thus enhancing the movement of beach sand into the bay. It is also during these seasons that the rate of river sedimentation reaches a maximum. The result is a net accumulation of both fluvial and beach sediments in the bay. A similar current system is probably responsible for Tillamook Bay acting as a sink for both beach and fluvial sands.

Large amounts of beach sand also entered Tillamook Bay following the breaching of Bayocean spit in November, 1952 (Figure 28). The breach remained open for four years and became the bay's major tidal channel. Brown (1958) estimated that beach sand covered over 1.6 square miles of former oyster beds. The large area of silty sand found by Avolio (1973) extending from the former breach well into the bay and surrounded by sandy silt may be the result of the beach sand intrusion into Tillamook Bay over 17 years ago.

The existing evidence then suggests that Tillamook Bay traps fluvial sands, and to a lesser extent littoral and aeolian sands, that would otherwise supplement the beaches of Bayocean spit. Over the long term, it appears that Tillamook Bay subtracts rather than adds to the littoral sediment budget along Bayocean spit.

Erosion Loss from Bayocean Spit. The known shoreline retreat of Bayocean spit since 1939, as shown in Figure 37, offers the possibility of quantifying the volume of sand loss from the spit. Corps of Engineers surveys show that erosion has occurred along approximately 3.5 miles of the spit with accretion at the northern extreme at Kincheloe Point. The eroded part of the spit has receded on the average 550 feet since 1939. Given an average sea cliff height of 20 feet, the total volume of erosion since 1939 has amounted to roughly 7,400,000 cubic yards of sand or 220,000 cubic yards per year. These eroded sands have entered the littoral currents to be transported and deposited elsewhere. As will be discussed in the next section, the progradation of Kincheloe Point and growth of channel shoals coincident with the construction of the north jetty (Figures 25 and 35) suggests that much of the sand eroded from Bayocean spit was deposited in those locations.

An estimate of the channel shoal volume was made to determine if there was a correlation between the accumulated volume within the channel shoal extending from Kincheloe Point and the volume sand loss from Bayocean spit since 1939. The area of the channel shoal was estimated to be approximately 0.63 square miles.

Table 7 presents the approximate shoal volumes using this estimated area and a variety of reasonable thicknesses of accumulation. Table 7 shows that an average 11.3 feet of sand deposition within the 0.63 square mile shoal would account for all of the estimated sand eroded from Bayocean spit since 1939. However, it should be noted that an undetermined volume of sand flowed into Tillamook Bay from 1952 to 1956 as the spit was breached.

Table 7. Estimated Shoal Volumes.

Thickness (ft.)	Cubic yards
8	5,240,000
9	5,890,000
10	6,550,000
11	7,200,000
11.3[a]	7,400,000
12	7,860,000
13	8,500,000

[a]Estimated sand loss to Bayocean (yd^3), 1939-1971.

Impact of the North and South Jetties upon Longshore Sediment Transport

Within 3 years following completion of the north jetty, the shoreline to the north prograded 2,500 feet (Figure 36). Within a few more years, the outer end of the jetty began to deteriorate, and as a result the shoreline north of the jetty receded. The shoreline again advanced to a total distance of 3,200 feet within a few years following the

reconstruction and 300-foot extension of the jetty in 1932-1933. Since that time, the shoreline has remained relatively stable. The U. S. Army Corps of Engineers (1970) calculated the amount of sand impounded by the north jetty and estimated the amount of north to south littoral sand transport. They estimated that the north jetty trapped a total of 8,000,000 cubic yards of sand. They then assumed that if the north jetty had not deteriorated, the shoreline to the north would have prograded 3,200 feet within 10 years following the jetty's construction. Given this 10-year deposition period, the U. S. Army Corps of Engineers estimated a north to south transport of approximately 800,000 cubic yards per year.

The very rapid sand deposition and beach progradation north of the north jetty caused the U. S. Army Corps of Engineers (1970) to identify a predominant north to south littoral transport for the Bayocean spit. Their conclusion appears to have been based on the classical models of unidirectional longshore drift. In the classical unidirectional model, sand deposition occurs on the updrift side of a jetty or groin constructed transverse to the nearshore zone and blocking the longshore sand transport (Wiegal, 1964). However, close scrutiny of the patterns of erosion and deposition along Bayocean spit and neighboring beaches suggests a seasonal reversal of longshore transport with a near zero net annual sand transport.

If the Bayocean nearshore was experiencing a large net north to

south littoral sand transport, the spit would have likely eroded along its entire length including Kincheloe Point (Figure 44). Under such conditions, although Kincheloe Point would lie within the "shadow zone" of waves approaching from the northwest, there still would remain a small net north to south component of sand transport to remove sand. As a result, sand would have been almost continuously removed, eroding Kincheloe Point and preventing deposition and shoaling within the channel.

Erosional and depositional shoreline patterns revealed in Figures 25 and 45 support the presence of a seasonally reversing longshore sand transport as opposed to a predominant north to south transport identified by the U. S. Army Corps of Engineers (1970). As discussed in Chapter I, National Marine Consultants (1961) and Neal et al. (1969) evidence is presented that the south longshore transport predominates during spring and summer, reversing to a north transport during autumn and winter. Figure 45 suggests that the north jetty has trapped and forced the deposition of the seasonally reversing transported sand. The result has been sand deposition, beach progradation, and shoaling, both north and south of the north jetty. Figure 36 illustrates the shoreline progradation north of the north jetty; similarly, Figure 35 shows the growth of the channel shoals south of the jetty since 1920. Figure 46 shows depth and width cross-sections for Tillamook Channel before and after construction of the

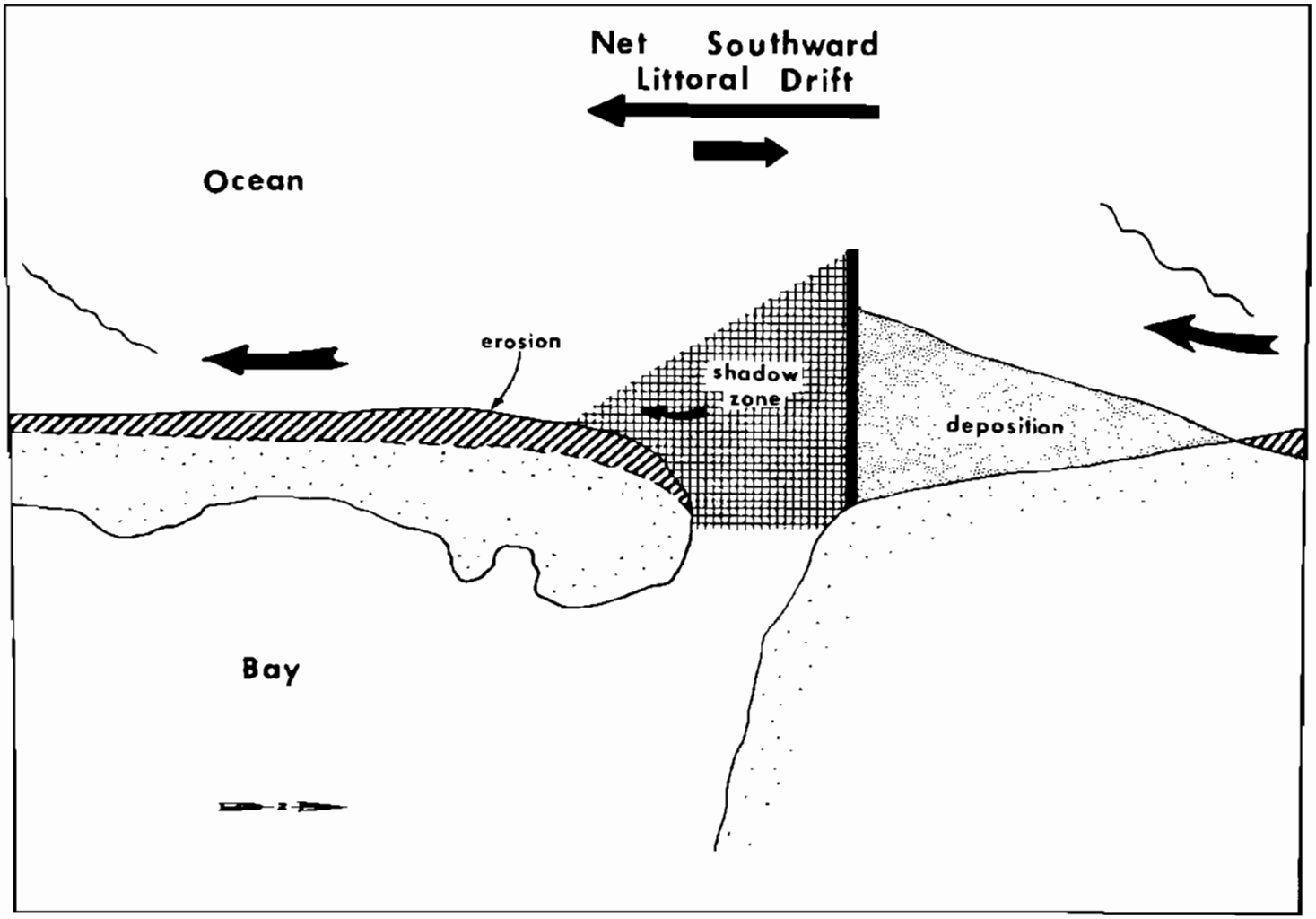


Figure 44. Schematic diagram of shoreline configuration of Bayocean spit resulting from net south longshore transport.

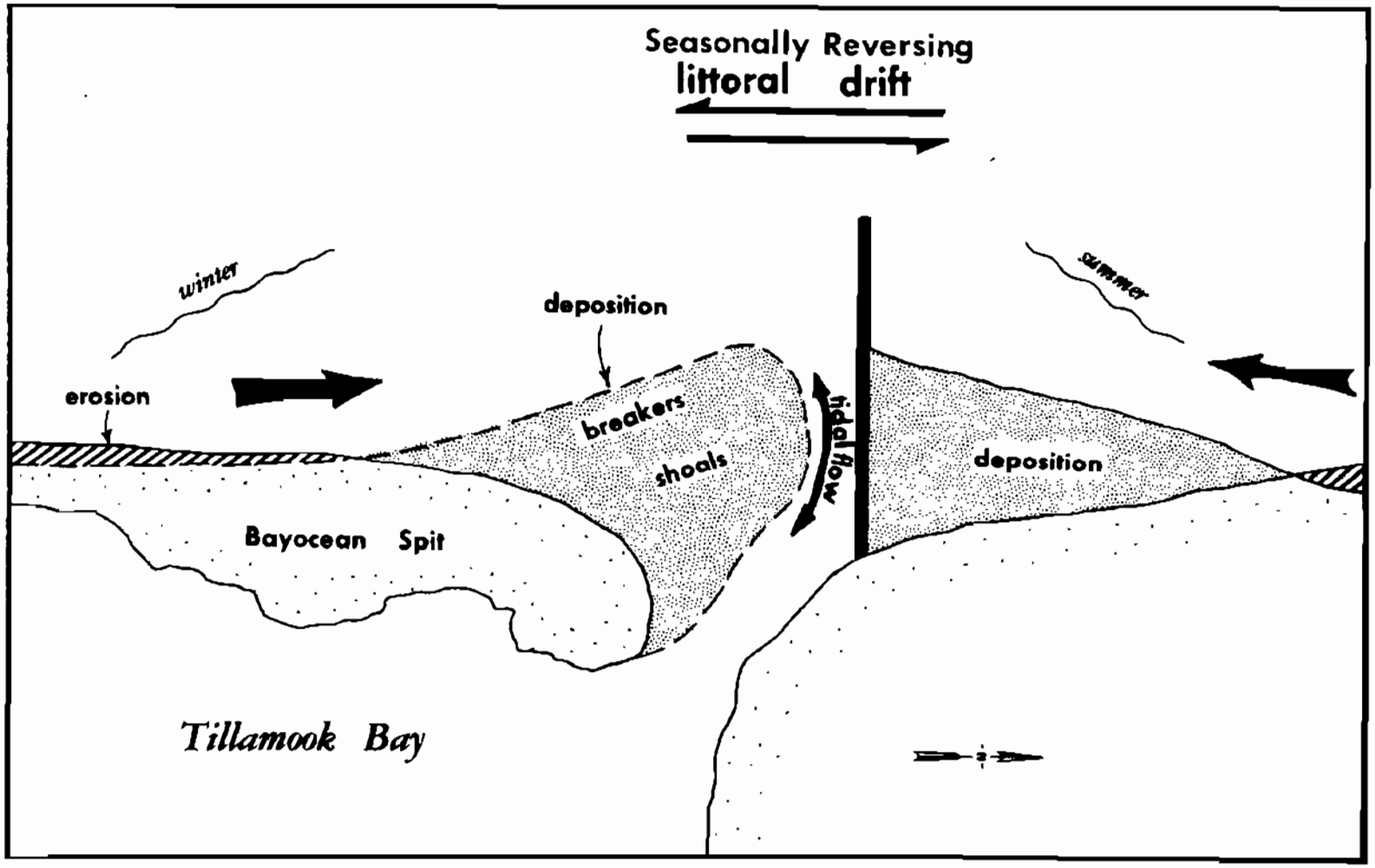


Figure 45 Schematic diagram of shoreline configuration resulting from near-zero net longshore transport.

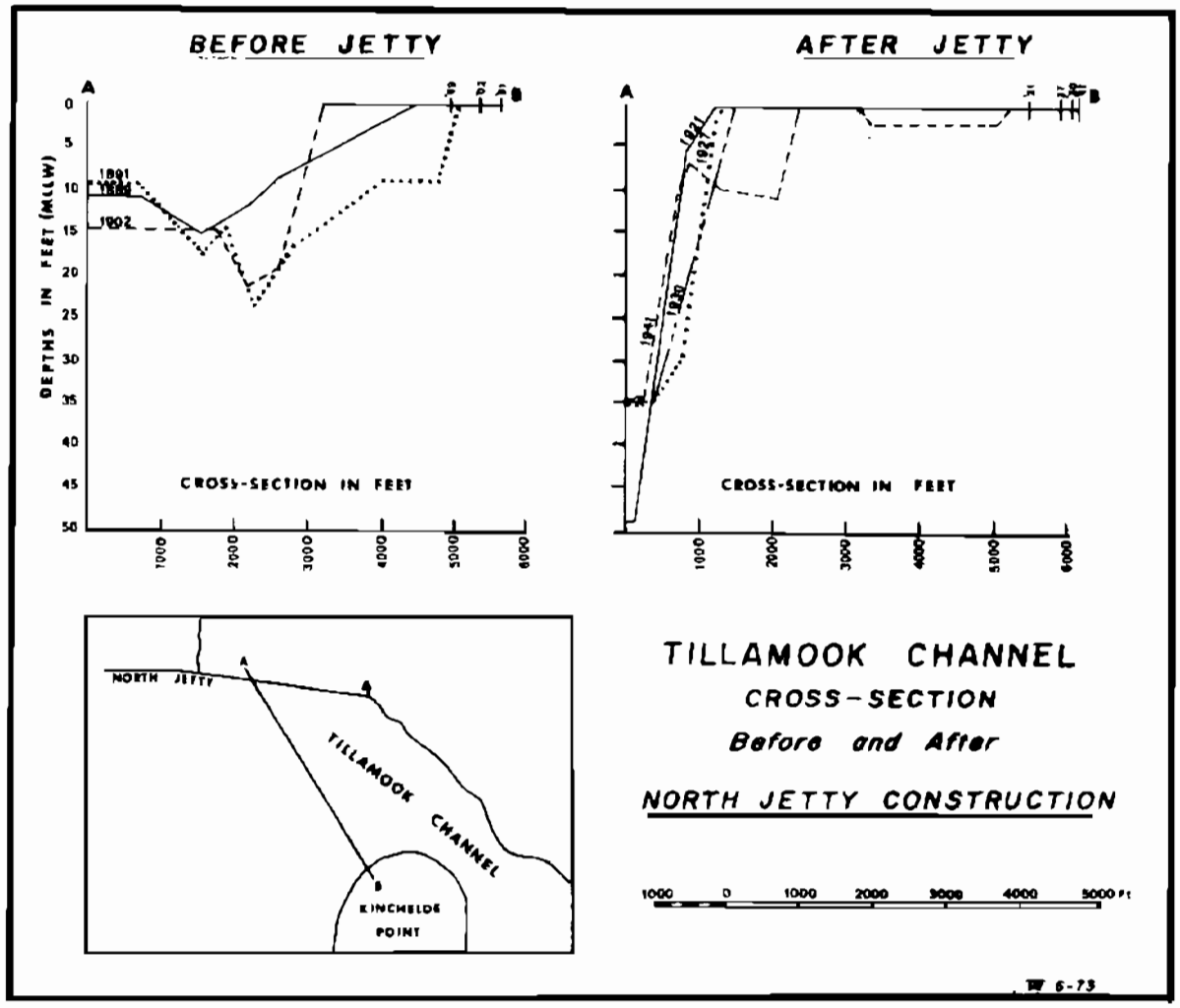


Figure 46. Tillamook channel cross-sections.

north jetty A striking change in the channel depth and width is seen after the construction of the jetty. The narrowing and concurrent deepending of the channel following jetty construction indicates that the jetty blocked the seasonal south to north longshore sand transport. The blockage caused a narrowing of the channel which had to be compensated by channel deepending to accommodate the semidiurnal tidal flow of Tillamook Bay.

In 1969, work was begun on the construction of a south jetty extending seaward from Kincheloe Point (Figures 33a, b, and c). The jetty was needed to impound the growing channel shoals and help clear the channel for navigation (U.S. Congress, Senate, 1965). Rapid sand deposition and shoreline progradation south of the new south jetty has provided additional evidence of a seasonal south to north littoral sand transport. Since the spring of 1970, the newly deposited beach south of the south jetty has grown to 0.17 square mile. Given this surface area and an estimated average height of accumulation of 10 feet above mean lower low water, the total estimated volume of deposition is 1,800,000 cubic yards. The total deposition averaged over a 3-year period (1970-1973) provides an average annual deposition of 600,000 cubic yards. Thus, a rough estimate of the seasonal south to north littoral sand transport is 600,000 cubic yards per year. This estimate is probably low since much of the drift undoubtedly escaped deposition during the initial phases of the south jetty's construction.

Summary

A view of the shoreline extending from Bayocean spit to Nehalem spit reveals a symmetry of shoreline erosion and deposition north and south of the Tillamook Channel (Figure 47). Cooper (1958) and Dicken (1961) report beach erosion along the Manhattan-Rockaway shoreline, although less severe than along Bayocean spit. It is suggested that the symmetry of shoreline erosion and deposition both north and south of the Tillamook Channel has occurred as a result of the north jetty trapping the seasonally reversing longshore sand transport. The entrapment of the sands in the immediate vicinity of the jetty has resulted in a net loss of beach sand for much of Bayocean spit and Manhattan-Rockaway beaches. The effect has been the loss of a beach sand "buffer" for these beaches, particularly Bayocean; this has allowed storm waves to reach the spit with greater energy and erosional capability to continue the erosion process.

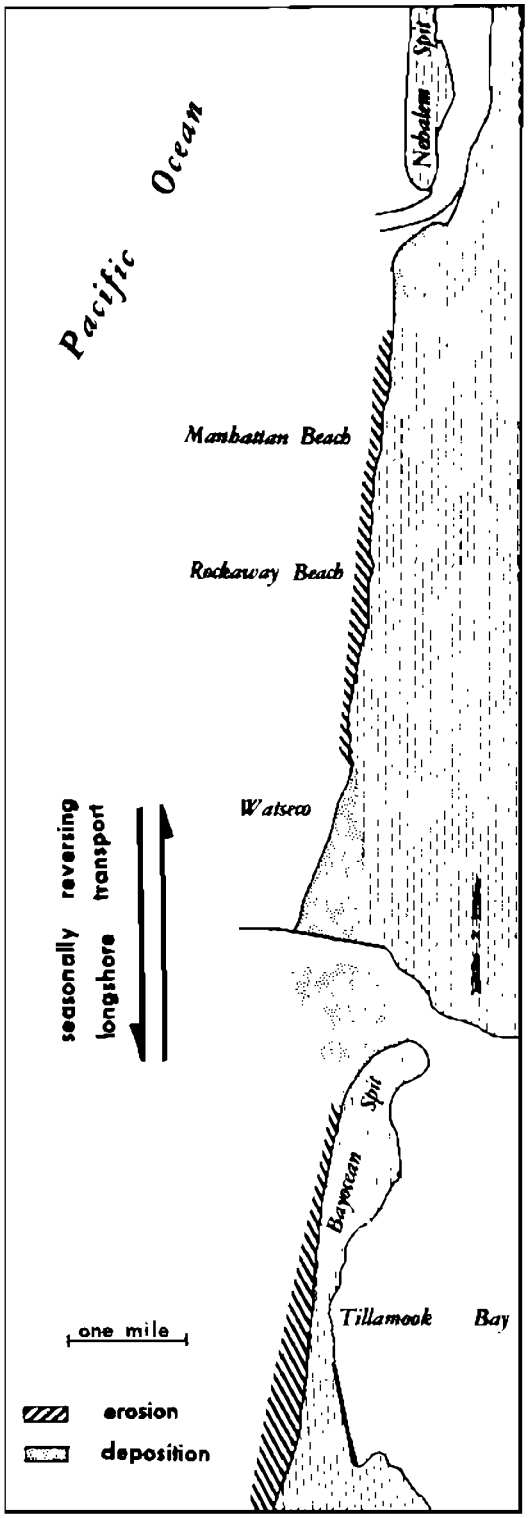


Figure 47. Shoreline symmetry north and south of Tillamook channel.

CHAPTER VI

CONCLUSIONS

Bayocean spit has had a long and interesting recorded history essentially beginning with the construction of Bayocean Park and ending with severe erosion and abandonment of the spit. Bayocean Park declined shortly after its initiation primarily as a result of its relative isolation and inaccessibility, economic setbacks and legal complications. However, had Bayocean Park become economically successful, its success would likely have been short-lived as severe erosion of the spit began in the early 1930's. The erosion of Bayocean spit appears to be related to the construction and later rehabilitation and extension of the north jetty to the Tillamook Channel. The thesis research demonstrates that the north jetty obstructs the seasonally reversing longshore sand transport causing sand deposition, shoaling and shoreline progradation both to the immediate north and south of the north jetty. Sand deposition to the south of the north jetty led to the growth of large channel shoals, which at times have prevented safe navigation of the channel. Consequently, in order to improve navigation of the channel a south jetty extending from Kincheloe Point was constructed and is presently being lengthened to impound the shoals south of the north jetty to help clear the navigation channel.

Most studies on the subject of man-made structures in the

nearshore zone have been concerned with beach erosion and deposition resulting from the construction of jetties or groins transverse to a unidirectional longshore sand transport. The typical sand transport pattern that emerges from these studies is sand deposition and shoreline progradation on the updrift side; erosion and beach recession on the downdrift side of the structure. At first glance, one would expect little or no erosion and deposition to occur along a shoreline by the construction of a structure transverse to a seasonally reversing longshore sand transport. However, as shown by this investigation, a configuration of shoreline symmetry is likely to result from sand deposition and beach progradation on both sides immediately adjacent to the jetty with concurrent erosion and beach recession along the coast at greater distances from the structure.

Construction of the south jetty will continue to cause sand deposition immediately south of the structure extending from Kincheloe Point. Bayocean spit will continue to serve as the source area for these deposited sands forcing further erosion and recession of the shoreline.

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BAYOCEAN COMMITTEE

Chairman	Paul C. Bates, Portland, Oregon
Vice-Chairman	Harland M. Woods, Tillamook, Oregon
Secretary	John Aschim, Tillamook, Oregon

MEMBERSHIP

		Representing
Paul C. Bates	Portland, Oregon	Property Owners
Harland M. Woods	Tillamook, Oregon	County Court
E. R. Huckleberry	" "	Tillamook Chamber of Commerce
Louis E. Hammer	" "	" " "
Arthur Paquet	Bay City, "	Commercial Fishing
Geo. D. Riechers	Tillamook, "	Oyster Industry
James Williams	" "	Daugherty Slough Drainage Dist.
Wm. F. Coats	" "	Industrial and Lumbering
Dr. M. B. Marcellus	" "	American Legion
H. T. Botts	" "	Bayocean Erosion Comm.
S. G. Reed	" "	Oregon Coast Highway Ass'n.
Ben Mills	Bay City, "	Pomona Grange
Frank L. Owens	Cloverdale, "	Tillamook Co. Creamery Ass'n.

DATE OF ORGANIZATION

January 28, 1939

PURPOSE

To devise ways and means of securing protection against ravages of Pacific Ocean now going forward at Bayocean on the West shore of Tillamook Bay, which if let go will ultimately merge the Ocean and Bay following which certain destruction impends for all lowlands adjacent to Bay which will include towns of Garibaldi, Bay City, and eventually the City of Tillamook.

WAR DEPARTMENT

Office of the Chief of Engineers

Washington 3-E

Refer to File No. 7402 (Tillamook Bay Region, Ore.)-47

February 7, 1941

Mr. John Aschim, Secretary,
Tillamook Chamber of Commerce,
Tillamook, Oregon.

Dear Sir:

Your letter of January 14, 1941, addressed to the President of the United States, in which you urge the appropriation of Federal funds for the purpose of preserving the shore line and protecting property from erosion at Bayocean, Tillamook Bay, Oregon, has been referred to this Department for consideration.

Under the provisions of the River and Harbor Act approved June 20, 1938, the Department was directed to make a preliminary examination and survey of Tillamook Bay, Oregon, with a view to protection of Bayocean and property thereon from erosion and storms. A field survey of the locality is actively in progress under the direction of the Division Engineer, North Pacific Division, Portland, Oregon, and the District Engineer at Portland, in collaboration with the Shore Protection Board. The survey report under preparation by the reporting officers is expected to be submitted to this office by March 1, 1941, at which time it will be forwarded to the Board of Engineers for Rivers and Harbors for review and recommendation, as required by law, prior to its transmission to Congress with the recommendation of the Chief of Engineers. Any works of improvement that may be recommended for adoption in that report, however, cannot be undertaken by the Department until they have been authorized by Congress and funds have subsequently been made available therefor.

As you are aware, the 76th Congress had under consideration legislation to authorize the appropriation of $120,000 to be immediately available as an emergency fund to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers for repairing damage to and checking erosion on the Bayocean Peninsula, in Oregon, caused by a storm in January, 1939, in order to provide adequate protection to property on such peninsula and in Tillamook, Oregon. The Department had indicated that this item

would provide sufficient authority to undertake emergency repairs pending transmission to Congress of the report on preliminary examination and survey referred to above. The legislation, as you are aware, failed to be enacted into law.

The interest shown by you in behalf of the proposed work of checking erosion at Bayocean, Oregon, is appreciated. I wish to assure you that appropriate action is being taken, as directed by Congress, in investigating the locality with a view to providing protection from erosion and storms, and that careful consideration will be given to the statements made in your letter in connection with any further recommendations that this Department may be called upon to make relative to an emergency appropriation for repairing damage to and checking erosion on Bayocean Peninsula.

For the Chief of Engineers:

Very Respectfully,

Albert H. Burton,
Major, Corps of Engineers,
Assistant Chief, Construction Section.

January 15, 1941

Honorable James W. Mott
Member of Congress
Washington, D. C.

Dear Mr. Mott:

RE: BAY OCEAN EROSION COMMITTEE

Since writing you yesterday, I have given further consideration to your letter of January 6th and that part of it in which you bring out very clearly that the President is definitely opposed to Rivers and Harbors legislation and this together with the fact that he vetoed the Rivers and Harbors bill last year makes it rather dubious that he will give favorable consideration toward Deficiency Appropriation Bill eventhough it has the approval of the Board of Army Engineers.

In view of the President's attitude I am inclined to believe that the letters which I wrote yesterday to different members of the Oregon delegation are likely to be considered from the standpoint of the property owners of Bay Ocean asking for a handout and without any good justifiable grounds other than the fact that they have sustained a very serious loss to their property investments and with the prospect of complete loss of any improved property still remaining on that sandspit.

Nothing could be further from the truth because the contention all along by all interests whether in Bay Ocean proper or in Tillamook County has been that there was no erosion or loss of property along the ocean frontage or elsewhere on the peninsula until after the completion of the government jetty on the north side of the entrance to Tillamook Bay, which was completed in 1932. Since 1932 the erosion has moved very rapidly over the entire frontage from Cape Mears (which is the southern end of the shore line at Bay Ocean) north to the mouth or entrance of the Tillamook Bay and in addition making cuts through the sandspit into Tillamook Bay at several points. In places the shoreline has receded at least 250 ft. and is progressing this winter at a rate where the loss of frontage will be greater than any other year if we allow for the movement which has already occurred during the winter and the possibility of continuing losses during January, February and March and the number of high tides which are greater than in almost any previous winter at this season of the year.

Major Moore of the U. S. Engineers for this district has never admitted that the completion of the north jetty was primarily responsible for the erosion movement which has become so noticeable since 1932 neither has he ever denied but what the completion of the jetty may have contributed to the loss and damage to property referred to but on the other hand there is very little, if any, disagreement among the old time residents of the county as to the completion of the jetty having been the direct cause of the erosion movement. Whether our losses can be compensated under a Deficiency Bill supported by the Board of Army Engineers or whether a direct appropriation to compensate the property owners referred to would be more favorably considered by the President and based upon losses due to the construction of the jetty as approved by the U. S. Engineers is a matter which I think ought to be considered and advanced as justifying the request which we are making for reimbursement of losses which the Bay Ocean residents are thoroughly convinced were caused by the completion of a jetty approved and constructed under the supervision of a federal agency.

I trust you will pardon me for having written you so extensively and attempting to place this matter before you in a more favorable light in view of what is a very serious situation to all property owners and one where we probably may not get relief if we went through the regular channels and under a Deficiency Bill advocated by the Board of Army Engineers where the President's known opposition is so well understood as opposed to relief from this direction.

Yours very truly,

Paul C. Bates
Chairman
Bay Ocean Erosion Committee

January 13, 1941

Honorable James Mott
Congressman, Third District
Washington, D. C.

Dear Sir:

RE: BAY OCEAN EROSION PROJECT

I notice in Sunday's Oregonian that you have introduced a bill providing for appropriation of $120,000.00 to repair storm damage to Bay Ocean peninsula in Tillamook, Oregon, under house proposal 1789.

I wrote you under date of December 24 relative to the interview of Mr. A. G. Beals of Tillamook with Major Miles Revor of the construction section of the U. S. Army Engineers and the assurance of that official to join with you in connection with any bill to be introduced in Congress for the purpose of relief to the Bay Ocean residents.

I have just returned here from a weekend visit to Bay Ocean and I found conditions deplorable in that on Christmas Day the water came through the Jackson Cutoff, according to some of those who saw it, to a depth of eight or ten feet and poured into the bay together with immense quantities of sand and rock cutting off the water supply temporarily and likewise the road which lies along the bay front. Saturday morning I came down the bay front about 8:30 toward Tillamook and it was a perfect day, clear with warm sunshine but the ocean was frightfully rough. Heavy combers were breaking at least one-half mile or more off shore. Immediately after the time that I passed through the Jackson Cutoff a big comber, two feet deep, crashed through and spread out to a width of 125 feet as it passed the roadway. All tracks of the road bed through the cut were completely obliterated by sand, stone, rocks and debris. A little later at the sand gravelpit about one-half mile south, I saw one large wave crash through the opening and cross the roadway at that point.

The entire shore line has receded anywhere from seven or eight feet to 15 feet. The Sanders home which was built in 1939 and is between the Jackson Cutt and the gravel pit a little further south is in danger of toppling into the ocean as the rear end of the house is already extending over the shore line which has been destroyed as results of this winter's storms. All of the roadway in front of Dr. Marcellos home, which I visited this last summer, has been completely washed out. Considering the fact that we have between the 10th of January

and the 31st, 18 more high tides from eight to nine feet and 19 tides in February which will run from eight feet up to nine feet six inches, these conditions will extend the erosion anyway from fifteen to twenty-five feet further particularly if these high tides are accompanied at the same time by southwest storms which are likely to prevail at some time during the months of January and February.

I talked with Mr. Mitchell and Mr. Beals and it is my opinion that any money appropriated at this time can not be used soon enough to prevent further encroachments by the erosion and the unquestioned loss of any residential property that may remain along the ridge of the peninsula.

There is no question but what the situation at present and the outlook is an extremely serious one to every resident who has any improved property left. There is no one in my opinion that can escape in the losses in addition to those already sustained before the government can give the relief necessary to prevent further losses.

I do not know what Major Moore of the U. S. Engineer Corps may have reported as results of the storms referred to or the complete survey of the Tillamook bay which I understand has been in progress the last year and a half but I do know that things are so hopeless from those who own any improved property that they would be glad to be compensated at this time for the small equities represented by the property under existing conditions. It is my opinion that $120,000.00 in any event not to exceed $150,000.00 would enable the government through the army engineers to acquire all of the existing property and thereby enable them to take their time about a comprehensive program of protecting the Tillamook bay interests and the county and state interests as against greater losses to come if such a plan is not inaugurated very shortly.

I will appreciate very much your cooperation as well as that of the other congressional representatives and senators from this state as naturally we dislike to see a complete loss of our property in addition to all of the losses which have proceeded the present efforts to secure some government relief. Thanking you in advance for your cooperation and earnest consideration to my statement of existing conditions, I remain

Yours very truly,

Paul C. Bates,
Chairman
Bay Ocean Erosion Committee

January 14, 1941

Franklin Delano Roosevelt
President of the United States
Washington, D. C.

Dear Mr. President:

I am very hesitant about approaching for the first time in my experience our national executive in this time of stress, and would not now do so were it not for the fact that I am convinced that only by so doing can I hope to relieve a situation of emergency facing a locality that is helpless unless National Relief is afforded.

Bayocean, Oregon has since 1933 been suffering from encroachment by the Pacific Ocean and each year has seen the situation grow progressively worse and there can only be one ultimate result, the complete destruction of that property and the probable loss of Tillamook Bay before long. I have written volumes in representations to Congress and various interested departments but with these I would not attempt to burden you.

I would like to partially quote from a brief filed on Sept. 27, 1939 with the Board of Army Engineers:

> "If the inevitable is allowed to come about and, in fact, Tillamook Bay becomes a part of the Pacific Ocean, there is reason to believe that it will further result in encroachment of the ocean into the tidal areas above described which means the destruction of all possibility for future activities in shell fish; total destruction of commercial fishing as an asset to Tillamook County; the destruction of industrial plants along the shores of Tillamook Bay with Garibaldi and Bay City included as well; the destruction of thousands of acres of diked tide-lands now being successfully farmed; the destruction of hundreds of homes representing a lifetime of savings; and the possible destruction of Tillamook City or at least rendering its location devoid of value; the entire elimination of the proposed base for the Oregon Coast Highway; and the destruction of the highway already constructed along the south shores of Tillamook Bay as above described.
>
> There would further be destroyed many miles of standard tracks of the Southern Pacific Company which represent an

enormous investment and many miles of roads now embodied in the State Highway system which cross the area above described.

In addition thereto, there remaining an element of national defense which, under modern conditions, cannot be overlooked. In case of invasion by foreign foe, Tillamook Bay is a favorable base for sea planes as well as a harbor for small defensive crafts and the roads now constructed around the Bay afford, as well, opportunity for the transportation of mobile units of artillery for placement at strategic points as a defense against invasion."

At that time encroachment had not reached a point where the ocean was breaking through, but later that year this actually came about and it has grown worse with each succeeding winter.

At one time this attracted your personal notice and in a letter in February 1939 to our County Judge you expressed concern at the condition.

The project was approved for relief in the amount of $120,000 in the last Congress by the House Committee on Rivers and Harbors, the Senate Committee on Commerce, the House, the Senate, and the Board of Army Engineers and passed the Congress as an item H. B. 6264 which you later found necessary to veto.

I recently appealed to Congressman Mott asking that if at all possible, an item of $200,000 be included in the Army and Navy Deficiency appropriation bill for Bayocean, but in a letter just received, the Congressman explains that this would be impractical, but states that he will again attempt to secure $120,000 and in press accounts I note that he has introduced such legislation.

While I personally think this amount small due to the increased encroachment by recent storms, it will of course be of help if judiciously expended.

In view of your former manifestation of personal interest, I am wondering of it is presuming too much to at least ask your indulgence in behalf of this condition and remedial appropriation.

I enjoy personal acquaintance with several members of Congress as well as with all of the members from Oregon, and I think that Senator McNary or Congressman Mott and Angell who have known

me many years will tell you that I am not inclined to enlarge any sutiation in representations, but try to confine myself to facts.

I earnestly ask your consideration in behalf of Bayocean.

Very truly yours,

_____

John Aschim, Secretary

February 12, 1941

Honorable James W. Mott
House of Representatives
Washington, D. C.

Dear Representative Mott:

I am now ready to release, as a matter of information, a letter which I wrote to the President of the United States under date of January 14 and of which I did not send copies to anyone. I have just received from Major Albert H. Barton, Corps of Engineers, a very interesting reply of which I also enclose copy.

My reason for writing the President was based on your letter to me of January 8 in which you enclosed copy of letter written to Mr. Paul C. Bates on the same date.

Apparently my correspondence had some effect and I think it may be of interest and possibly of assistance to you.

Very truly yours,

John Aschim, Secretary-Manager

Tillamook Chamber of Commerce

OSU

Phone 867-3011

COOPERATIVE EXTENSION SERVICE

OREGON STATE UNIVERSITY
MARINE SCIENCE CENTER
Marine Science Drive
NEWPORT, OREGON 97365

BIOLOGICAL CONSIDERATIONS IN ASSESSING FLOOD DAMAGE OF JANUARY, 1972, TO THE TILLAMOOK BAY AREA, OREGON

by

William Q. Wick, Professor and Head,
Oregon State University Marine Advisory Program

Oregon is estuary poor. Less than a tenth of one percent of the land area of Oregon is estuarine. Tillamook Bay is the second largest estuary, nearly 9,000 acres. About 90 per cent of Oregon's oysters are produced in Tillamook Bay. Several hundred acres of clam beds produce all major species of clams found in Oregon. A 1963 study indicated a production of more than a ton of clams per acre in the Bay. Nursery grounds for English sole, shad, salmon and other fishes provide food and protection for these species. This Bay is the major wintering home in Oregon for the black brant. Other waterfowl and shorebirds use the Bay for migration and wintering. Substantial eel grass beds provide food for waterfowl and shelter for fish, clams and shrimp.

The five Tillamook Bay rivers are major spawning grounds for salmon (chinook, coho, and chum), trout (steelhead and cutthroat), and other anadromous fishes.

The January Floods

All Oregon estuaries are in the process of filling. This is a gentle, dignified aging process. The January, 1972 floods, however, which jammed stream mouths, mutilated salmon spawning beds, reduced the salt water prism in the Bay, killed thousands of clams, devastated the oyster beds, and caused a major shift in ecological zones----brought the Tillamook Bay ecosystem to the verge of collapse.

It will take several years to discover, for sure, and in a measurable fashion, the total biological damage to the Tillamook Bay system. Simply stated, we have to ask the animals how much damage has been done and how much habitat was destroyed. In the meantime, however, we can make some educated assumptions:

1. The gravel and log plugs in the Wilson, Trask-Tillamook and Kilchis rivers will hinder spawning migrations for salmon, trout and other anadromous

Marine Resources Education
Oregon State University, U.S. Department of Agriculture, National Science Foundation, and Oregon Counties Cooperating

species. It is probable that some spawning grounds for chum salmon have been destroyed.

2. Plugging of the river mouths has restricted the tidal prism. This has several effects:

a. Animals requiring levels of salinity, even modest levels (10-15 ppt), will not survive in the upper bay areas. Probably several hundred acres of habitat are involved.

b. The cleansing effect of salt water (killing of pollution organisms such as E. coli) is reduced with the lessened saline wedge thus increasing ambient pollution.

c. The channel flushing effect of the salt water wedge (denser water) is reduced, thus tending to increase siltation and sedimentation. The salinity structure is intimately related to the circulation of the estuary because of density currents induced by the salt-fresh water relation.

3. River mouth plugging and lessening of salt intrusion reduces the overall nutrient contribution of the rivers and Bay to ocean processes.

Summation

The January floods in the Tillamook basin were disastrous to homes, farms, and businesses. The Bay itself suffered crucial damage. Estuarine damage has seldom been considered in assessing losses from floods or other freaks of nature. Perhaps the time has come to recognize that the compounded economic loss from estuarine destruction may be greater and longer lasting than the more obvious upland losses. A balanced estuary can produce several times more in living products per acre than the best cornfield. Tillamook Bay can be renovated to pre-flood levels of production by removal of river plugs. This will result in restoration of salt-fresh water density currents, tidal prism, and anadromous fish migration channels.

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May 30, 1972