Analysis of coastal changes along the New River Spit, Bandon Littoral Cell, relevant to an adjustment of the Statutory Vegetation Line on the south coast of Oregon

by

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Research Report

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"They say that time changes things, but actually,
you have to change them yourself"

Andy Warhol

... to my wife;

"Great spirits have always encountered strong opposition
from mediocre minds"

Albert Einstein

...to my friends;

"Muertos los piojos por hacer columpio"

Dicho popular mexicano

...to my parents.

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INTRODUCTION

Overview

Among Oregon's major tourist attractions is the State's beautiful and impressive coastal scenery. Sandy beaches, usually backed by sea-cliffs or dune fields, are regularly disrupted either by the mouths of shallow bays and estuaries, or by massive rocky headlands extending hundreds of meters into the Pacific Ocean. Storm-generated waves, tides, and coastal winds are counted among the many factors that constantly change the shoreline, reshape the beaches, erode the cliffs, generate dunes and form sand spits. The thousands of tourists who visit the coast each year have the opportunity to enjoy hiking, surfing or simply walking on the beach, thanks to the State's policies and regulations adopted to provide the public with access and use of Oregon's diverse coastal natural and scenic resources. The concept of having a public easement along the coastline was first introduced by the Oregon State Senate one-hundred years ago. The 1899 General Laws of Oregon declared the coastal beaches in Clatsop County a "public highway", while the 1913 Beach Bill extended the concept from the mouth of the Columbia River south to the California border. Both laws identified the public right of use only within the tidal portion of the beach, excluding the adjoining dry sand area. The 1913 bill also recognized that the State had already sold sections of the coast to private ownership: Of the 400 km of usable beach along Oregon's 570 km coastline, 190 km are privately owned. Thus, public and private rights over Oregon beaches have been in constant dispute ever since. In an attempt to resolve such problems, the State Senate convened in 1967 to create a new Beach Bill which would ensure those owning beach-front property the rights of private ownership, and at the same time preserve for the public as much of the beach as possible for their use and enjoyment [55th Legislative Assembly, 1969]. Thus, the 54th Legislative Assembly in 1967 created a Statutory Vegetation Line (SVL) to represent the landward limit of the beach zone, open to the public. Location of the SVL or beach zone line was originally established by the 16-foot elevation contour but became subject to much controversy, thus this criteria was analyzed and the SVL was redefined to be formed by a series of straight lines connecting a set of points defined within the Oregon Coordinate System [ORS 093.330], which at the time of the surveys, coincided approximately with the actual line of vegetation [ORS 390.770]. This new beach zone line, located slightly landward from the previous one, was enacted by the 55th Legislature Assembly and became law in 1969. However, far from halting disputes, the location and criteria established to define the SVL provided the ground for new problems; this study serves as an example to illustrate such continued conflicts.

Background

Intensive coastal and beach-front development in Oregon has occurred mainly on the north and central regions of the state, leaving the southern coast relatively natural and undeveloped. Local, state and national forests, refuges and preserve areas, as well as large tracts of privately owned range land, are sources of abundant and fairly pristine natural resources for hunting, fishing and other outdoor recreational activities. The conflict basis for the present study arose in this south coast region, beginning about ten years ago when two canoeists landed on the west bank of the New River (Figure I-2), which they thought to be part of the publicly owned beach. Unaware of the landward location of the beach zone line in the adjoining property, residents of the area confronted the canoeists alleging it was private property and not subject to public use. Notice of the incident was given to the Oregon State Parks and Recreation Department (OPRD), the agency vested with jurisdiction to protect public rights on the ocean shores as well as other recreation areas [ORS 390.620]. Other incidents reported by the local office of the Bureau of Land Management (BLM) were first about cattle trespassing into BLM property, and second about the presence of electric fences stretched across the New River, impeding navigation. State Parks performed a survey of the location of the SVL established in 1967, and concluded that it ran along the east bank of the New River, across several privately owned ranches. In response, on February 1991 the Curry County Board of Commissioners requested State Parks to review the location of the SVL along the New River. The Commissioners' request was evaluated by State Parks' staff as well as by experts from both Oregon State and Portland State Universities, who concluded that "the location of the beach zone line in the New River area was consistent with the rationale and intent of the Legislature in 1969", and since no significant changes in the physical conditions of the area had occurred during the last 22 years, they recommended that no change in the location of the zone line be considered [Bond, *et al.*, 1991]. The request was deferred several years while BLM negotiated with the ranchers over the purchase of land on the New River Spit and the creation of a scenic easement east of the river. After negotiations broke down, the ranchers appealed the decision of State Parks to the Attorney General, renewing their request to move the beach zone line. In 1995 the ranchers' attorney filed an application requesting the relocation of the SVL (from point Co-7-252 south to and including point Cu-7-12) seaward of its present location, to a position that coincides with the visible line of vegetation adjacent to the sandy beach of the actual ocean shore. OPRD is currently under procedures to re-evaluate the proposal and prepare a recommendation. As part of these process OPRD contracted the scientific expertise of Dr. Paul D. Komar and Dr. John J. Marra, through Shoreland Solutions, to provide the technical information required to support a recommendation. The present report represents a contribution to those technical investigations.

Objectives

The main objective of this study is to provide some of the technical and scientific information set forth in OAR 736-023-0030, necessary to support an adjustment in the current location of the of the Statutory Vegetation Line, segment Co-7-257 south to Cu-7-12, which corresponds approximately to the east bank of the New River in Coos and Curry Counties. A second objective is to provide a review of the origin and evolution of the SVL, and to analyze the implications and possible ramifications of relocating one of its segments, for the first time since its enactment in 1969.

Description of contents

The present report consists of two parts, the first integrating some of the technical and scientific investigations completed to support State Parks' statutory review, and a second part presenting an analysis of the possible consequences of relocating the SVL, from a management perspective. The following five chapters constitute the main body of the report. Chapter I presents a general description of the New River area, the Bandon Littoral Cell and the New River sub-cell, including the tectonic setting of the Oregon coast, the geology and hydrology of the site, the oceanographic and atmospheric conditions prevailing in the area, as well as a brief description of the ecological resources at New River. Chapter II describes the series of technical and scientific investigations conducted to examine the evolution of the coastal environment, here defined as shoreline changes, as well as to develop a budget of sediments for the Bandon Cell. Chapter III presents and discusses the results of the above investigations, including a series of detailed descriptions of shoreline changes that have occurred in the area since 1939, an assessment of the extent to which the vegetation line has moved, as well as accurate analyses of beach erosion, migration of the New River mouth, and geometry of rip-current embayments. Chapter IV reviews the origin and evolution of the SVL, from the concept of "public highway" to its enactment in 1969, examining the process of periodic reexamination and adjustment. It includes a discussion of the rancher's request to relocate the SVL, the likelihood of this action based on technical investigations, its effects on public and private interests, and a brief analysis of the consequences, local and statewide, that could arise from either decision. Finally, Chapter V concludes the report, summarizing the study's findings and providing recommendations for future investigations.

CHAPTER I

NEW RIVER AND THE BANDON LITTORAL CELL

General description

The Oregon coast consists of long stretches of sandy beaches backed by steep sea-cliffs or ample dune fields, dissected at regular intervals by shallow estuaries conforming to the mouths of coastal rivers or massive rock headlands extending several hundreds of meters into the Pacific Ocean (Figure I-1). Most of these headlands are large enough to prevent the along-shore passage of sand from adjacent beaches, separating the shore into isolated coastal units often referred to as littoral cells [Clemens, 1987; Komar, 1997]. The New River is located on the southern Oregon coast, within a long stretch of beach geographically bounded at the north by Coquille Point in Coos county, and to the south by Blacklock Point in Curry County (Figure I-2). This stretch of beach, further referred to here as the New River sub-cell, is included within a much bigger coastal unit, the Bandon Littoral Cell, constrained by two of the largest headlands in southern Oregon, Cape Arago to the north and Cape Blanco to the south, which seem to constitute the real boundaries of the littoral cell. The New River sub-cell has an alongshore length of about 28 km and consists mainly of medium to coarse sand and pebble beaches [Clemens, 1987; Orr, *et al.*, 1992]. Most of the central portion of the cell, about 20 km, is backed by dunes up to 6 m high, partially vegetated mainly by European beachgrass (*Ammophila arenaria*). Steep sea-cliffs, 6 to 50 m high, back the beaches in the north and south ends of the cell. There are several water bodies located within a few kilometers inland from the ocean, providing the area with abundant recreational activities such as fishing, boating, and wind-surfing. From Bandon to the south, these latter include Bradley Lake,

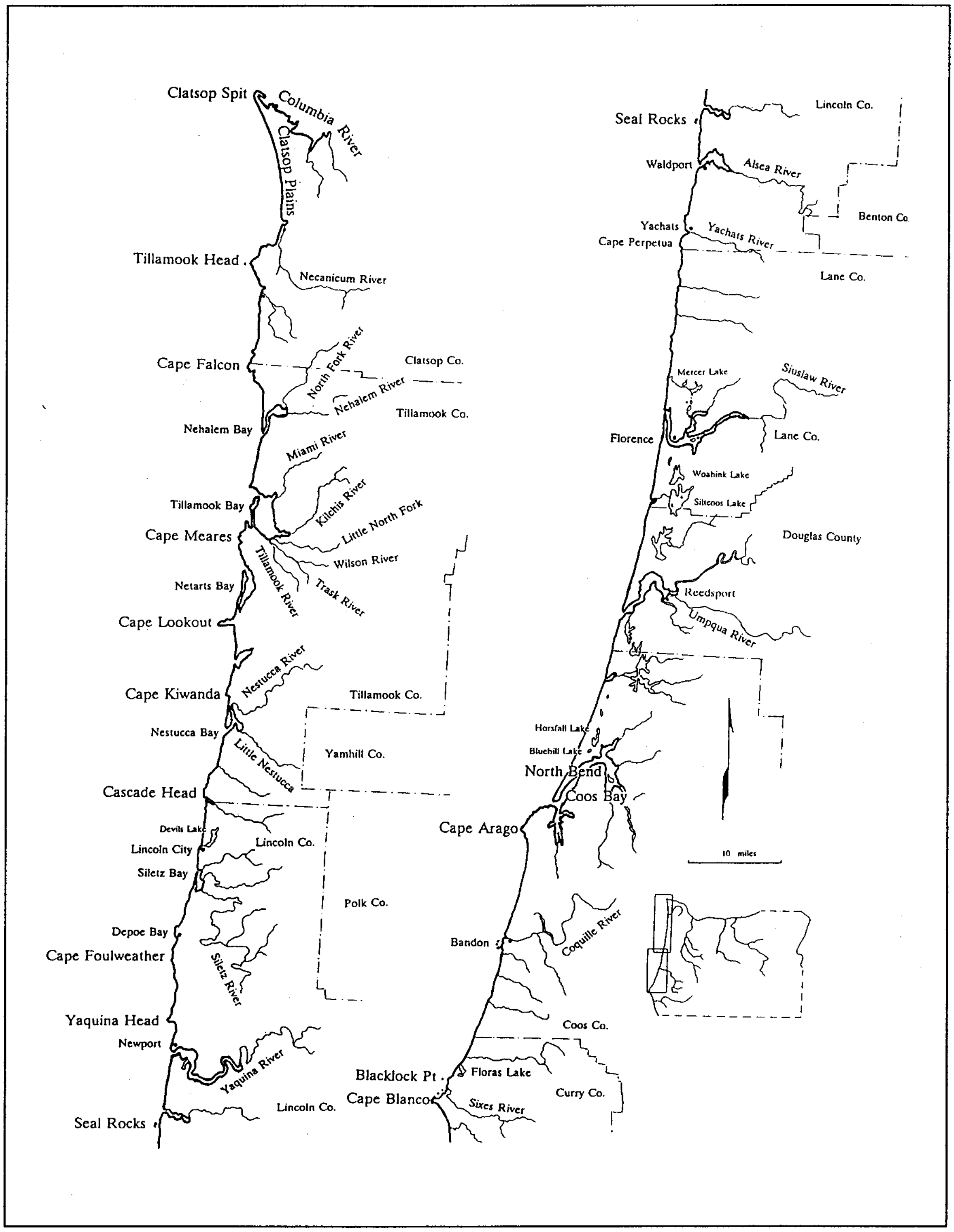

Figure I-1. The Oregon coast, composed of long stretches of sandy beaches dissected by coastal rivers and rocky headlands [from Orr, *et al.*, 1992].

Laurel Lake, Muddy Lake, Croft (formerly Crooks) Lake, New Lake and Floras Lake, the last and largest of the lakes. They play an important role in the cell's hydrology, discussed below, as most feed the series of coastal streams which discharge either into the New River or to the Pacific Ocean. The New River begins where Floras Creek, after meandering due west for several kilometers, makes a sharp turn and flows due north parallel to the ocean shore for about 15 kilometers before it finally reaches the sea. The New River Spit is the stretch of beach and dunes located at the central portion of the littoral cell and partially isolated to the east by the channel of the New River –which forms its landward boundary– and to the west by the Pacific Ocean.

There are few coastal communities in the immediate area. While intensive beach-front development has occurred mainly on the north and central portions of the state, the southern coast remains fairly pristine and undeveloped, having a variety of county, state and national forests, refuges and preserve areas, as well as large tracts of privately owned range land. The city of Bandon, located on the south bank of the Coquille River estuary, is the largest community in the study area, having a population of nearly 2,800 [Lighthill, 1998]. Although there is evidence of native settlers in the New River area dating back 3,000 years B.C. [BLM, 1995], the first white settlers, mostly miners and French trappers, arrived in Bandon in the 1850's. Between 1884 and 1898 the U.S. Army Corps of Engineers completed the construction of the jetties at the mouth of the Coquille River, and by 1912 Bandon became an important transit port between Portland and San Francisco [Lighthill, 1998a]. Other smaller settlements are found along interstate Highway 101, 3 to 5 km inland from the ocean, including the communities of Dew Valley, Laurel Grove, Langlois, and Denmark (Figure I-2).

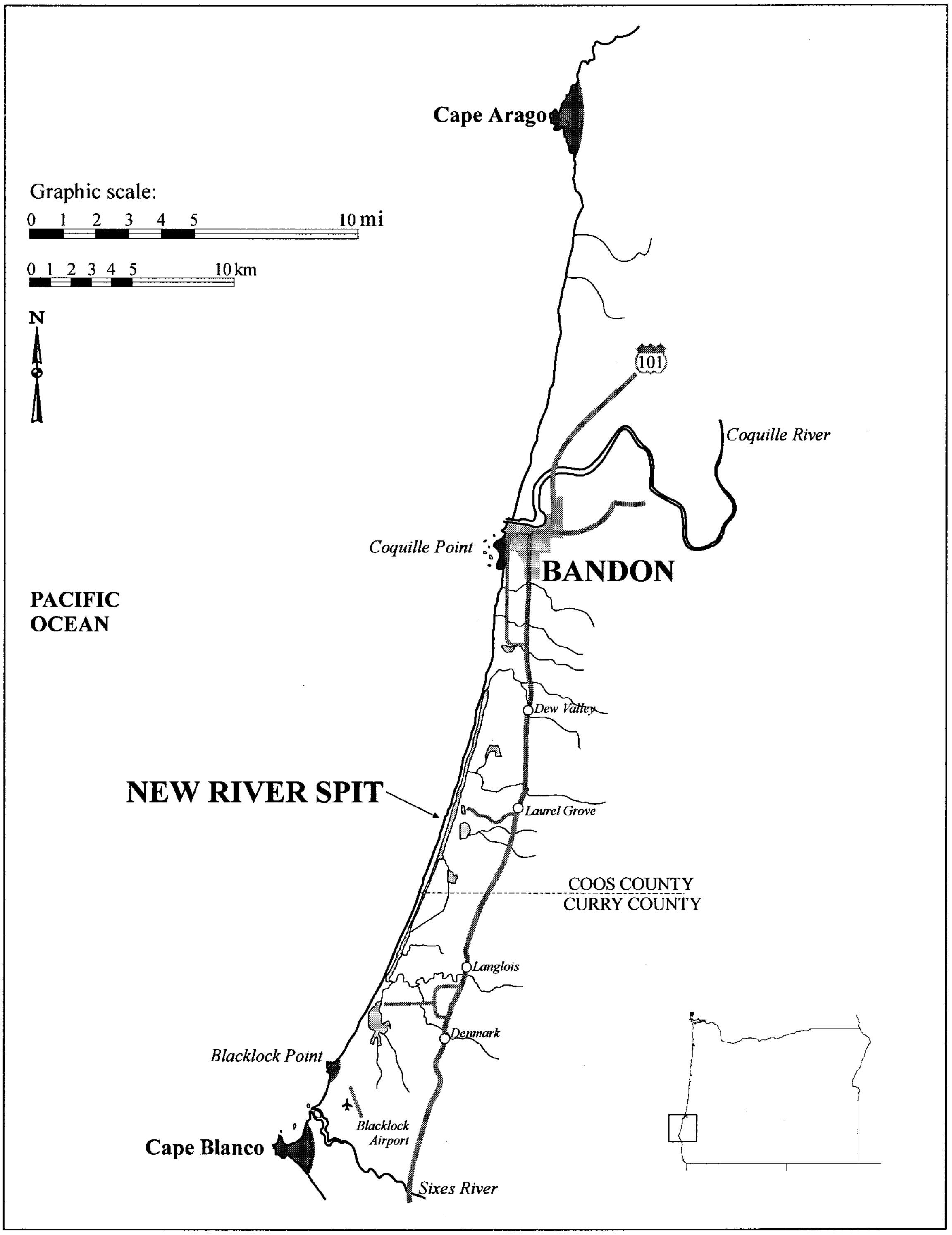

Figure I-2. Location of the New River Spit and the Bandon Littoral Cell, in the southern coast of Oregon.

Tectonic setting

Plate tectonics in the northeastern Pacific Ocean have had substantial influence in determining the physical features and geographic characteristics of the western United States. Located approximately 60 to 120 km off the Oregon coast, the Cascadia Subduction zone defines the western boundary of the North American plate as it overrides two small sections of denser oceanic crust: the Juan de Fuca and the Gorda plates. As shown in Figure I-3, the latter plates move eastward and collide with the North American plate as new oceanic crust is formed at the Juan de Fuca and Gorda ridges, located further to the west. Offset by the Blanco Fracture zone, these spreading ridges form the boundaries between the subducting plates and the massive Pacific plate, which has a general western motion. Marine magnetic anomalies and global plate reconstructions indicate that the Juan de Fuca plate is being subducted beneath the North America plate at a relative velocity of ~ 4 cm/yr in a northeasterly direction [Douglas, 1991]. These processes of regional tectonics account for some of the principal geomorphic features of the Pacific Northwest, including Mount Saint Helen, Mount Hood and the other large peaks of the Cascade Range, the existence of marine sedimentary rocks accreted to the continent, and the occurrence of vertical land movements along the coast [Komar, 1998a; Komar, 1992]. Orr, *et al.* (1992) indicate that rock fractures, faulting and folding, terraces on the western slope, and tilting phenomena suggest a close relationship between uplift of the Coast Range block and the subducting slab of the Juan the Fuca plate beneath North America. According to Douglas (1991), there is a distinct variation of sea level relative to land due to regional and local tectonic effects.

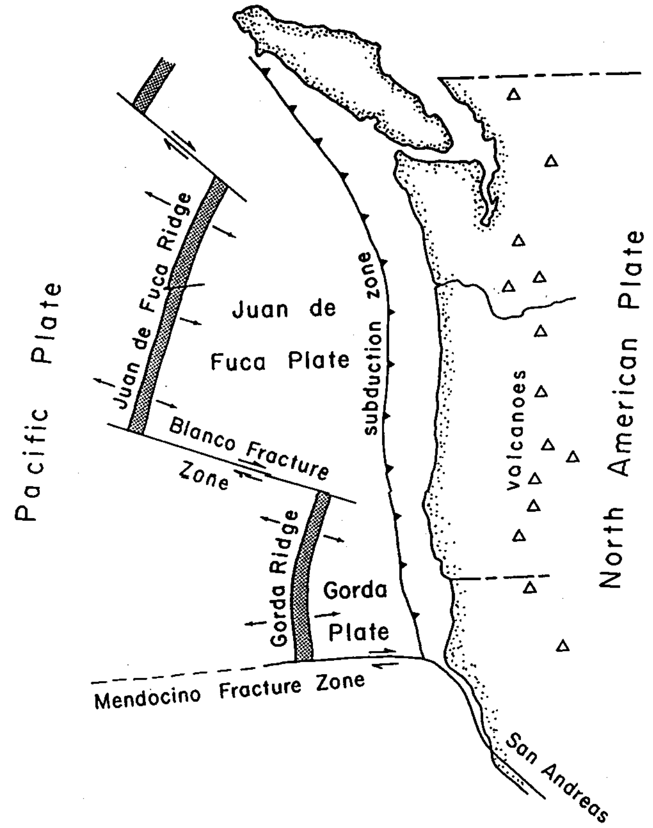

Figure I-3. Regional tectonics in the Pacific Northwest [from Komar, 1998].

Geology

The Bandon littoral cell is included within the Coastal Range physiographic province described by Orr, *et al.* (1992). The Coast Range, a long narrow belt of moderately high mountains and coastal headlands, extends southward from the Columbia River to approximately the middle fork of the Coquille River, and inland from the continental shelf and slope to the western edge of the Willamette Valley. Over 320 km long, and 50 to 100 km wide, the province averages 450 m in altitude with its highest point, Mary's Peak near Corvallis, reaching almost 1,250 m. Cape Blanco in the southwest corner of the province is a distinctive terraced promontory that extends into the Pacific Ocean as Oregon's most westerly point. Continued uplift and tilting of the coastal mountains, combined with Pleistocene sea level changes, has created raised marine terraces, up to 480 m high, in the vicinity of Cape Blanco and Cape Arago. These terraces consist of uplifted beach and dune deposits, composed primarily of poorly sorted, unconsolidated sands, silts, clays and gravels [BLM, 1995; Komar, 1992], varying from 6 to over 15 m in thickness. A small terrace 80,000 years old covers much of Cape Blanco. North of the cape, other recognized terraces include Whisky Run, Pioneer, Seven Devils, Metcalf and Arago Pea, which are 83,000 to 230,000 years old. The youngest and best known is Whisky Run terrace, which is made up of recently deposited marine and stream sediments, composed of coarse to fine grained quartz, various plagioclases, opaque mica, amphiboles, pyroxenes, and other minor silicates. It is a relatively thick terrace, possibly up to 15 m thick, and was deposited approximately 83,000 years ago during the Pleistocene ice age. During that time, the area was part of a long, flat beach that extended from Charleston south to Port Orford. This beach was uplifted by plate tectonics and then dissected by streams flowing from the Coast Range [BLM, 1995]. All of these terraces rest atop the Otter Point formation, deposited about 150 million years ago, which is composed primarily of sheared sedimentary rocks with smaller amount of volcanic material, chert and blueschist. These marine terraces compose the sea cliffs both at Coquille and Blacklock Point. Blacklock point marks the northernmost extent of Mesozoic rocks along the Curry County coast [Martin & Frenkel, 1978]. The older exposed rocks representing the stratigraphy of the northern limb of the Cape Blanco anticline are overlain by a series of Miocene and Pliocene beds consisting of tuffaceous indurated sandstone which is collectively referred to as the Empire Formation and is seen in the precipitous light-colored cliffs north of Blacklock Point [Baldwin, 1964; in Martin & Frenkel, 1978]. The section of the littoral cell between Coquille and Blacklock points consists of medium to coarse sand beaches backed by a field of well-sorted sand dunes and foredunes. The foredune is the low ridge of sand, varying in width from 60 to 180 m, which separates New River from the Pacific Ocean [BLM, 1995]. According to Cooper (1958), the outer sheet of dunes –the foredune– is active, while the inner sheet is an inactive, stabilized field of dunes. The area between both sets of dunes, the deflation plain, presents a mosaic of wet and dry, vegetated and bare areas.

Hydrology

Two major rivers and several coastal creeks drain the Coast Range and discharge into the Pacific Ocean (Figure I-2). The Coquille River, forming the north boundary of Bandon, is presumably one of the main sources of sediment to the coastal beaches at the north. Added together, its North, Middle and South Forks account for a combined drainage area of about 2,575 km^2 [Moffat, *et al.*, 1990]. Streamflow data have been recorded for several sites along the Coquille River since the 1930's, providing information on average discharges and rainfall, as well as on peak flow events. Table I-1 shows streamflow data from several USGS gage stations in the Coquille River and the Sixes River basins. Average discharge values vary from 4 m^3/s in the South Fork above Panther Creek to 22 m^3/s in the same fork near Powers. The largest event of record was registered for this same location and yielded a maximum discharge volume of 1,387 m^3/s on December 22, 1964. The lowest discharge volumes in the record were registered at the South and North

Table I-1. Available streamflow data from USGS gage stations for the Coquille and Sixes rivers in southwestern Oregon. Original data retrieved from Moffat, *et al*. (1990) and USGS (1998) in English units.

Reach / Station number	Drainage Area km^2	Period of Record (mo/yr)	Average Rainfall (m/yr)	Average Discharge (m^3/sec)	Maximum Discharge (m^3/sec)	Event Date (dd/mo/yr)	Minimum Discharge (m^3/sec)	Event Date (dd/mo/yr)
Coquille River, South Fork [1] 14324600	80.77	10/56 - 09/70	1.59	4.08	250.81	22/12/64	0.026	23/09/70
Coquille River, South Fork [2] 14324700	105.10	10/56 - 09/74	1.69	5.64	340.47	22/12/64	0.034	27-29/09/67 28-30/09/64
Coquille River, South Fork [3] 14324900	241.28	10/56 - 09/70	1.90	14.58	839.82	22/12/64	0.184	3-5/10/60
Coquille River, South Fork [4] 14325000	437.52	09/16 - 10/87	1.62	22.52	1,387.42	22/12/64	0.249	28/09/87
Coquille River, Middle Fork 14326500	789.60	10/30 - 09/46	-	21.08	669.59	02/01/33	0.028	16/07/31
Coquille River, North Fork [5] 14326800	191.31	10/63 - 09/81	1.30	7.97	220.17	02/03/72	0.056	09/09/67
Coquille River, North Fork [6] 14327000	730.06	12/28 - 09/68	-	26.81	1,089.50	23/12/64	0.034	12/08/68
Sixes River, near Sixes, OR. 14327150	300.31	10/67 - 07/70	-	21.41	453.96	23/01/70	0.510	13/08/68

USGS gage stations in Oregon: [1] above Panther Creek, near Illahe; [2] near Illahe; [3] near Powers; [4] at Powers; [5] near Fairview; [6] near Myrtle Point.

forks, stations 14324600 and 14326500 respectively, yielding values of 0.026 m^3/s in September, 1970, and 0.028 m^3/s in July, 1931. Average rainfall in the basin ranges from 1.3 to 1.9 m per year. Suspended-sediment discharges for the Coquille are on the order of 245,000 metric tonnes per year [Peterson, *et al.*, 1991]. While there is strong evidence to believe that the Coquille River contributes to the budget of sediments in the Bandon Cell, sediment supply by the Sixes river still remains to be determined. The Sixes river, located between Blacklock Point and Cape Blanco, runs for about 58 km before it opens to the Pacific Ocean, draining an area of about 300 km^2 [Casali & Diness, 1984; USGS, 1998]. Mean daily discharge varies from about 0.5 m^3/s in the summer to over 200 m^3/s in winter; the peak discharge recorded in January, 1970, was ~ 454 m^3/s [USGS, 1998]. Most of the tributaries have been logged, resulting in high turbidity in these streams and in the main river during freshets. Daily concentrations of suspended sediment in the lower main river during the water-year 1968 were in excess of 100 mg/l on 37 days, while the highest mean daily concentration of suspended sediment was 1,000 mg/l [Reimers, 1971].

As mentioned above, the several lakes located in the study area support a number of coastal streams which dissect the littoral cell and either contribute to the formation of the New River channel or discharge directly into the Pacific Ocean. The New River originates as a lower extension of Floras Creek, where it makes a sharp turn north and runs parallel to the ocean for about 15 km before it finally reaches the sea. Flow of the New River is aided by several streams discharging into its channel, thus contributing to the historical migration of the mouth progressively to the north. Shown in Figure I-4, these include Floras Creek and the outlet of Floras Lake, Langlois Creek, Bono Ditch, the

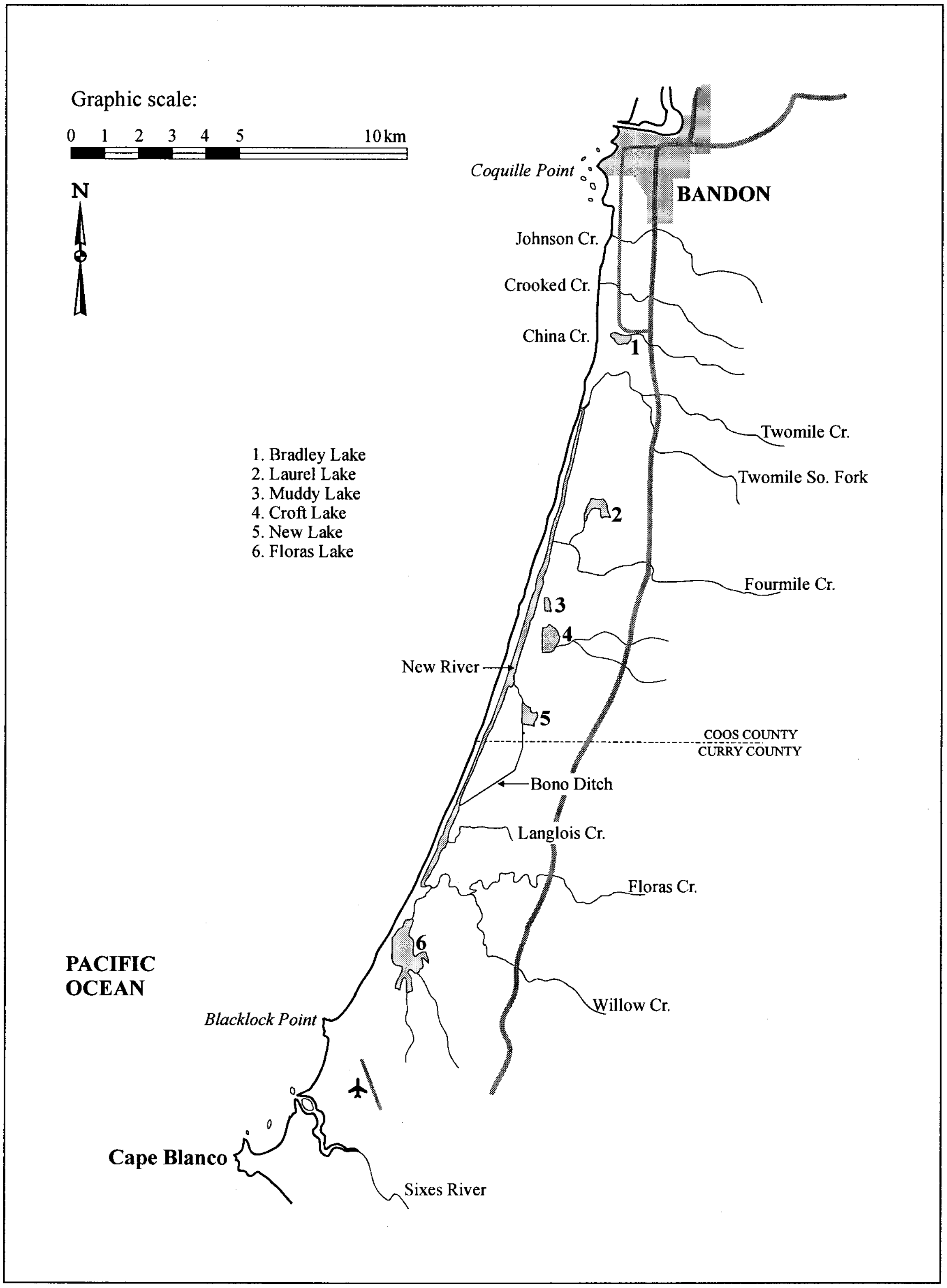

Figure I-4. Coastal streams and water bodies in the New River sub-cell.

outlets of New and Croft lakes, Fourmile Creek and the outlet of Laurel Lake, as well as the south-flowing reach of Twomile Creek, all combining to give the New River basin a total drainage area of about 331 km^2 [BLM, 1995]. According to the BLM report, estimated monthly average discharges, measured at the Floras Lake outlet, vary seasonally from 0.3 to 21.3 m^3/s. Seasonal rain and runoff patterns have a strong effect on the river. There is little water storage in the system and almost 80 per cent of annual runoff occurs between November and April, coinciding with precipitation patterns, while less than one percent occurs in August and September. Annual runoff in the basin averages about 1.27 m, and the annual yield of water measures approximately 340,000 acre-feet. Like most coastal streams discharging into the Pacific Ocean, the New River shows a yearly cycle of change. Influx of tidal salt-water mixes with the fresh-water runoff and estuarine-like conditions develop in the lower one third of the river during the winter months. During the dry season of late summer and fall, northwest winds blow sand across the river mouth, usually closing it. This yearly blockage persists until the river overflows and the dunes on the sand spit fail during late fall and winter. This foredune failure or breaching can occur either at an old or new location, leading to the formation of one or more river mouths [BLM, 1995]. The presence of multiple outlets draining the New River creates a rather complex condition, often characterized by flow reversals of the northward current, and upstream saline intrusion [BLM, 1995].

Oceanography

Physical conditions of the ocean and atmosphere are strongly dependent on each other, thus making one difficult to isolate. In general, temperate latitudes are characterized by having a strong seasonal variability of atmospheric conditions which determine two typical weather patterns: winter, usually November through March, and summer, April through October. In the Pacific Northwest, winter conditions consist generally of a series of atmospheric low pressure cells coming in from the ocean. These create storms that bring moderate temperatures, abundant rain and strong winds from the south or southwest. Summer conditions bring winds from the north and west, moderate temperatures, little rain and frequent fog. It is important to realize that summer storms are generally less frequent and violent than winter ones. Similarly, mild weather conditions may also occur during winter months [Jay & Blanchard, 1976].

Atmospheric conditions

The ocean is the single most important factor influencing the climate around the New River sub-cell [Martin & Frenkel, 1978]. According to historic records provided by NOAA's National Data Buoy Center (C-MAN Station CARO3 located on top of Cape Arago) for the period of January 1985 through December 1993, temperature in the area never exceeded 28 °C and only during extreme conditions dropped below -5 °C. December, the coldest month, had a mean temperature of 8 °C, while July, the warmest, averaged 13 °C. Precipitation is also greatly influenced by the proximity to the ocean. Abundant rainfall occurs on the coast and most of western Oregon. The Cape Blanco area receives a mean annual precipitation of 190 cm, most of which occurs during late fall and winter [Martin & Frenkel, 1978]. Oceanic influence causes yearly variations in the wind direction and velocity. Strongest winds are found during winter months and are associated with storms that bring most of the annual precipitation. These storms generally come onshore from the southwest, and often generate winds up to 120 km/hr [Martin & Frenkel, 1978]. The average wind speed for the period between January 1985 and December 1993 is 16 km/hr at Cape Arago. Directional summaries for November 27 through 30, 1998 show S and SW as the main wind direction [NDBC, 1998]. According to historic data provided by Martin & Frenkel, 1978, the general wind direction shifts to the northwest in the spring and continues from that direction until late fall when it moves back to the southwest.

Wave climate

Ocean-wave climate, strongly dependant on atmospheric conditions, similarly experiences strong seasonal variability. Generated by the wind stress blowing on the surface of the ocean, waves tend to increase as the strength of the storm-generated wind increases; thus, larger waves occur during the winter months, when the strong winds from the south and southwest are present. Tillotson and Komar (1997), studied the wave climate for the Oregon and Washington coasts, comparing data records derived from four different measurement systems and wave hind-cast techniques. Direct measuring techniques include deep-water buoys from the National Buoy Data Center, NOAA, shallow-water directional arrays and deep-water buoys of the Coastal Data Information Program, Scripps Institution of Oceanography, as well as an innovative microseismometer system installed in the Hatfield Marine Science Center (HMSC) in Newport, OR, which provides the longest available record of wave measurements. Additional data was provided by the Wave Information Study of the U.S. Army Corps of Engineers, derived from hindcasts based on daily weather charts spanning the years 1956 to 1975. Table I-2 provides a summary of the above wave data sources including their locations and time periods of wave recordings.

Table I-2. Wave data sources for the OR and WA coasts [Tillotson & Komar, 1997].

Program	System	Location	Water depth (m)	Time period
CDIP	buoy - 1D	Coquille, OR (43° 06.4' N; 124° 30.4' W)	64	12/81 - present
CDIP	directional array	Coquille, OR (43° 07.4' N; 124° 26.5' W)	11	08/83 - present
CDIP	buoy - 2D	Grays Harbor, WA (46° 51.1' N; 124° 14.9' W)	43	12/81 - present
CDIP	directional array	Long Beach, WA (46° 23.4' N; 124° 04.6' W)	10	09/83 - present
NDBC	buoy	Cape Foulweather, OR (44° 40.2' N; 124° 18.4' W)	112	05/87 - present
OSU	microseismometer	Newport, OR	20*	05/71 - present
WIS	hindcast	Station 42 (44.8° N; 125.0° W)	deep water	01/56 - 75

buoy - 1D = surface following buoy for deep-water wave energy measurements
buoy - 2D = surface following buoy for measurement of deep water wave energy and direction
* Depth to which the original calibration corresponds.

As expected, a marked seasonality was found in the wave climate, with significant wave breaker heights averaging 1.25 to 1.75 m during the summer months, and increasing to 2 to 3 m during the winter months (Figure I-5). The significant wave-height H_s refers to the average one-third of the tallest waves for a given wave record, and approximately coincides with the reported height derived from visual observations [Komar, 1998a]. Individual storms yielded H_s values usually over 6 m, while the largest storm-waves recorded during the 23 years of data accumulation had a deep-water significant wave height of 7.3 m. Estimation of breaking-wave conditions during these storms yielded significant wave breaker heights (H_s) values of 9 to 10 m. Extreme wave conditions are important since they often serve as the design-value used in engineering analyses and to establish erosion and flooding zones in coastal zone management. This usually involves the projection of the 50-year or the 100-year event (extreme-wave condition) based on wave measurements obtained over a much shorter span of time; for statistic validity, it is recommended that the projection of the extreme events are as much as three times the length of the recorded measurements [Tillotson & Komar, 1997]. Based on 23 years of data, the projected 50-year significant wave height is 7.8 m, while the projected 100-year event –of questionable validity– has a H_s of 8.2 m.

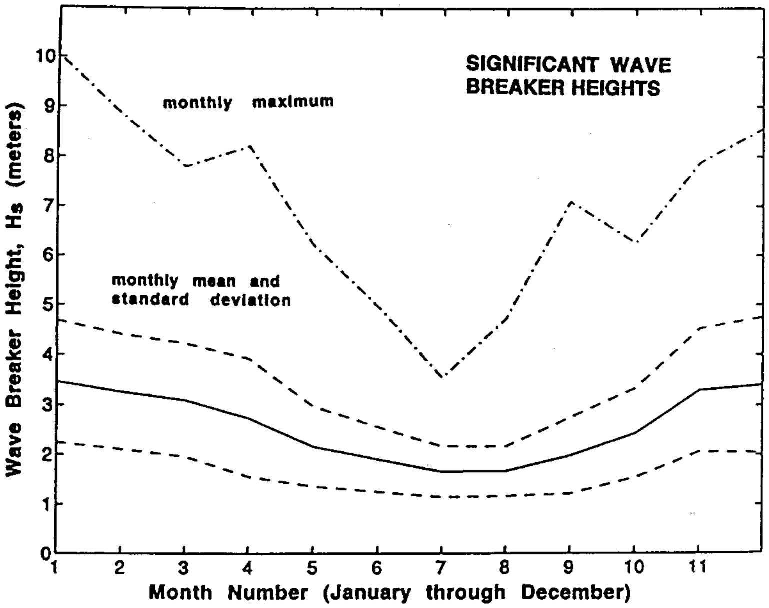

Figure I-5. Seasonal variations of significant wave breaker height along the Oregon coast [from Komar, 1998a].

Tides and extreme water levels

Tides along the Pacific Northwest are moderate, with a maximum tidal range of about 4 m and an average range of 2 m [Komar, 1998]. As most of the Pacific Northwest, Oregon has a mixed semi-diurnal tide regime, characterized by having two highs and two low tides with different elevations, in a 24 hour period (Figure I-6). Tidal elevations are usually referenced to the mean of the lower low water level (MLLW) for a given period of time; thus, most elevation values are positive numbers and only the extreme low water levels are represented by negative numbers. Predicted water elevations for 1998, estimated by the HMSC, have a range of high tides between 2.7 to 3.2 m, averaging 2.9 m for the complete set of predictions, and low tides ranging from -0.7 to -0.3 m, with an annual mean of -0.5 m below MLLW [Creech, 1998]. These predictions can be corrected for Bandon by multiplying the high tide values by a factor of 0.83 and the low tides by a factor of 0.85 [Creech, 1998a], hence yielding water elevations about 80 per cent smaller than those predicted for Newport, 200 km to the north. Corrected elevations predict annual mean tide-levels between 2.4 to -0.4 m, having the highest predicted elevation of 2.6 m above MLLW, for November and December, and the lowest tides -0.6 m below MLLW, expected to occur during May and June. Additional corrections relevant to the study area include those for Port Orford, located about 40 km south of Bandon, where ratios of 0.88 and 1.02 apply to the high and low tides predicted for Yaquina Bay, respectively. Table I-3 shows predicted monthly water elevations for Yaquina Bay, and the corrected elevations for Bandon and Port Orford, Oregon.

Table I-3. Predicted monthly water elevations (tides) for Yaquina Bay and corrected elevations for Bandon and Port Orford, Oregon, in 1998 [after Creech, 1998 and 1998a].

Month	Yaquina Bay		Bandon		Port Orford	
	High (m)	Low (m)	High (m)	Low (m)	High (m)	Low (m)
January	3.02	-0.46	2.51	-0.39	2.66	-0.47
February	2.93	-0.40	2.43	-0.34	2.58	-0.40
March	2.93	-0.34	2.43	-0.29	2.58	-0.34
April	2.93	-0.61	2.43	-0.52	2.58	-0.62
May	2.93	-0.73	2.43	-0.62	2.58	-0.75
June	2.87	-0.70	2.38	-0.60	2.52	-0.72
July	2.75	-0.52	2.28	-0.44	2.42	-0.53
August	2.71	-0.52	2.25	-0.44	2.39	-0.53
September	2.71	-0.34	2.25	-0.29	2.39	-0.34
October	2.93	-0.43	2.43	-0.36	2.58	-0.44
November	3.08	-0.61	2.56	-0.52	2.71	-0.62
December	3.17	-0.64	2.63	-0.54	2.79	-0.65
Mean	**2.91**	**-0.52**	**2.42**	**-0.45**	**2.56**	**-0.53**

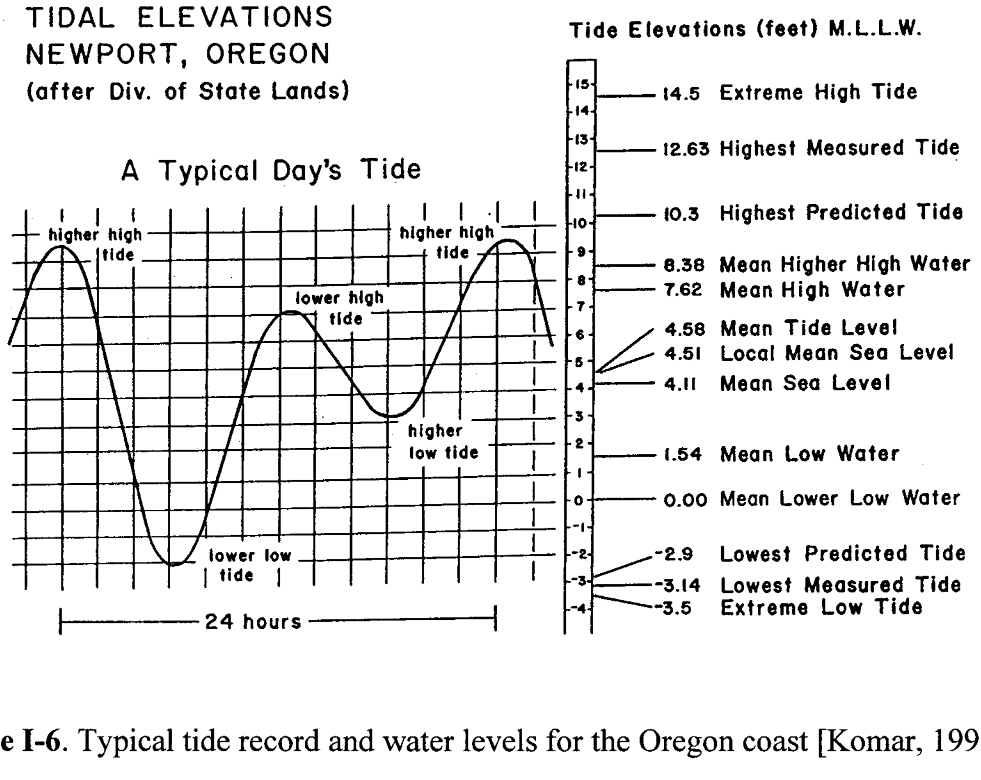

Figure I-6. Typical tide record and water levels for the Oregon coast [Komar, 1998].

Predicted water levels usually differ from measured tides. Water levels measured by local tide gages often yield greater values than the predicted levels due to the influence of many factors including storm surges, fluctuations in atmospheric pressures, onshore winds, the effects of water temperature, ocean currents, and the occurrence of inter-annual events such as the El Niño Southern Oscillation (ENSO) [Ruggiero, *et al.*, 1997; Komar 1998]. All these factors combined, result in water elevations that tend to be 10 to 38 cm higher than expected from the tides alone, consistently higher in the winter than in the summer because on-shore winds tend to be stronger during the winter and water temperatures are higher than during the summer [Komar, 1998]. Ruggiero, *et al.* (1997), analyzed a 24-year time series of hourly measured tides to investigate the effects of these processes and to document the occurrence of extreme water levels at Newport. Yearly maximum elevations were treated statistically by fitting the data to a Fisher-Tippet Type I extreme-value probability distribution (e-v pdf), commonly referred as the Gumbel distribution, and return intervals were computed for extreme tides. This values are graphed in Figure I-7 along with extreme values derived from predicted tide levels also fitted to a Gumbel distribution. As shown in the graph, differences on the order of 0.4 m exist and are significant particularly for long return-periods.

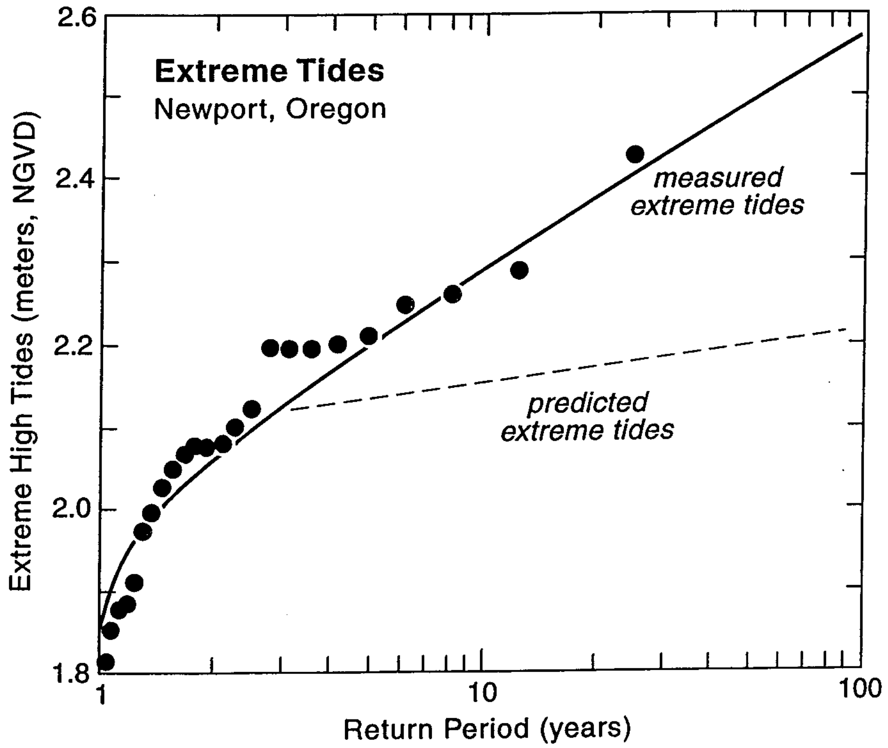

Figure I-7. Extreme water levels calculated for Yaquina Bay, Oregon [from Ruggiero, *et. al.*, 1997].

Relative sea-level rise

A series of tide gauges studies, measuring trends in sea level at selected stations all over the world [Barnett, 1983 and 1984] have demonstrated that a coherent pattern of increasing relative sea level exists on average. Subject to considerable assumption, the rate of relative sea level rise associated with these patterns was found to be in the order of 15 cm per century. Subsequent more exhaustive studies performed on tide records for the periods of 1930 to 1975 have demonstrated that sea level is increasing relative to emerged land at all stations except on those located in the eastern North Pacific Ocean.

According to these studies [Douglas, 1991; Mitchell, *et al.*, 1994], most of the Pacific Northwest is rising at rates of ~ 0.4 mm per year in Astoria, Oregon, and as much as ~ 0.9 mm per year in Crescent City, California. Mitchell, *et al.* (1994), have suggested that land elevation is currently changing relatively to the global trend in sea level rise due to a net coastal uplift along the Oregon continental margin. Based on data collected by Vincent (1989), the smallest uplift has occurred along the north-central coast between Newport and Tillamook, with progressively higher uplift further south and along the very northernmost portion of the coast towards the mouth of the Columbia River. According to the results graphed in Figure I-8, the submergence rates along the central stretch are on the order of 1-2 mm per year, while the southern coast is tectonically rising at a rate of about 2-3 mm per year. Data recorded for Bandon indicate uplift rates on the order of 1.5 mm per year [Vincent, 1989; Komar, 1992].

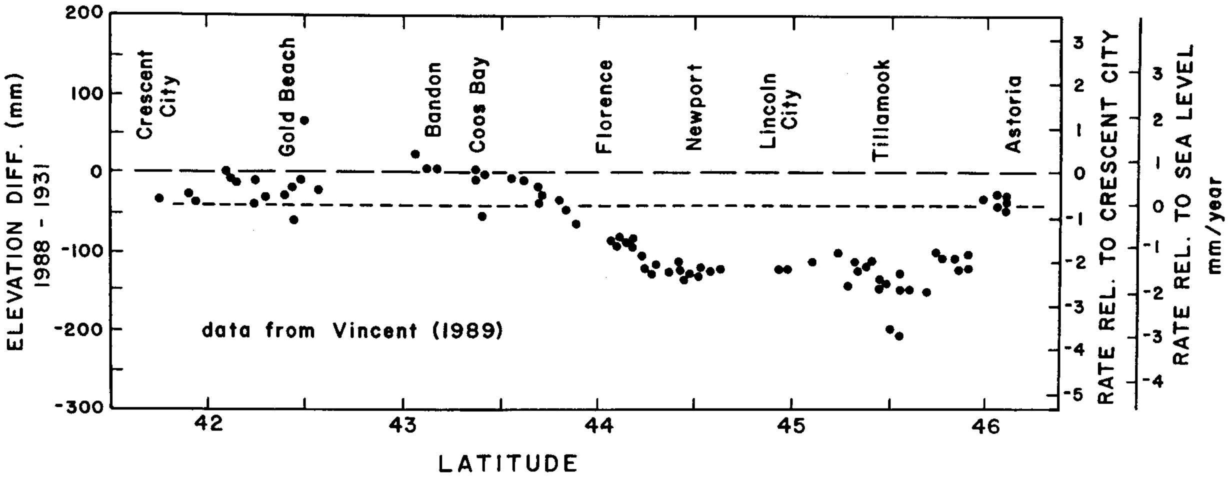

Figure I-8. Submergence rates recorded along the Oregon coast [from Vincent, 1989].

Ecological Resources

Vegetation and wildlife species are a significant component of the Bandon littoral cell, particularly given the fact that the relatively low human development in the area has granted the preservation of fragile, endemic species otherwise threatened or long ago disappeared from other coastal areas. The BLM (1995) report on the New River's Area of Critical Environmental Concern (ACEC) provides one of the most extensive reviews of the ecological resources for the study area. According to this study, plant communities develop on open and stabilized sand dunes, wetlands, and upland shrub, blend together and lead to the coniferous forests consisting of sitka spruce, western hemlock, Douglas-fir, or shore pine. Twenty-two specific plant communities, assembled into seven vegetation types and/or wildlife habitats, exist in the area and include: Open sand dunes, European beachgrass, wetland/riparian, mixed conifer/shrub, shore pine/beachgrass, meadows/grasslands, and willows/sedges. Open sand dunes are scattered and declining due to the rapid expansion of the non-native European beachgrass, introduced to the area around 1930; native plant species in this area include the seashore bluegrass, beach morning-glory, American glehnia and yellow sand verbena; shorebirds particularly the protected Snowy plovers, gulls, and occasionally sea turtles. European beachgrass covers much of the foredune, and the deflation plain, east of the New River, providing suitable habitat for raccoons, northern harriers and striped skunks. High seed production (~20,000 seeds/plant/year) and the fact that plants can withstand sand burial up to 1 m per year, are some of the characteristics that make European beachgrass such a successful species.

Wetlands are scattered throughout the study area in the form of bogs, ponds, mudflats, and salt- and fresh-water marshes, supporting many species of sedges, rushes, and the yellow pond-lily and California pitcher-plant. Species of concern include bog blueberry, tufted hairgrass, and Sphagnum moss. Wetland habitat is critical for juvenile Coho salmon, amphibians and others these two species support, including ducks, perching birds, and beaver, as well as predators such as peregrine falcon, northern harrier, bobcat, fox, raccoon, and snakes. Conifer and shrub communities are dominated by woody vegetation, including Sitka spruce, shore pine, Douglas-fir, and occasionally Port Orford cedar. Meadows, grasslands and pastures occur in the eastern portion of the cell and are disseminated throughout the other upland habitats, while willows and sedges dominate the banks of the river and adjacent lakes. Some of the plant and animal species included within these assemblages are considered rare, due to the fact that they are found only along the North American Pacific Coast [BLM, 1995]. Plant species having a special status designation, documented or suspected to occur in the area include, Yellow (*Abronia latifolia*) and Pink sand verbena (*Abronia umbellata* ssp. *brevifolia*), Earth brodiaea (*Brodiaea terrestris*), Beach evening-primrose (*Darlingtonia californica*), Russet cotton-grass (*Eriophorum chamissonis*), Whorled marsh penny royal (*Hydrocotyle verticillata*), Western lily (*Lilium occidentale*), Bog club-moss (*Lycopodium inundatum*), Timwort (*Microcala quadrangularis*), Paintbrush owl-clover (*Orthocarpus castillejoides*), Silvery phacelia (*Phacelia argentea*), and Sticky tofieldia (*Tofieldia glutinosa ssp. glutinosa*). Special status wildlife species include Aleutian Canada goose (*Branta canadensis leucepareia*), American bald eagle (*Haliacetus leucocephalus*), Brown pelican (*Pelicanus occidentalis*), Harbor seal (*Phoca vitulina*), Peregrine falcon

(*Falco peregrinus*), Red-leg frog (*Rana aurora*), a variety of sea turtles, Western pond turtle, and Snowy plover (*Charadrius alexandrinus*). Plovers (Figure I-9) nest from March to September and, due to the fact that these nests are easily disturbed by animal predators and human activities, BLM scientists have restricted beach access along federal property in the area, particularly near Floras Lake, which is one of the most important Snowy plover nesting sites on Oregon coast [BLM, 1995]. Finally, it is worthwhile mentioning that fishing and angling are two of the most important recreation activities in the area. Fish species abundant in the study area include Chinook (*Oncorhynchus tsawytscha*) and Coho (*Oncorhynchus kisutch*) salmon, Cutthroat (*Oncorhynchus clarkii*), Steelhead and Rainbow (*Oncorhynchus mykiss*) trout, Shiner perch (*Cymatogaster aggregata*), Starry flounder (*Platichtys stellatus*), Largemouth bass (*Micropterous salmoides*), and Pacific lamprey (*Lampetra tridentata*).

Figure I-9. Two significant ecological resources in the study area, **A**) European beachgrass (*Ammophila arenaria*), and **B**) Snowy plover (*Charadrius alexandrinus*).

CHAPTER II

METHODOLOGY

This chapter describes the methodology of technical investigations conducted to examine changes of the coastal environment in the New River sub-cell. The investigation are required to adjust the current location of the SVL along a section which approximately coincides with the west bank of the New River. Division 23 of the Oregon Administrative Rules, Chapter 736, specifies the guidelines essential for any SVL re-examination process, which relate directly to the physical conditions and stability of a given littoral cell. Technical and scientific investigations specified in these guidelines include a general description of the littoral cell where the review will be performed, a history of coastal changes that have occurred since 1967, an assessment of the extent to which the vegetation line has moved, an examination of the perceived cause of this movement, the likelihood that such movement is continuing and will be permanent, a consideration of the probability that the present location of the vegetation line will remain stable over a period of 25 years or more, and finally, a review of the overall stability of the site based on the physical conditions and expected processes. Therefore, a series of analyses integrating an assessment of historic shoreline changes were completed through the examination of historic aerial photos, maps and other historic documents, as well as field investigations, during the summer and fall of 1998 in order to comply with OAR-736-023 and to provide elements relevant for a decision regarding the relocation of the SVL at New River.

Assessment of coastal changes using aerial photos

Evaluations of historical changes in the coastal morphology of the study area were conducted through the study of aerial photographs, first by observing and describing significant changes in the overall conditions of the littoral cell, and then by systematically measuring observed coastal variations, particularly the beach width and the location of the foredune scarp or line of vegetation. Seven sets of historic aerial photographs were compiled and examined, providing documentation of the littoral zone south of Bandon for the period of time between 1939 and 1997. This collection of historic photographs, summarized in Table II-1, consists basically of two types of images, large 90 × 60 cm (36 × 24 in.) black/white photos called Beach mosaics, and small 23 × 23 cm (9 × 9 in.) individual aerial photos. Despite the fact that most photos and mosaics come in different scales, they all cover at least two thirds of the New River spit and adjacent beach areas. It is important to note that while these large mosaics have been edited and ortho-rectified, presumably yielding distortion free images [Frolander, 1967], the rest of the photos, except perhaps the mosaiced 1939 set, have not been corrected. Given the time constraints and reduced resources allowed for the study, as well as the lack of available control points in the study area, ortho-rectification of the images was not possible. However, variability introduced to our estimations due to this factor was considered and avoided by working with as many images as possible. Since most of the images, or stereo-pairs, had a 60 per cent overlap, in most cases it was possible to take a measurement on a photo where the feature of interest appeared as close to its center, or focal point, as possible (the greatest distortion on an aerial photo occurs at its edges); and

Table II-1. List and characteristics of aerial photographs and beach mosaics compiled and analyzed for the New River Spit study.

Date of flight	Source	Approx. scale	Quality	Alongshore coverage	Observations
1939	ACE / USDA	1:65,000	Low	~ 10 miles, from Johnson creek in Bandon to Langlois creek in the south.	Set is composed of 22 B&W aerial photos reduced and mosaiced by the Agricultural Adjustment Admin., USDA. Mosaic not ortho-rectified.
1967 Sept. 5 & 13	OSHD / ODOT	1" = 100 '	High	~ 18 miles, from the mouth of the Coquille river south to Blacklock Point.	Set is composed of 28 large (36x24 inch) B&W beach mosaics. All sheets are distortion free and include a plot of the SVL or Park boundaries, and elevation contours.
1971 Oct. 2	ODOT	1:10,000	High	~ 17 miles, from the mouth of the Coquille river south to Blacklock point.	Set composed of 26 color stereo pairs (9x9 inch). Photos have about 60% overlap but are not ortho-rectified.
1980 April	OSHD / ODOT	1" = 200 '	Medium	~ 35 miles, from Cape Arago south to Cape Blanco.	Sixteen large (36x24 inch) B&W mosaics conform the set. SVL or Park boundaries are plotted on all sheets.
1981 May 12	BLM	1:5,000	High	~ 5 miles, from Fourmile creek in the north to Langlois creek in the south.	Least complete set. Only ten (every other stereo pair out of 20 with 60% overlap) were compiled. None of the 9x9 inch color photos are ortho-rectified.
1990 May 25	BLM	1:7,000	High	~ 8 miles, from north of Fourmile creek south to the base of the New River spit.	Nineteen color photos (9x9 inch) compose the set. Not rectified, these stereo pairs have about 60% overlap.
1997 May 17 & June 19	BLM	1:10,000	High	~ 35 miles from Cape Arago south to Cape Blanco.	The most current and complete set; composed of 51 color aerial photos size 9x9 inch, covering most of the coast and many adjacent land areas.

Key:
ACE - U.S. Army Corps of Engineers
USDA - U.S. Department of Agriculture
ODOT - Oregon Department of Transportation
OSHD - Oregon State Highway Department
BLM - Bureau of Land Management
SVL - Statutory Vegetation Line
B&W - Black and white

often repeated measurements were systematically recorded and averaged. Also, whenever possible, horizontal distances were compared to a distortion-free base-map, corrected through ground-truth sampling. Such a base-map of the study area, from Cape Arago to Cape Blanco, was provided by a composite of six, 7.5 minute series, Topographic Quadrangles edited by the U.S. Geological Survey (Table II-2). Additionally, the different scales of the images represented another source of error that had to be evaluated for all sets of photos; although most of them specify a particular scale (Table II-1), usually these reported scale factors are approximate. Thus, a series of control distances (on the order of 5 to 10, depending on availability of control points) were measured on each set of images, and compared to equivalent distances measured on the base-map, in order to estimate the degree of variation of the approximate scale factors reported on the photos with respect to real-scale corrected factors. Corrected factors, reported in Table II-3, were then used to convert our measurements into meters. Another significant source of error in the methodology also dependant on the aerial images, was introduced by the state of the ocean at the time of the pictures. The combined effect of tides and waves acting on a sloping beach provide a large variability in the location and establishment of the shoreline for any given day: The higher the tide, the narrower the beach would appear on the aerial photos; thus, an average tidal range of 2 m may decrease the width of a 1V:20H slope beach (both typical of the Oregon coast) by 40 m in just 6 hours! This time-dependent variability of the beach width is furthermore increased by wave set up and the horizontal component of the wave run up, which have periods on the order of 5 to 25 seconds.

Table II-2. USGS, 7.5 minute series, Topographic Quadrangles covering the study area from Cape Arago in the north to Cape Blanco in the south.

Quadrangle	Reference number	Scale	Year of edition	Shoreline coverage
Cape Arago	43124-C4-TF-024	1:24,000	1970	Sunset Bay State Park south to Agate Beach
Bullards	N4307.5-W12422.5/7.5	1:24,000	1970	Seven Devils State Wayside south to Bullards State Park
Bandon	43124-A4-TF-024	1:24,000	1970	Mouth of the Coquille River south to mouth of the New River
Langlois	42124-H4-TF-024	1:24,000	1986*	Croft Lake south to Floras Lake
Floras Lake	42124-H5-TF-024	1:24,000	1986*	Floras Lake south to Blacklock Point
Cape Blanco	42124-G5-TF-024	1:24,000	1986*	Blacklock Point south to Port Orford

* indicate provisional edition

Table II-3. Reported and corrected scale factors corresponding to all sets of aerial photos used in the analyses.

Set of photos	Approximate scale	Reported scale factor*	Corrected scale factor*
1939	1 : 65,000	65.0	61.88
1967	1" = 100 '	1.2	1.20
1971	1 : 10,000	10.0	12.50
1980	1" = 200'	2.4	2.40
1981	1 : 5,000	5.0	5.19
1990	1 : 7,000	7.0	7.12
1997	1 : 10,000	10.0	12.16

* Scale factor refers to the horizontal distance in meters represented by 1 millimeter on the photos.

Unfortunately, it was not possible to eliminate these sources of error from our results since even a rough estimate of the tidal stage was very difficult to obtain due to the fact that none of the sets of aerial photos report the time of the flight and some of them not even report its exact date (Table II-1).

Description of coastal changes

A first assessment of coastal changes was integrated by a series of detailed descriptions , where significant morphologic landforms in the New River sub-cell were studied and compared on each set of images. Examinations focused on the location and morphology of the New River mouth, the length and width of the New River channel and Spit, vegetation cover on the foredune and along the banks of the river, the general appearance of the dunes including the extent and location of wave overtopping events, evidence and relative size of rip current embayments and rhythmic shoreline morphology, presence and location of drift logs, as well as the general appearance of the nearshore.

Long- and short-term quantitative analyses

Quantitative analyses were completed in order to accurately assess the extent of shoreline accretion or retreat, as well as the extent of cross-shore migration of the vegetation line and associated dune scarp along the littoral cell. Series of transects, oriented perpendicular to the shore, were drawn on the photos and mosaics. Aided by ruler and stereoscopic lenses, linear distances along each transect were measured in millimeters from a given reference point –usually a natural feature or man-made structure fixed in time and space– to it's intersection with the wetted-beach mark and with the line of vegetation, yielding respectively the values for ***a*** and ***b*** shown in Figure II-1. Using a computer spread-sheet package, distances measured from the photos were converted to meters by multiplying them by the corrected scale factor, described above, corresponding to each particular set of aerial images. The wetted-beach mark (Figure II-1), also called the wet sand line, was selected as the most seaward limit of the beach, though it is important to recognize that this feature fluctuates with time and depends directly on the tide elevation and the horizontal component of wave runup. The line of vegetation represents the most seaward limit of both the foredune scarp and the edge of the cliff, and it has been established to constitute the most landward limit of the beach.

Quantitative evaluations were separated in two different sets of investigations, according to the time span analyzed (represented by the number of aerial sets), and to the number of transects examined per set of photos: a long-term analysis, which registered shoreline changes over a larger period of time, and a short-term analysis, which observed changes in greater detail over a shorter period of time. The long-term analysis examined the evolution of the wetted beach and the vegetation line at 15 sites along the study area from 1967 to 1997; the 1939 set was not included in this analysis due to the high degree of uncertainty presented by its relative reduced scale –approximately 1:65,000. Transects, shown in Figure II-2, were evenly spaced in the longshore direction, approximately 1.6 km (1 mi) away from each other, covering most of the littoral cell, from the mouth of the Coquille River south to Floras Lake. The short-term analysis consisted of a detailed assessment of the changes that have occurred within the littoral cell from 1967 to 1980. This detailed study was completed using only the OSHD beach mosaics, which include a plot of the SVL, it's station points, the county line, and the boundaries of all Federal, State and County owned property. Using the SVL station points as references, distances ***a*** and ***b*** were measured on eighty-seven transects covering a longshore distance of about 22 kilometers, from just north of Crooked Creek in Bandon (SVL station point Co-7-224 in Coos County) to Floras Lake in the south, station Cu-7-25 in Curry County. Since the SVL is not included within State property, six additional transects were distributed along the 6.7-km stretch of beach in Bandon State Park.

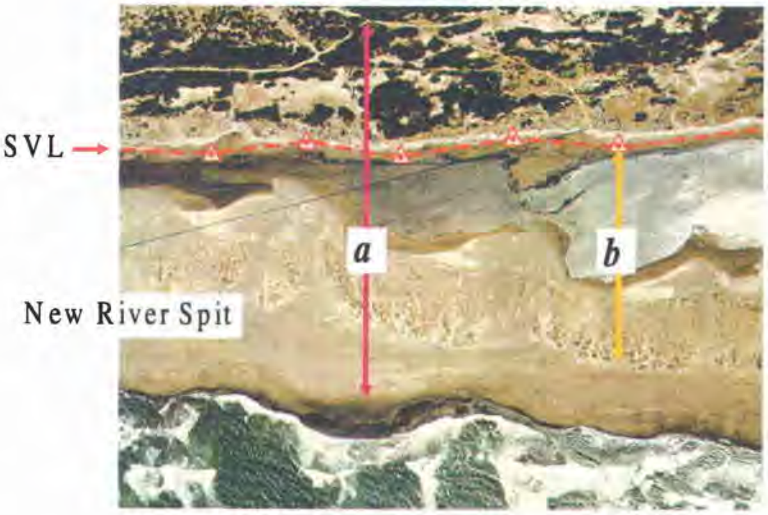

Figure II-1. Distances ***a*** and ***b***, recorded from a reference point (SVL coordinate point or a fixed structure) to the wetted-beach mark and to the line of vegetation, respectively.

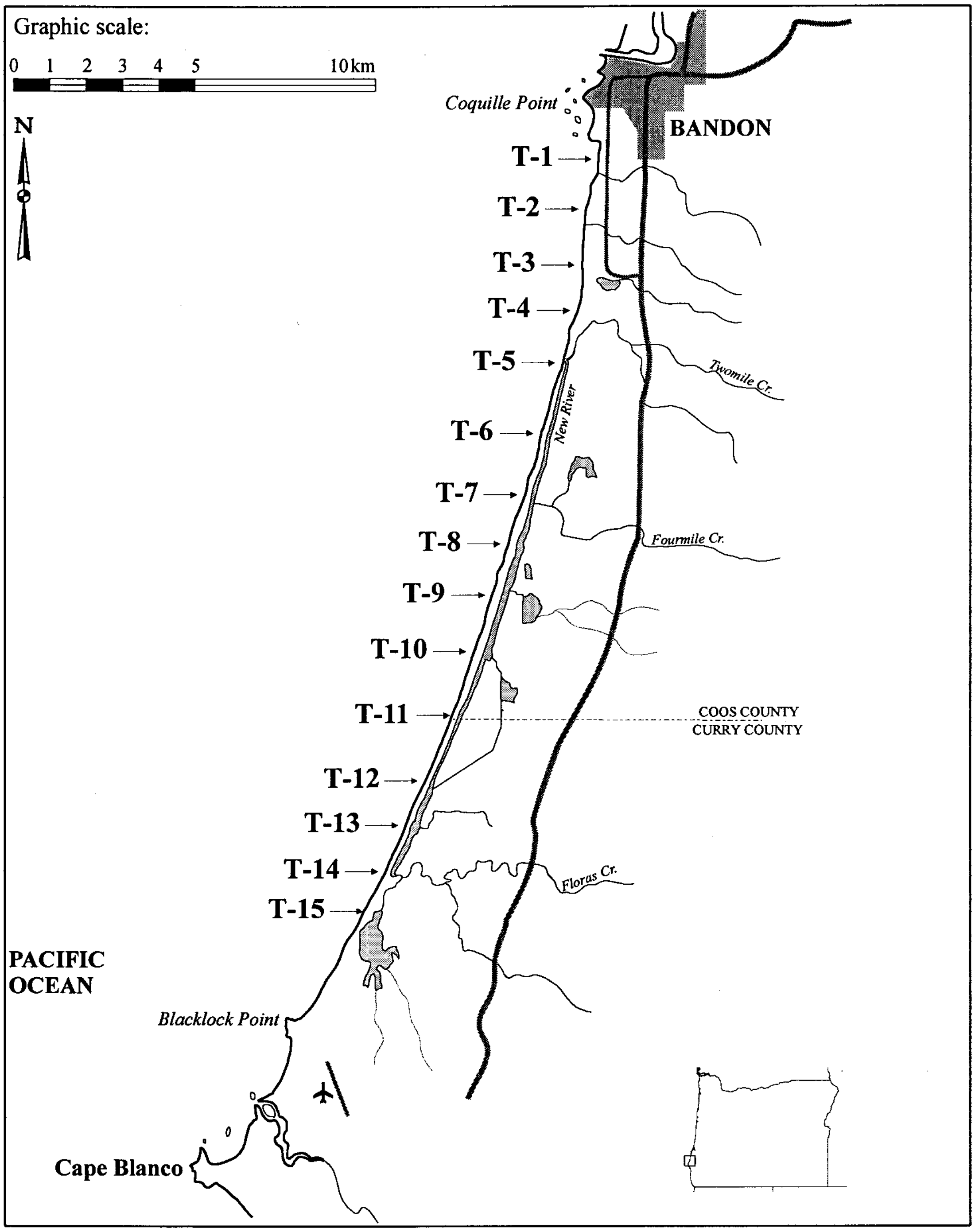

Figure II-2. Location of the 15 transects used to estimate long-term changes along the Bandon Littoral Cell.

Identification of factors affecting the stability of the New River Spit

As part of the series of investigations set forth in OAR-736-023, State Parks is required to review information regarding the likelihood that the current location of the vegetation line will remain stable over a period of 25 years or more, regardless of seasonal erosion and accretion events. Although the stability of the vegetation line, within a given littoral cell, depends on a wide variety of physical and ecological processes, natural and man-induced, specific factors have been identified that have a direct impact on the location of the vegetation line atop the New River Spit. This set of factors includes the progressive migration of the mouth of the New River to the north, periodic foredune failure due to flooding in the river channel and/or wave overtopping events, as well as episodes of severe beach erosion, resulting from the combination of processes such as extreme water levels discussed briefly in Chapter I, and the presence of rip currents. Two of the latter seem particularly important and will be analyzed in detail: first, an examination of the alongshore migration of the New River mouth, and second, an evaluation of rip-current embayments.

In order to assess the extent of the northward migration of the river mouth, its alongshore location was identified on each individual set of historic aerial photos, and accurately recorded on the base-map described in the previous section. Once all the locations had been registered on the base-map, their distances to the base of the Spit were measured through the use of a drawing compass, employed to account for the longshore curvature of the beach. The base of the New River Spit was established by the seaward projection of a line, perpendicular to the shore, extending from the southernmost bank of Floras

Creek, at the location where it bends to the right and becomes the New River. In addition to the aerial photos, a number of historic documents and maps, summarized in Table II-4, were consulted in order to provide a longer and more complete record. All measurements were entered into a computer, scaled, and compared to provide an estimate of the overall migration of the New River mouth through time.

Table II-4. List of historic documents providing additional information to the photo-interpretation analysis.

Document	Year of edition	Scale	Editor
Diagram of a portion of the Oregon Territory	1851	-	J.B. Preston
Map of Oregon	1882	-	J.K. Gill
Topographic quadrangle	1903	-	U.S.G.S.
Atlas of Curry County	1941	2" = 1 mi	C.F. Metsker
Atlas of Coos County	1941	2" = 1 mi	C.F. Metsker
Atlas of Curry County	1955	2" = 1 mi	C.F. Metsker
Atlas of Coos County	1958	2" = 1 mi	C.F. Metsker
Atlas of Curry County	1974	2" = 1 mi	C.F. Metsker
Atlas of Coos County	1975	2" = 1 mi	C.F. Metsker

Another significant factor identified to influence the stability of the Spit is the presence of rip current embayments. Rip embayments are the erosional depressions hollowed into the shoreline by the strong seaward flow of rip currents. In order to evaluate their effect along the study area, an additional photo-interpretation analysis consisted of recording the geometry and alongshore location of all the rip embayments identifiable on each set of aerial images. The basic geometry of a rip-embayment, shown in Figure II-3, is simply assessed by the length l, and depth d of the embayment. As appreciated in this diagram, l is the horizontal distance measured between the apexes of consecutive beach cusps, while d is the maximum horizontal distance, measured normally to l, to the wetted-beach mark. The latter is independent of the embayment symmetry, and may be located either at its center or closer to either cusp; though not considered for this analysis, asymmetry reflects a strong alongshore component in the direction of the rip-current flow. Pairs of values, ***l*** and ***d***, were measured, entered into a computer, and treated statistically in order to provide information with respect to their lengths and depths. The alongshore location of these embayments with respect to the base of the Spit was also recorded and evaluated to determine the position along the littoral cell which could be most susceptible of erosion due to the presence of rip currents.

Figure II-3. Parameters, ***l*** and ***d***, describing the basic geometry of rip-current embayments.

CHAPTER III

STUDY RESULTS AND DISCUSSION

Historic coastal changes from 1939 to 1997

Significant morphologic shoreline changes that have occurred in the New River sub-cell during the last 60 years are studied and presented in this section, through the detailed description of seven sets of historic aerial photos and beach mosaics, representing the years 1939, 1967, 1971, 1980, 1981, 1990 and 1997 (Table II-1).

May-July, 1939

The oldest set of historic images consists of 22 black and white aerial photos covering approximately 16 km of coastline in southern Coos County, south of Johnson Creek, and about two in northern Curry County. The images were obtained by the U.S. Army Corps of Engineers in May through July of 1939, and a photo mosaic was compiled by the Agricultural Adjustment Administration, U.S. Department of Agriculture, in 1941. Individual 23 × 23 cm photos were not available for our use, but a reduced copy of the photo mosaic, scaled 1:65,000 approximately, provided rough information regarding the conditions of the New River sub-cell at that time.

The most striking characteristic of the littoral cell observed in 1939 is that there is no evidence of an outlet for the New River north of Bono Ditch, which is the south limit of the area covered by the photo-mosaic. At the time the photos were taken in 1939, the New River appears not to have been a continuous stream, but rather to have consisted of at least two channel systems all flowing parallel to the shore, independent from one another. The southernmost one was formed as an extension of Floras Creek and the outlet of Floras Lake, and flowed northward for 1.8 km before it drained into the ocean – this section is not covered in the 1939 photo-mosaic, but it is documented in Cooper, 1958. About 4 km north, the next channel is formed by the combined outlets of New Lake and Croft Lake, which flowed for another 4 km before disappearing into the sand, without reaching the ocean. A third segment –which later became part of the New River channel– begins 1.6 km further to the north, and is formed by Fourmile Creek, which flowed south parallel to the shore for a distance of about 500 m before it reached the ocean. About 1.6 km north of Laurel Lake, there was a long and narrow area, presumably inundated, backing the foredune; it appears to have been a series of coastal marshes extending about 3 km north to Bradley Lake. Twomile Creek meandered due west and then south for approximately 400 m before it reached the ocean forming a small sand spit, nearly 1,000 m long.

The width of the beach was not very consistent throughout the cell. It varied from about 400 m just west of Bono Ditch, to almost 1.2 km west of Laurel Lake, its widest location. The vegetation line was somewhat inconsistent, and presented a serrated pattern from the south end of the cell up to Croft Lake; this pattern in the vegetation resembles beach ridges [Komar, 1998a] and might have been the result of long-term accretion in the southern end of the cell. North of Laurel Lake, a dense line of vegetation presumably composed of shrub and small trees, shifted landward compared to the vegetation line in the rest of the area. On the stretch of beach located between the outlets of Fourmile and Twomile creeks, a patchy scarp of grass-covered dunes fronted the series of marshes described above.

Despite its poor resolution, foam patterns in the surf zone are clearly evident on the mosaic. Foam patterns depict the presence of a region of shallow water followed by a region of deeper water, presumably a longshore bar and trough system, immediately adjacent to the swash zone, where the waves finally break on the beach face. A long and fairly continuous offshore bar extended for nearly 9.4 km from Bono Ditch north to Fourmile Creek. A more complex system of welded bars [Komar, 1998a] and rip current embayments continued further to the north, from Fourmile Creek towards Bandon. Incoming waves in this area, delineating the seaward boundary of the surf zone, broke as far out as 350 m from the shoreline, while waves at the lower end of the cell tended to break no further than 170 m from the shore. These differences indicate that the narrower surf zone at the south of the cell may be characteristic of a reflective beach having a steeper slope, while the wider surf zone at the north, characterized by complex alongshore morphology, may be a dissipative to intermediate beach [Komar, 1998a].

September, 1967

The second oldest set of photographs belongs to the Oregon State Highway Department (OSHD) *Ocean Shores Recreation Area* beach mosaics, Bandon-Port Orford section. Sheets 1 through 28 cover the area from the mouth of the Coquille River in the north to Blacklock Point in the south. These large mosaics, scaled 1"= 100', are dated September 5 and 13, 1967. One of the most significant characteristics of this set is that a plot of the SVL and it's station points, as well as elevation contours seaward of the latter, are included on all of the sheets except those covering areas administered by the state: Bandon State Park and Floras Lake State Park.

The New River flowed north continuously from Floras Creek in the south to the southward flowing channel of Fourmile Creek, except for a small section about 120 m long just north of Bono Ditch, where the channel appears to be dry. There are two sites where the river channel breached the spit and presumably reached the ocean, though both appeared to be closed at the time the mosaics were shot. The south breach, 600 m long, was located at the base of the spit, where Floras Creek made a sharp turn to the north. A narrow 60 m wide beach prevented the New River channel from flowing into the ocean. The second breach was located about 10 km north from the first, where New River joined the south flow of Fourmile Creek. At this location the breach was 100 to 150 m long and was separated from the ocean by a 60 m wide sandy beach. Vegetation on top of the spit varied from scarce to non-existent, appearing to have consisted mostly of beach grass and shrub, distributed in patches, which were isolated by sand tracks presumably the result of wave overtopping events. Besides being associated with the breaching locations, a substantial lack of vegetation occurred on the northernmost 1.6 km of the Spit, from the outlet of Croft Lake north to the New River mouth; also, on most of the small, 1.3-km long, sand spit formed by the south flow of Twomile Creek. It is worth mentioning that in the cross-shore direction, vegetation seemed to be distributed more densely on the foredune scarp than behind it, along most of the spit, on the low laying west banks of the New River. Wave overtopping events were clearly identified due to the high resolution of the photo-mosaics. Presumably consequence of a Tsunami which struck the Oregon coast in 1964, wave overwash occurred along most of the cell, overwash tracks seemed to concentrate on the southern half of the cell, particularly at the base of the New River Spit, west of Bono Ditch, and west of Fourmile Creek. Widths of the tracks varied from 6 m south of Bono, to 30 m just north of Fourmile Creek.

Another striking feature observed on the 1967 mosaics is the presence of drift logs 540 m inland from the sea shore, presumably carried inland by the 1964 tsunami. Along the cliffs on the south and north ends of the cell, drift logs concentrated at the canyons carved by the mouths of small streams, while along the rest of the cell they tended to concentrate at the scarp of the foredune; otherwise they appeared scattered on the east bank of the New River.

Finally, it is worth commenting about the nearshore configuration. Presence of erosion resistant, massive sea-stacks was evident at both ends of the littoral cell, on the face of the beach as well as offshore. For the rest of the cell it appeared that the beach face sloped evenly towards the ocean, not presenting any drastic changes in bathymetry. Alongshore variability in the morphology of the beach is denoted by the presence of rip current embayments, varying in lengths from 20 to 50 m, and carving 3 to 10 m deep within the shoreline. They appear to be located randomly along the length of the cell. Based on the width of the surf zone, gently-sloping, dissipative beaches dominated at the northern portion of the cell, having widths over 20 m, while steeper, more reflective beaches with narrower surf zones, 5 to 10 m wide, were more common in the south.

October, 1971

This set consists of 26 aerial photos dated October 2, 1971, scale 1:10,000 approximately, covering the shore from the mouth of the Coquille River in the north to Blacklock Point in the south (Figure III-1a). Though the resolution is not very high, contrasting colors

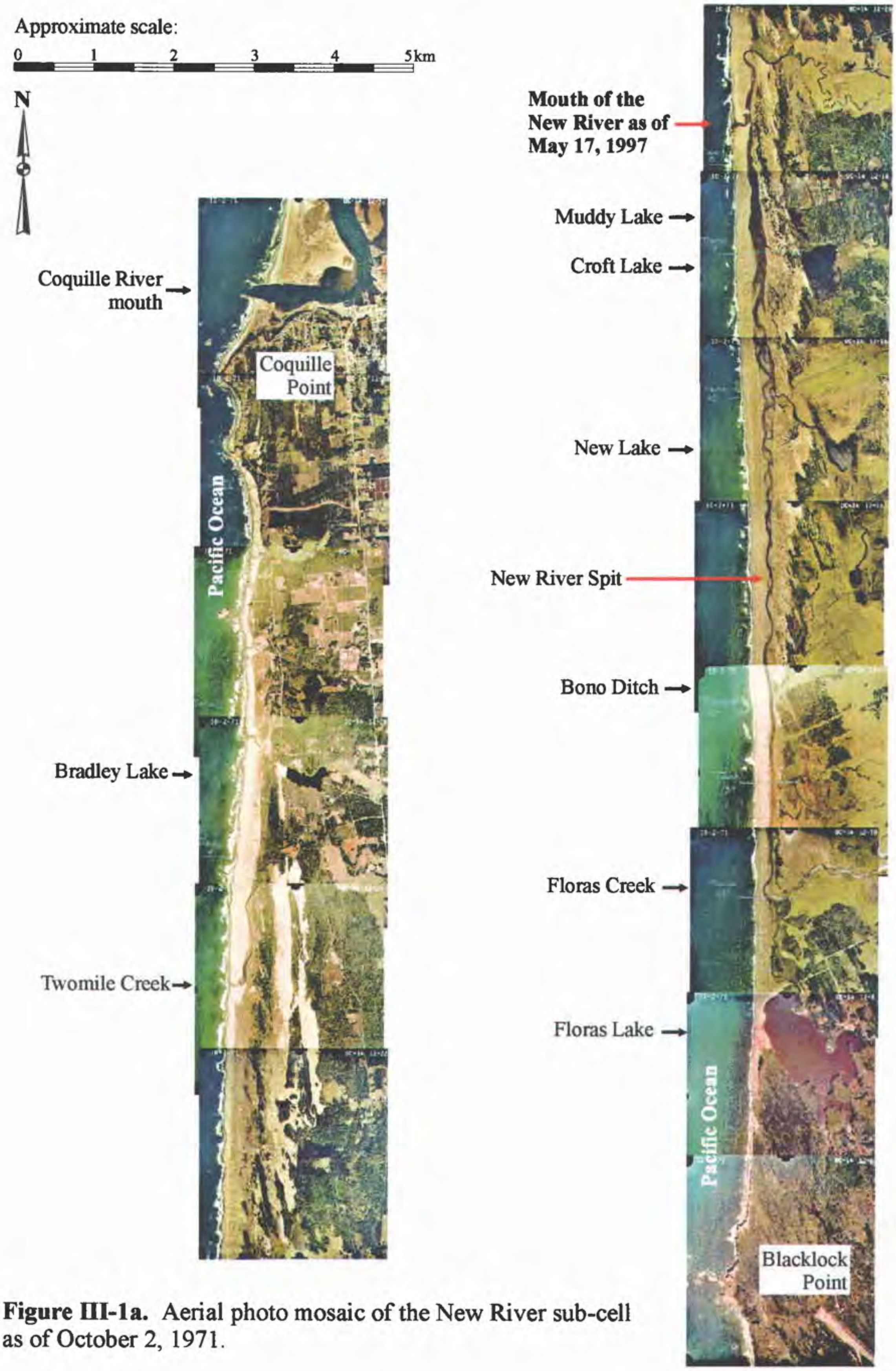

Figure III-1a. Aerial photo mosaic of the New River sub-cell as of October 2, 1971.

help to distinguish the most significant morphologic features. For example, the channel of the New River appeared inundated all the way from the base of the spit to the river's only mouth, almost 10.4 km further north. The 150-m long south breach, located at the base of the spit, was not open to the sea, rather, it was blocked by an 87 m wide sand beach. Vegetation atop the foredune was scarce and consisted mainly of beach grass. It formed a fairly consistent line of vegetation that extended from the dunes west of Floras Lake to the outlet of Bradley Lake, in Bandon. The vegetation cover, and the foredune itself, was interrupted at several locations along the shoreline, either by the outlets of the New River/Fourmile Creek system, Twomile Creek and Bradley Lake, or by several sand tracks presumably the consequence of wave overtopping events. Lack of vegetation cover existed over the last 980 m of the New River spit and over the beach across the river mouth, for about 175 m further to the north, as well as in the area approximately 190 m to the north and 190 m to the south of the Twomile Creek outlet. Overtopping sites were fairly common and were located as far south as Floras Lake, where waves appeared to have washed over a 125 m wide foredune into the lake. Other sites included a stretch of beach 560 m north of Bono Ditch, where the spit narrowed to about 150 m wide, a 400-m long section of the beach west of Croft and Muddy Lakes, the beach and foredune located west and north of the sharp bend to the south of Fourmile Creek –to all appearances the largest events in the cell, and a few events on the foredune west of Twomile Creek. Drift logs were not easily identified, due to the relatively small scale of the photos. Changes in the nearshore configuration, on the other hand, were more obvious to identify. Foam patterns in the surf zone indicated the presence of a series of longshore bars connected to the shore by their north ends. These types of features were observed from west of Croft Lake up to Haystack Rock in Bandon. Rip currents seem to be associated with these bars and are usually present at the south end of a bar. Rip current embayments were present all along the littoral cell, appearing particularly well defined along the stretch of beach west of Twomile creek. Embayment lengths varied from 360 to over 1,000 m, most of them being in the 400-m range, while observed embayment depths went from 40 to 70 m between cusps.

April, 1980

This set of aerials is also part of the OSHD *Ocean Shores* program, and the mosaics belong to the Coos and Curry Counties' sections. Sixteen sheets cover the stretch of the coast from Crooked Creek, near Bandon State Park, to Cape Blanco in the south. These black and white images, scaled 1"= 200', include important information such as a plot of the SVL and its station points, names of towns and significant morphological features, boundaries and location of State parks, townships, and county line, etc. Though resolution is not as high as on the 1967 mosaics, significant features such as drift logs, subtle changes in elevation, and alongshore variations in the beach morphology, for example, are fairly conspicuous.

The mouth of the New River migrated about 1,000 m to the north compared to its position in 1971, accounting for a total Spit length of almost 11.5 km. But the mouth of the New River was not the only one migrating at this point; the outlet of Twomile Creek was located almost 400 m south compared with its location in 1971. The south breach of the New River channel was open to the ocean, but it was also located at a different position, close to 1 km further to the north, than seen in the 1967 photos; whether this was result of a natural process or an artificial breach is not evident, but the outlet was fairly narrow, barely 60 m wide. The foredune atop the Spit and the overlying vegetation cover did not present significant changes, other than a series of more dramatic wave overtopping events. This time, overwash was concentrated mainly in a 4-km long stretch of beach, comprising the northern one-fourth of the spit and some 900 m north of the New River outlet, though some tracks were present atop the small Twomile Spit. Some of the more dramatic events presented fan deposits, up to 150 m wide and 70 m across, washed into the New River channel. This set of aerial photos was shot too far inland to show any characteristics of the adjacent nearshore environment. One of the photos, however, shows the presence of rip currents carving deep embayments into the beach face. A high concentration of narrow rips occurred along a 6-km long stretch of beach north of the county line; not surprisingly, coinciding with the area where dramatic wave overtopping had occurred. Rip currents were separated 140 to 480 m from one another, yielding embayment lengths of the same order of magnitude, and up to 90 m deep. Finally, the surf zone in this region appears to be wider than in other areas further to the south –the width of the surf zone to the north of the cell is not shown in the mosaics.

May, 1981

The May 12, 1981 group of photos is the smallest set compiled for the study. It consists of only 10 images scaled 1:5,000 approximately. These color photos cover in great detail most of the study area, from Bono Ditch in the south to about 100 m north of the New River/Fourmile Creek outlet (Figure III-1b). With a few exceptions, most of the characteristics observed on these photos are very similar to those observed on the

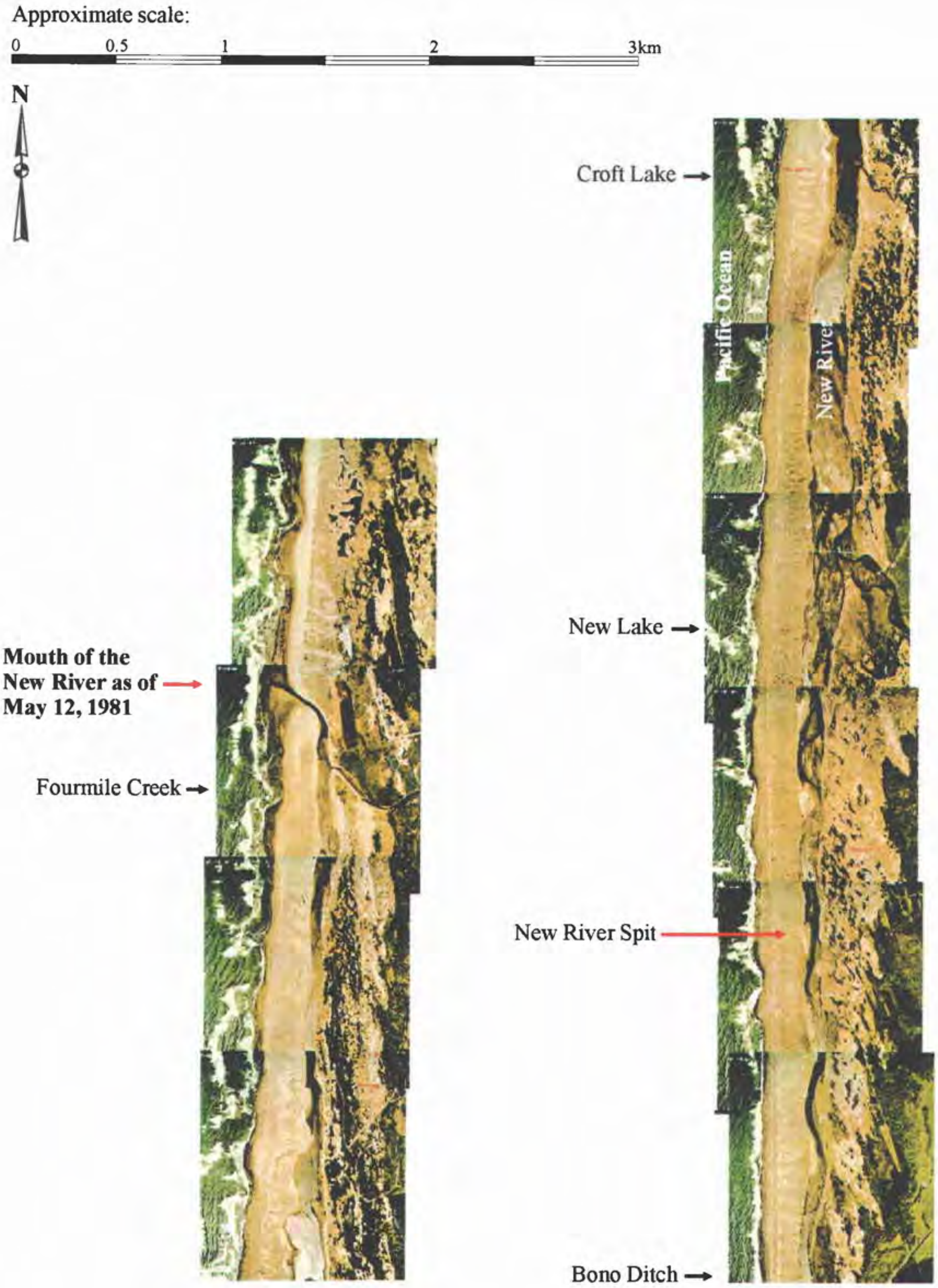

Figure III-1b. Aerial photo mosaic of the New River sub-cell as of May 12, 1981.

previous set, shot a year before. One evident exception is the continuous migration of the New River mouth, which in only one year advanced close to 340 m to the north, yielding a spit length of 11.8 km, almost 2,000 m longer than in 1967, fourteen years earlier. Fourmile Creek became another tributary, discharging into the New River channel. These high contrast color photos reveal the presence of a more densely vegetated west bank of the New River, contrasting with the scarce grassy vegetation atop the foredunes, which actually was lacking over the northern one-third of the spit. Wave overwash into the river channel and rip current embayments described for the previous photos were more evident on this set. The tips of most fan deposits had been deformed by the northward flow of the river, while the base fronting the flow had been eroded as much as 75 m deep into the Spit. Finally, rip current embayments were present along most of the area, and ranged in sizes from 230 to 580 m long and from about 50 to over 100 m deep. While distributed along most of the cell covered by the photos, a high concentration of embayments occurred along the upper one-third of the New River Spit, again coinciding with the area where the overtopping events were present.

May, 1990

Nineteen color photographs compose this set of historic aerials. These images were shot by the BLM on May 25, 1990, and have an approximate scale of 1:7,000. Aided by good color contrast and a high resolution, they cover most of the study site from the base of the Spit to the New River mouth, located almost 13 km further to the north (Figure III-1c). The aerial photos show the continuous migration of the mouth, then located some 1,150 m further north than in 1981. One of the most striking features observed on this set is the lack of vegetation over the entire 1.3-km long lower Spit, except for a small patch 213 m long by 92 m wide. The west bank of the river along this section appeared to be profusely indented with fan-shaped deposits, however, they did not seem to be associated with sand tracks usually left by wave overtopping events. Immediately north of this long breach, vegetation appeared abundant, especially on the west bank of the river which was fairly straight along this section; however, vegetation cover disappeared again along the northernmost 850 m of the spit. There was evidence of a long and narrow, 400 by 50 m, island forming at the center of the channel, just north of Bono Ditch. Dramatic wave overtopping events were evident along the usual stretch of beach, west of Croft and Muddy Lakes and all the way north to the mouth of the New River, comprising the upper one-third of the Spit. Fan deposits, up to 260 m long by 100 m deep, were deformed by the river flow, and most were associated with narrow foredune breaches, some reaching up to 40 m wide. Nearshore configuration was fairly apparent on these pictures. Waves broke further offshore along the upper one-third of the spit, than along the lower two-thirds, and yielded surf zone widths of 170 versus 50 m on average, presumably indicating the relative higher steepness of the beaches at the north and south ends of the spit. Embayments carved by rip currents were less abundant towards the south of the cell, but were long and relatively shallow, around 430 m long by 35 m deep, while a large number of short and comparatively deeper embayments, typically 300 by 30 m, were concentrated towards the north end of the Spit, just as in previous years.

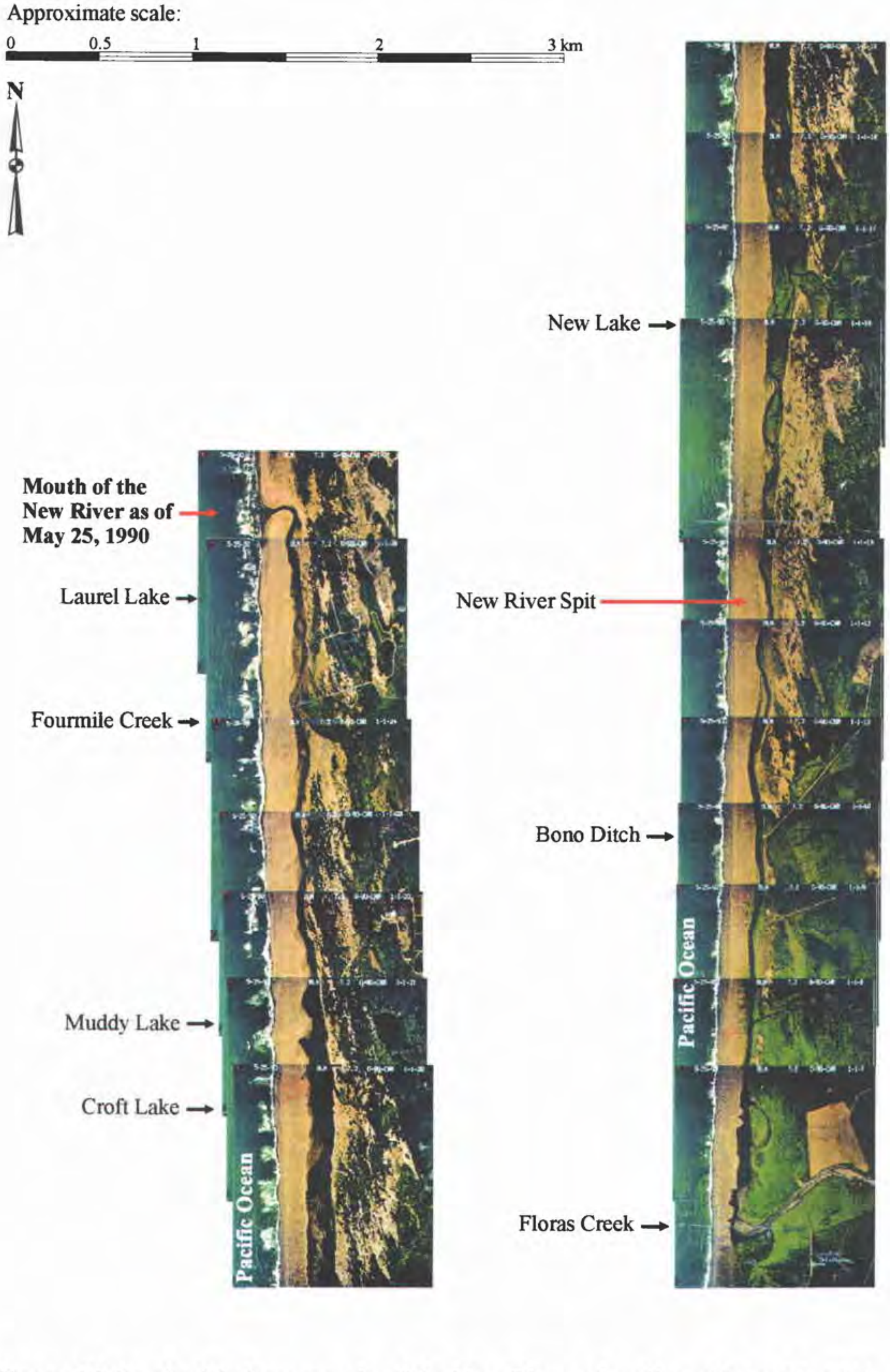

Figure III-1c. Aerial photo mosaic of the New River sub-cell as of May 25, 1990.

May and June, 1997

The last set of aerial photos consists of 51 color prints dated May 17 and June 19, 1997. These photos, scaled 1:10,000 approximately, cover most of the coast and adjacent inland areas from Cape Arago in the north to Cape Blanco in the south (Figure III-1d). This is the most complete and recent set of aerial photographs for the New River area, and hence provides the most up to date documentation of changes in the coastal environment for the New River sub-cell. Here, the northern migration of the New River channel finally reached the south-flowing Twomile Creek. The New River Spit had reached a length of 14.5 km, 4.6 km longer than in 1967, 30 years earlier. The substantially smaller Twomile Spit contributed to the latter extension, by increasing its own length from 1.38 km in 1980 to 1.76 km as reflected in 1997. Vegetation was less profuse along the entire length of the New River Spit, particularly at its southern end where the south breach, though not open to the ocean, extended 1.44 km north from the base of the Spit, almost 150 m more than in 1990. Greenery prevailed on the east and west banks of the river, mainly along the lower two-thirds of its channel, while beach grass turned patchy and eventually disappeared from atop the foredunes close to the river mouth. The line of vegetation at the north end of the cell, particularly to the north of the New River outlet 4.2 km up to Crooked Creek in Bandon, appeared to be accreting seaward, based on the observation of certain patterns in the vegetation, resembling beach ridges along this area. Wave overwashing events were not as evident as in previous years, and the few observed fan deposits looked slightly vegetated and smoothed by the river flow. A significant number of well-defined rip current embayments were distributed along a 10 km stretch of beach comprising the northern half of the New River Spit, and ~ 3 km north of the river mouth.

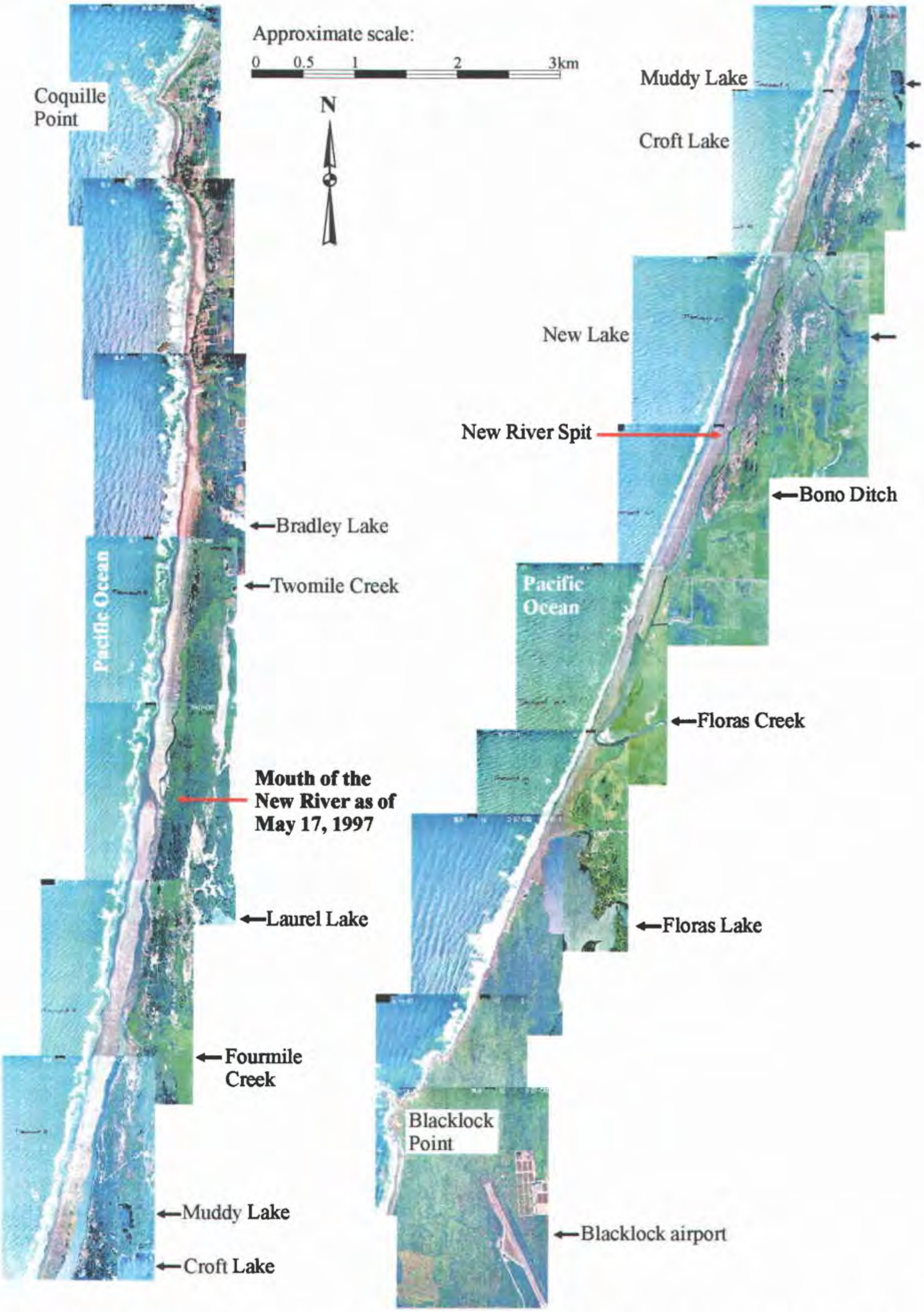

Figure III-1d. Aerial photo mosaic of the New River sub-cell as of May 17 and June 19, 1997. Of the 51 images compiled in this set of photos, only 17 are shown in the figure.

Particularly in this area, a set of fairly symmetrical embayments, around 425 m long and 115 m deep, aligned one next to another forming a regular pattern. Rip embayments south of the New River mouth differed more in size and had a random distribution. They varied in size from 200 up to 420 m long, and from 25 to 110 m deep. Nearshore configuration was inferred by foam patterns in the surf zone. Breaking wave patterns indicated the existence of a longshore bar and associated trough system continuous along most of the lower half of the cell, from Floras north to New Lake. A more complex morphology was found further to the north. A series of segmented longshore bars, separated presumably by rip current channels, extended for about 12 km from New to Bradley Lake. These bars, some up to 850 m long and formed just in front of beach cusps about 100 m seaward from the wetted-beach mark, are described in Komar (1998a) as *inner bars*, a type of rhythmic topographic feature associated with crescentic bars.

Additional sources of information

Historic documents, including maps, atlases, and navigation charts, have provided additional information on the conditions of the littoral cell, dating as far back as 1851. Though these documents have not been subject to as thorough a description as provided above, they have supported some of the statements, particularly regarding the existence of a New River mouth south of Bono Ditch prior to 1939. A list of these additional sources is provided in Table II-4. The 1851 *Diagram of a Portion of the Oregon Territory*, by John B. Preston, was studied because of its historical value more than because of its accuracy. This map includes a sketch of the south Oregon coast, depicting Cape Arago and Cape Blanco as two prominent headlands, while a smaller headland –

presumably Blacklock Point– remained unnamed. The Coquille River drained into the Pacific through a straight channel extending due west. There is no sign of the New River at this time. In 1882, J. K. Gill & Cos. of Portland, edited a *Map of Oregon* based on information dating back to 1878. Several streams drained into the ocean along the coast from Cape Blanco to Cape Arago (named C. Gregory on the map) including the Coquille and Sixes Rivers, as well as the *Flowers* and New Creeks, the latter being followed by wagon trail. A topographic chart edited by the U.S. Geological Survey in 1901, compiled from surveys performed in 1897 and 1898, provided detailed information about the area. By the turn of the century, the outlet of *Flores* Lake joined *Flores* Creek, which after flowing due west made a sharp turn to the right and flowed due north, parallel to the shore for about 4 km before reaching the ocean. Additionally, the outlet of New Lake formed another channel flowing north parallel to the coast, and discharged into the Pacific ~ 2 km further north.

Finally, Charles F. Metsker edited several maps and atlases of Oregon counties as early as 1931. Earliest editions for the study area include an *Atlas of Curry County* dated November, 1941, and the *Atlas of Coos County* dated July, 1941. In both documents, the New River mouth was located about 1.25 km north of Bono Ditch, while in the July 1941 edition, an additional outlet was open west of Croft Lake, almost 5 km further to the north. Subsequent editions (Table II-4) located the mouth of the New River just north of Bono Ditch, at the same position as depicted in 1941, except for the July 1955 edition, which showed an additional mouth at the same location as in July 1941.

Long-term photo-analysis

A series of transects, normally-oriented with respect to the coast, were measured on six sets of aerial photos (1967 through 1997, Table II-1), and compared to provide a long-term assessment of shoreline changes in the Bandon Littoral Cell. Distances to the wetted-beach mark and to the line of vegetation, values ***a*** and ***b***, were measured along 14 of the 15 transects originally selected (T-1 through T-15 shown in Figure II-1), due to the fact that there was no identifiable reference point, fixed in time, close to the assigned location for T-6. Along with these transects, a series of control distances were measured on each set of photos and compared to a base-map corrected through ground-truth sampling, in order to estimate the degree of variation of the approximate-scale factors reported on the photos with respect to real-scale corrected factors. Corrected factors, reported in Table II-3, were then used to convert our measurements into meters.

Tables III-1a and 1b display the computed values for ***a*** and ***b*** in meters for all years of analyses. Estimated magnitudes for ***a*** and ***b*** varied significantly from one location to another according to the closeness of a suitable point selected as a reference from which to measure, a feature easy to identify and that remained relatively fixed throughout the years of analyses. Thus, individual values alone do not assess the amount of beach erosion/accretion or cross-shore migration of the vegetation line; rather, the long-term evolution of the shoreline was estimated by comparing relative variations of individual (***a*** or ***b***) values for a given station throughout the period of analysis. These values have been plotted in Figures III-2 and III-3 to provide a better sense of the cross-shore changes of both parameters through time.

Table III-1a. Recorded data for ***a***, the distance from a reference point to the wetted-beach mark in meters for all the years of analyses, 1967 through 1997.

Transect	1967	1971	1980	1981	1990	1997
1	180	156.25	*	*	*	206.72
2	352.2	357.50	408.72	*	*	314.94
3	429.36	441.25	459.12	*	*	456
4	504.96	475.00	482.88	*	*	514.37
5	310.8	281.25	265.2	*	*	286.98
7	845.4	795.00	729.6	684.04	813.82	792.83
8	384	341.25	397.2	351.36	371.66	374.53
9	858	831.25	862.8	850.74	877.9	847.55
10	551.76	522.50	561.6	524.19	539.7	504.64
11	*	703.75	689.88	726.60	731.94	719.87
12	462.6	325.00	330	*	373.8	350.21
13	503.76	478.75	488.4	*	501.96	520.45
14	439.8	417.50	406.08	*	402.28	401.28
15	251.76	212.50	217.44	*	*	228.61

Asterisk (*) represents data not available for a particular year of analysis.

Table III-1b. Recorded data for ***b***, the distance from a reference point to the line of vegetation in meters for all the years of analyses, 1967 through 1997.

Transect	1967	1971	1980	1981	1990	1997
1	137.16	135.00	*	*	*	176.32
2	292.20	297.50	293.52	*	*	300.35
3	383.16	366.25	394.56	*	*	364.80
4	387.00	410.00	431.28	*	*	459.65
5	204.00	137.50	224.88	*	*	249.28
7	756.00	722.50	713.28	422.99	708.44	733.25
8	0.00	0.00	250.32	254.31	309.72	316.16
9	0.00	777.50	776.40	754.20	811.68	778.24
10	468.00	415.00	481.20	466.06	499.82	477.89
11		643.75	667.92	665.88	684.94	668.80
12	477.60	282.50	289.68	*	311.86	307.65
13	456.60	440.00	451.92	*	445.00	419.52
14	0.00	0.00	0.00	*	0.00	0.00
15	196.80	172.50	189.12	*	*	167.81

Asterisk (*) represents data not available for a particular year of analysis. Values of $b = 0$ refer to locations where there was no vegetation observed near a given transect on the New River spit.

While Figures III-2a and 2b display the relative evolution of the wetted-beach mark, Figures III-3a and 3b similarly depict the seaward/landward migration of the vegetation line versus the year of analysis. With a few exceptions, total cross-shore change of ***a*** and ***b*** at individual locations through the entire period of analyses, was found to be less than 100 meters; thus, the vertical axes of all the panels are scaled accordingly. The exceptions are the panels for T-7 (Figure III-2a) and T-12 (Figure III-2b) where cross-shore changes are in the order of 200 m, and T-5, T-7 (Figure III-3a) and T-12 (Figure III-3b), where changes range from 125 to 200 m. These locations represent areas where the most significant changes have occurred, and correspond approximately to the recent migration of the New River mouth (T-5 and T-7) and to the historic location of artificial breaches of the spit north of Bono Ditch (T-12).

Orientation of the plotted line segments in Figures III-2 presents evidence of shoreline retreat along most of the cell from 1967 to 1971, with maximum recession of about 140 m occurring at Bono Ditch (T-12). This period is followed by a trend of beach accretion from 1971 to 1980, reflected mildly in the north (T-2, T-3 and T- 4) and south (T-12, T-13 and T-15) ends of the cell, and markedly in the area west of Croft and New Lakes (T-8, T-9 and T-10), with beach recovery rates of 20 up to 60 m. These three sections are separated by two areas of continued erosion; T-5 and T-7 in the north, and T-11 in the south, representing the most unstable sections of the cell. Despite the fact that the 1981 photos cover only a small section of the coast, their analysis provided evidence of an abrupt shift in the trends of transects 7 through 11; except for T-11, all showed severe retreats on the order of 10 to 50 m. Continuous records were available only for the area located between T-7 and T-11, which correspond to the stretch of beach located approximately between Laurel Lake and the County line (Figure II-2). From 1981 to 1990 a significant beach recovery occurred, particularly towards the north end of the section where T-7 shows an increase close to 150 m, presumably due to the migration of the New River mouth further to the north. Transects 7 through 14 are included in the 1990 to 1997 analysis, and most of them show mild beach erosion, the exceptions being T-8 and T-13. An overall comparison of the wetted-beach mark location along the entire littoral cell between 1967 and 1997 does not show a general northward trend of net accretion or erosion as suggested by Peterson, *et al.* (1991). When values estimated for 1967 (Table III-1a) are subtracted from those for 1997 in order to assess the shoreline evolution over the 30-year period, no particular bias seems to appear in the results; however, when these differences are added, a negative balance of -275 m reflects an overall shoreline retreat in the littoral cell, averaging about -21 m when divided by 13, the total number of values computed for 1967.

Comparatively, the line of vegetation (Figures III-3) does seem to have an overall trend for all the years of analysis. When comparing the results plotted for 1967 and 1997, the vegetation line appears to be migrating seaward along the northern half of the cell (T-1 through T-11, except T-3) while receding in the south (T-12 through T-15). T-2, T-7, and T-14 do not show much variation throughout the entire period, the latter having a constant value of "zero" vegetation, which represents that no vegetation was ever observed on top of the foredune at the base of the New River spit. In contrast, some of the panels (T-5 through 10, T-12) depict a larger degree of variability, mostly associated with the northward migration of the New River mouth. This migration and the associated growth of the New River spit are reflected in panels T-8 and T-9, where vegetation

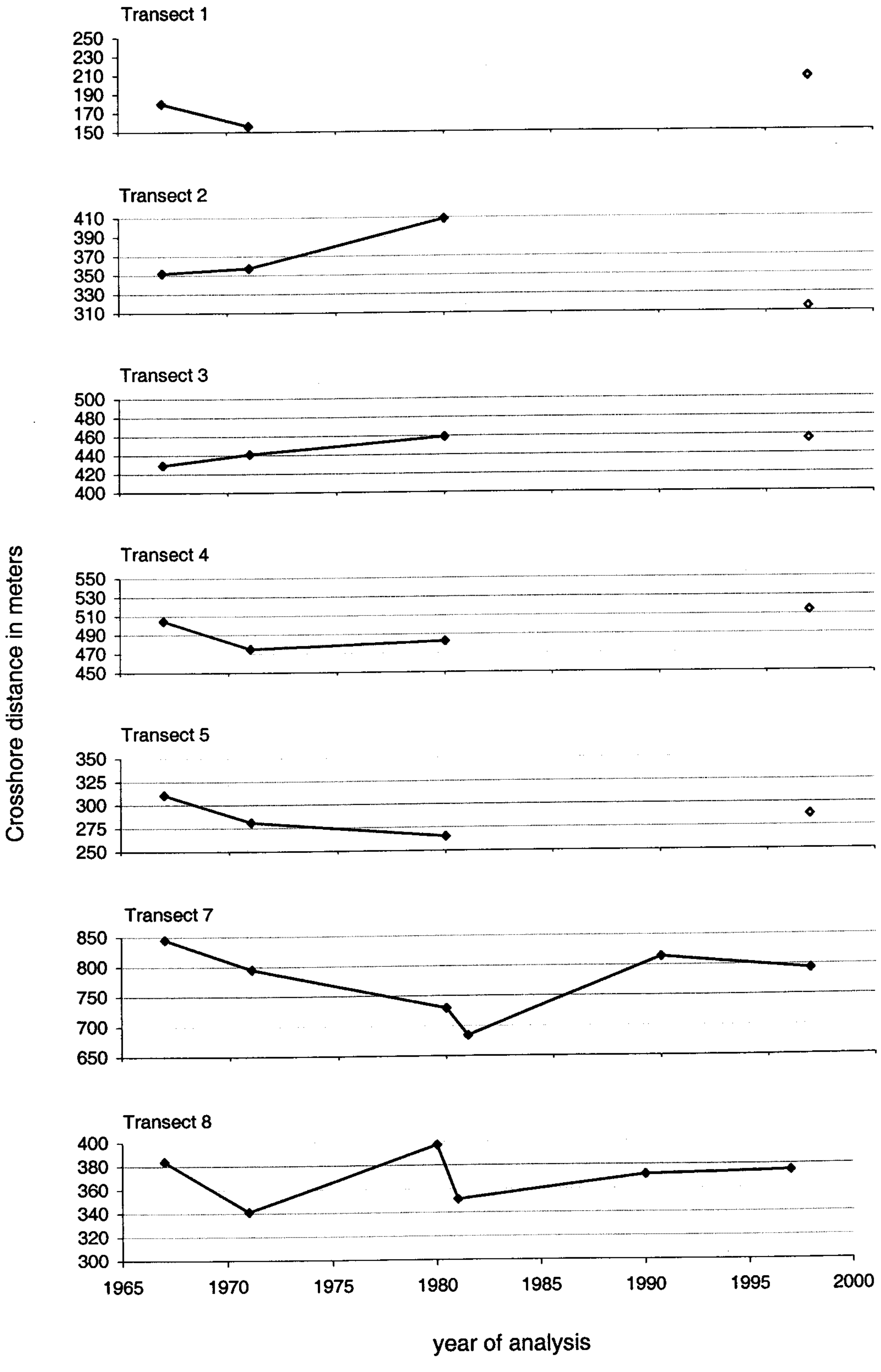

Figure III-2a. Long-term analyses of wetted-beach mark migration, ***a***. Transects 1 - 8.

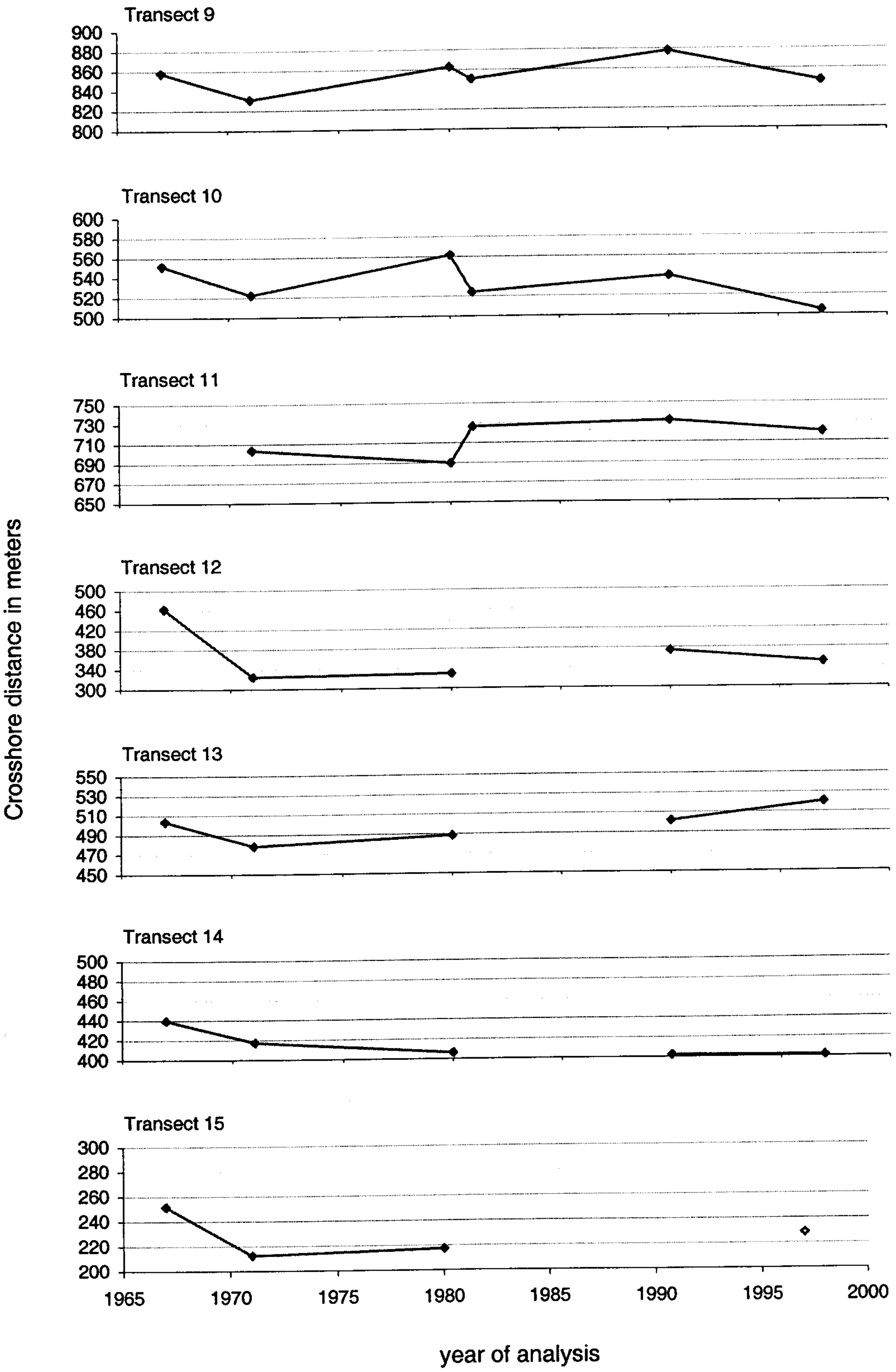

Figure III-2b. Long-term analyses of wetted-beach mark migration, *a*. Transects 9 - 15.

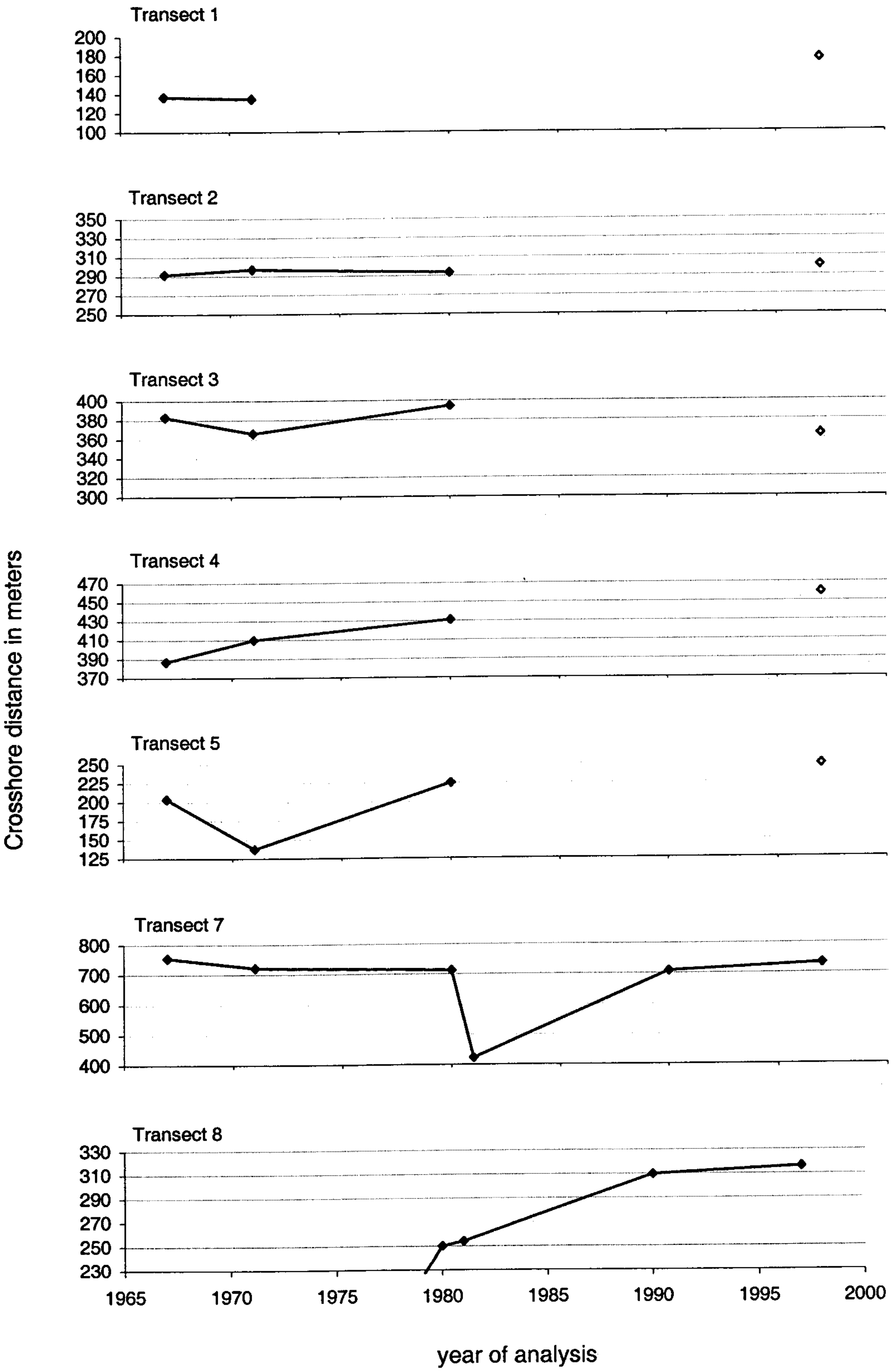

Figure III-3a. Long-term analyses of vegetation line migration, ***b***. Transects 1 thru 8.

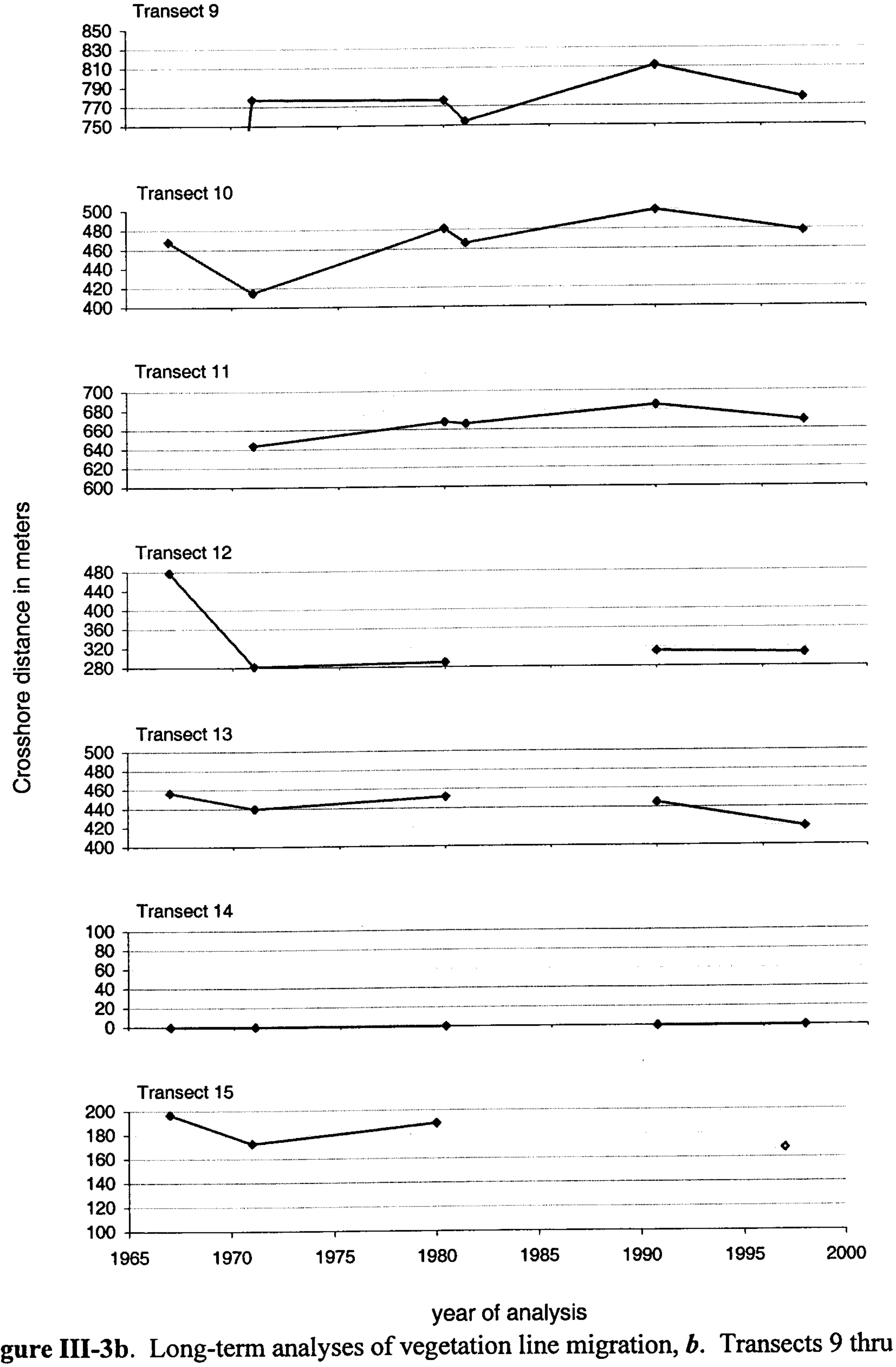

Figure III-3b. Long-term analyses of vegetation line migration, *b*. Transects 9 thru 15.

recovers on top of the foredune (positive values) after a period of no vegetation, first along T-9 in 1971, and then along T-8 in 1980. The progressive migration is depicted in panel T-7, where an abrupt drop of the graph in 1981 reflects the failure of the foredune. The sudden landward migration of the vegetation line occurred from 1980 to 1981 in T-9 seems to be associated with wave overtopping events.

Short-term photo-analysis

In order to assess shoreline and vegetation changes with a higher degree of accuracy, investigations similar to the above were completed through the analysis of 87 transects over a shorter period of time. Computed values ***a*** and ***b*** for 1967 were subtracted from those corresponding to 1980, and the resulting cross-shore differences were plotted against alongshore distance parting from the south jetty of the Coquille River. Figure III-4 shows the apparent seaward/landward migration of the wetted-beach mark relative to the SVL in the New River sub-cell from 1967 to 1980. Positive values, located to the left of the vertical axis, indicate apparent beach accretion while negative values, located to the right, represent erosional trends. Shoreline change values for this 13-year period range from 97 m of relative seaward migration of the wetted-beach mark at the northern end of the cell, to -102 m of relative shoreline retreat occurred at the mid-spit. The base of the spit is located approximately 24.9 km south of the jetty, while the New River mouth during 1967 is 15 km away from it, and 13.5 km during 1980. Positive values at the north end of the cell represent beach accretion associated either with Coquille River sand being transported south around the headland into the New River sub-cell, driven by the summer southward littoral drift, or to a typical winter alongshore configuration as described by Komar (1998) and Peterson, *et. al.* (1991), when the net northward littoral drift accumulates sediment towards the north end of a cell. These last model results are appropriate to accommodate the general beach retreat depicted in the graph from about kilometer 19 south to the end. Extreme negative values, representing wetted-beach mark retreat in the order of 70 to 90 m, are associated with the southward migration of the outlet of Twomile Creek (depicted along the vertical axis 9 km south of the jetty) and the northward migration of the New River mouth (13.5 km from the jetty) from 1967 to 1980. Although wetted-beach points appear to be evenly scattered in the cross-shore direction along most of the cell, an average shoreline retreat in the order of -9 m was calculated from the recorded data, for the time period of 1967 to 1980. Although the latter suggests a recession rate of about 70 cm per year, a systematic variability is introduced by the sole estimation of the wetted-beach mark position which fluctuates with time, such that the apparent erosion is likely due to the combined effects of tides and the horizontal component of wave runup.

Relative migration of the vegetation line is presented on Figure III-5. As in the previous figure, data-points plotted on or close to the vertical axis represent insignificant to little difference in the vegetation coverage from 1967 to 1980, while values departing significantly from the axis represent substantial evolution during the period of analysis. A general seaward trend is observed along most of the littoral cell, except for two areas where localized vegetation retreat occurred during this period. Extreme negative values up to -290 m, are associated with the northern migration of the New River mouth, while differences in the order of -50 to -150 m, located 25 km south of the jetty, reflect breaching of the foredune at the base of the New River spit. Extreme positive values, up to 350 m, located 16 km south of the jetty, contrast with the extreme negative values described above. Presumably, these values represent the recovery and stabilization of the foredune along that particular segment of the Spit, after the New River mouth migrated further to the north. Although there is significant variability in the cross-shore migration of the vegetation line along most of the cell, an overall seaward trend is reflected on the

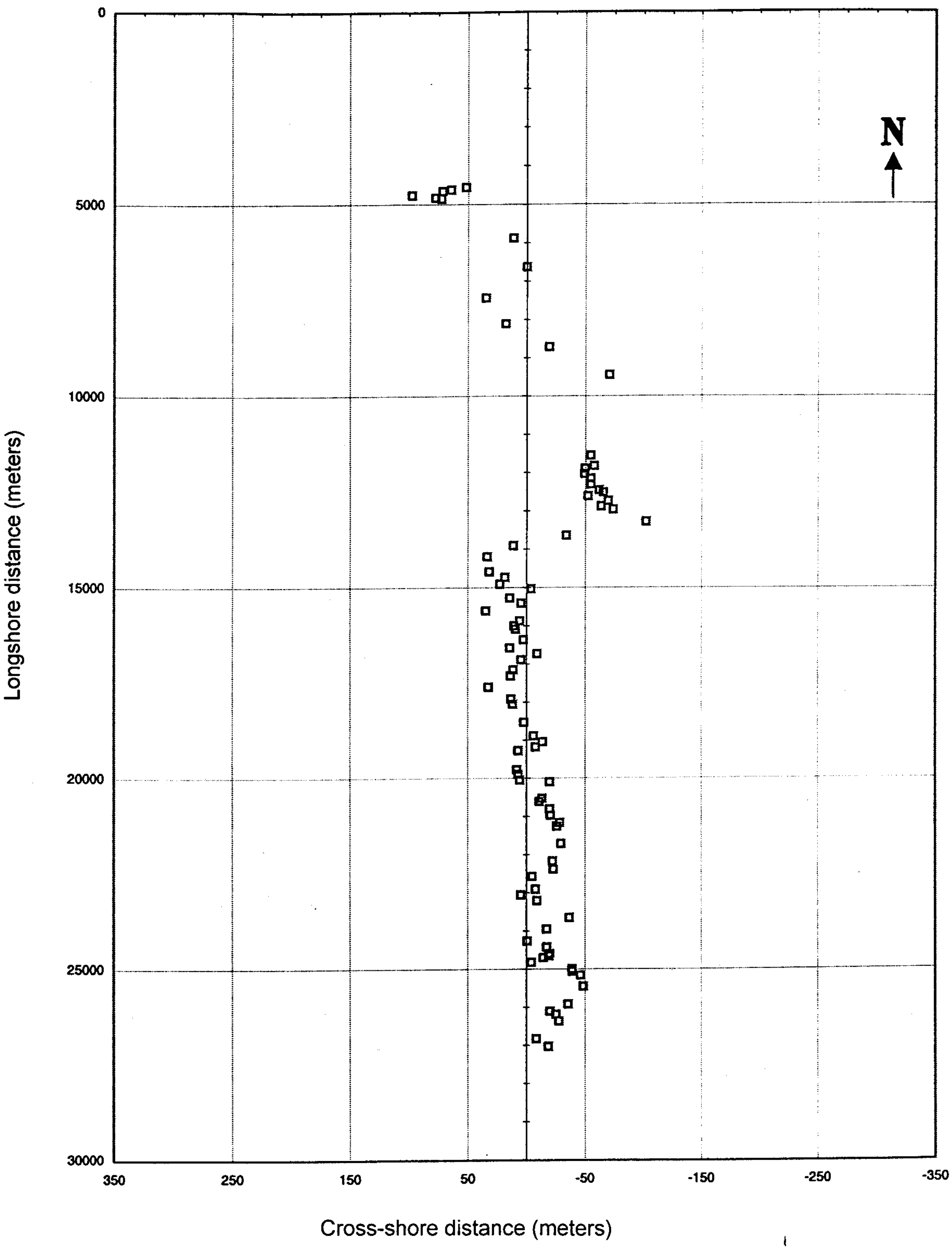

Figure III-4. Short-term analysis of the wetted-beach mark migration, ***a***.

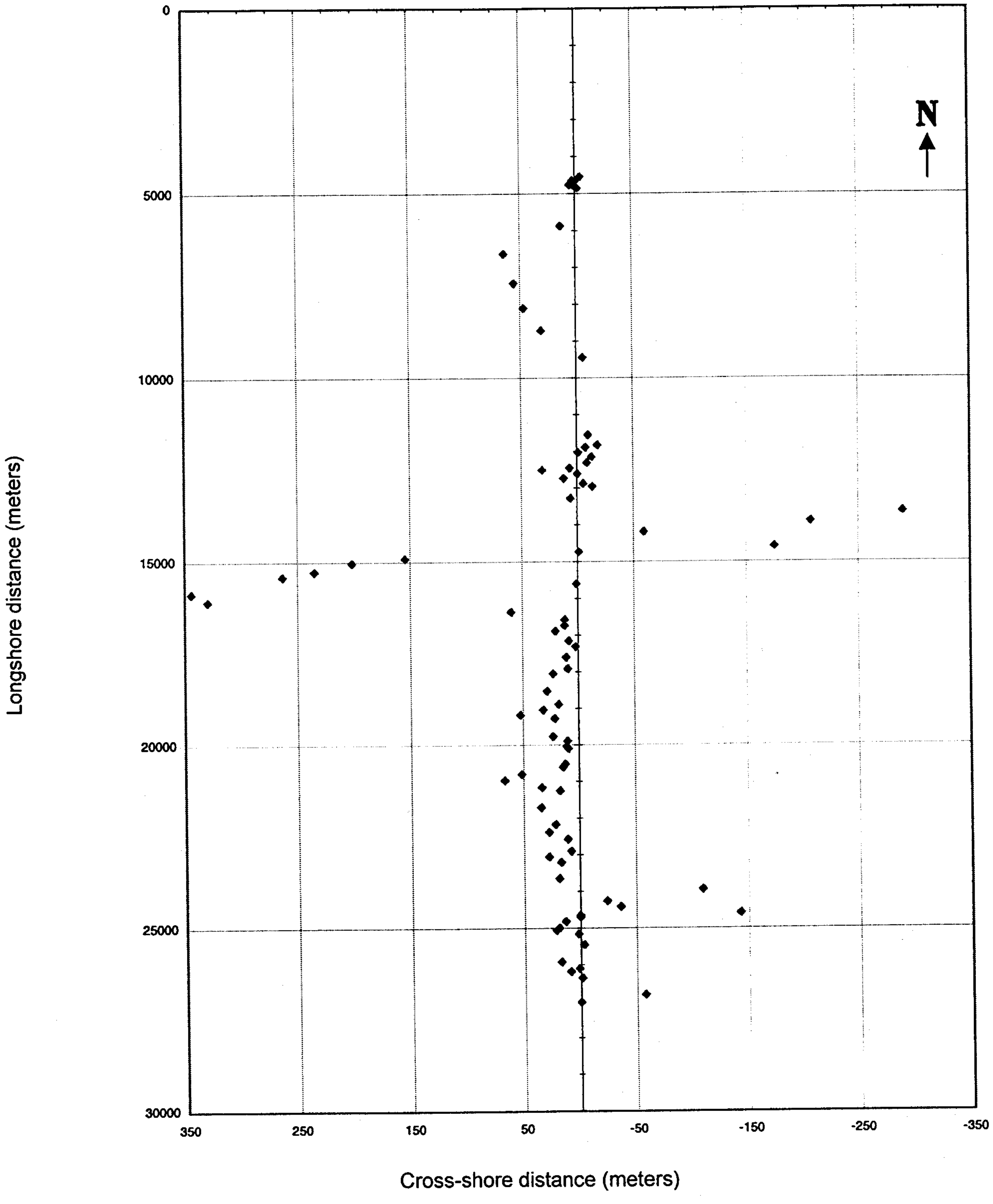

Figure III-5. Short-term analysis of the vegetation line migration, ***b***.

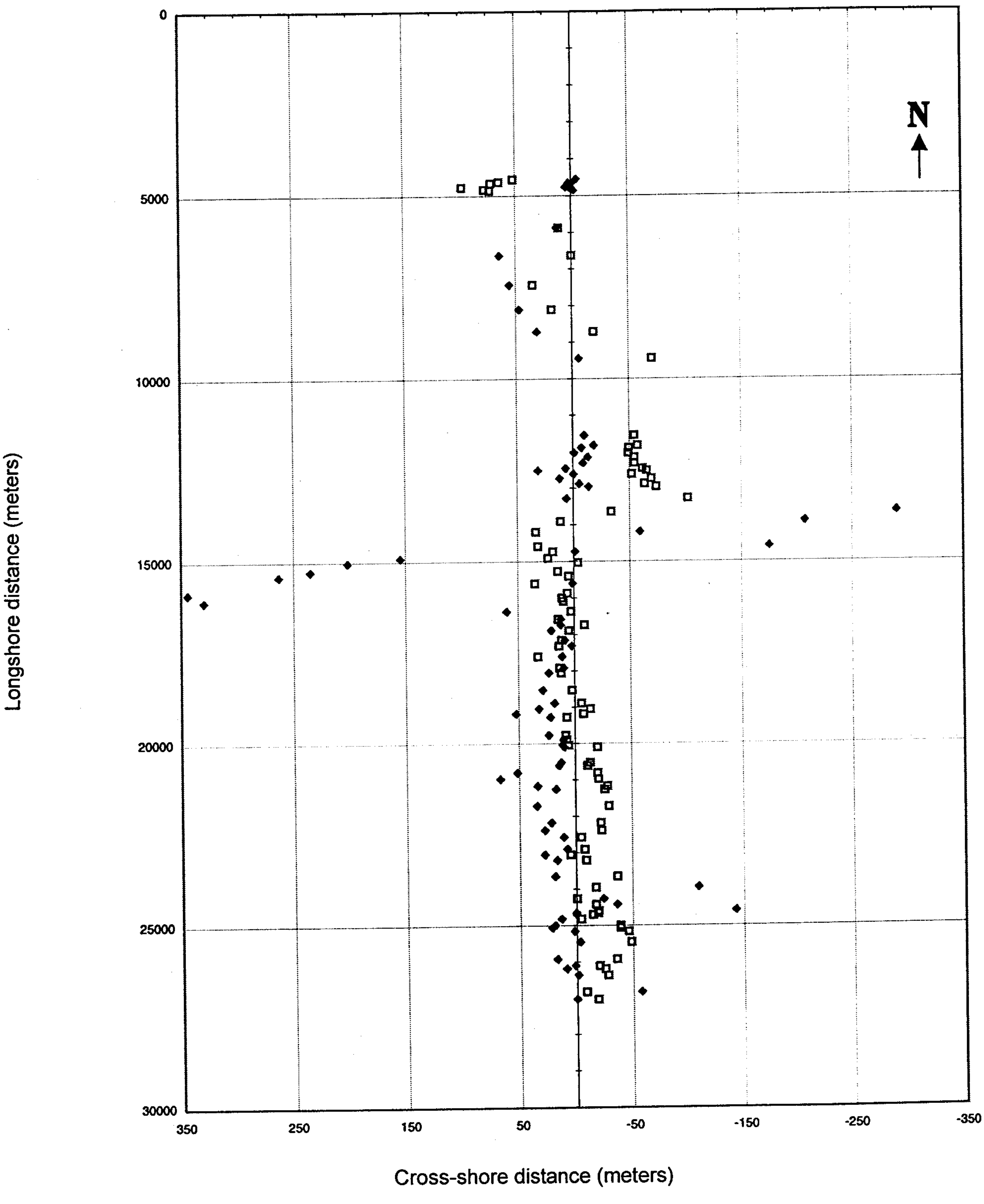

Figure III-6. Comparison between ***a*** and ***b*** data, for the short-term analysis.

figure. This average migration, estimated from the recorded data, was found to be in the order of 20 m.

It is worthwhile noting the presence of rhythmic patterns described by data-points plotted on the above figures. Semicircular patterns, concave to the west and ranging from 200 to 300 m wide by 25 m deep, are clearly distinguishable seaward of the axis on Figure III-4, 14 to 20 km south of the jetty, and landward, 7 km further to the south. Figure III-5 shows similar patterns (convex to the west) depicted by the vegetation data-points, seaward of the axis, 17 to 27 km south of the Coquille River. When plotted together (Figure III-6), it was observed that these features, particularly those located 20 to 27 km south of the jetty, faced one another in such way that the most seaward points of the vegetation line are located approximately at the same longshore distance than the most landward points of the wetted-beach mark. It also appears that the vegetation has a wider range of cross-shore variation than the wetted-beach, with almost 700 m compared to just under 200 m, respectively.

Stability of the New River Spit

Northward migration of the New River mouth

The set of descriptions integrating the first part of Chapter III show a significant variability of the shoreline morphology, not only with respect to the position of the New River outlet along the littoral cell, but also with respect to the number of outlets draining into the Pacific Ocean. While some of these outlets remain fixed in time, most of them show a distinct migration to the north, progressively increasing the length of the New River channel and Spit. It is apparent that this northward migration has been aided by the integration of a series of coastal streams, most of which, after flowing due west, make a sharp right bend behind the foredune and flow parallel to the coast for some distance before they reach the ocean. Although most of these streams flow due north, others have flowed due south at some point; such is the case of Bono Ditch in 1939, Fourmile Creek from 1939 to 1980, and Twomile Creek from 1967 to the present. However, neither process has been a continuous occurrence. Figure III-7 shows the historic locations of the New River mouth recorded from the aerial photos and historic documents. According to the figure, this northward migration reflects periods of rapid migration, particularly from 1939 to 1958, as well as periods characterized by relatively slow advance, from 1958 to 1967. This northward migration has directly resulted in an alongshore expansion of the New River Spit. Alongshore distances were measured from the base of the Spit to the river mouth for each year of analysis, to provide an estimate of migration rates since 1939. Figure III-8 presents a graph of Spit expansion that has occurred during the last ~ 60 years. This figure supports the hypothesis that the New River has not been steadily

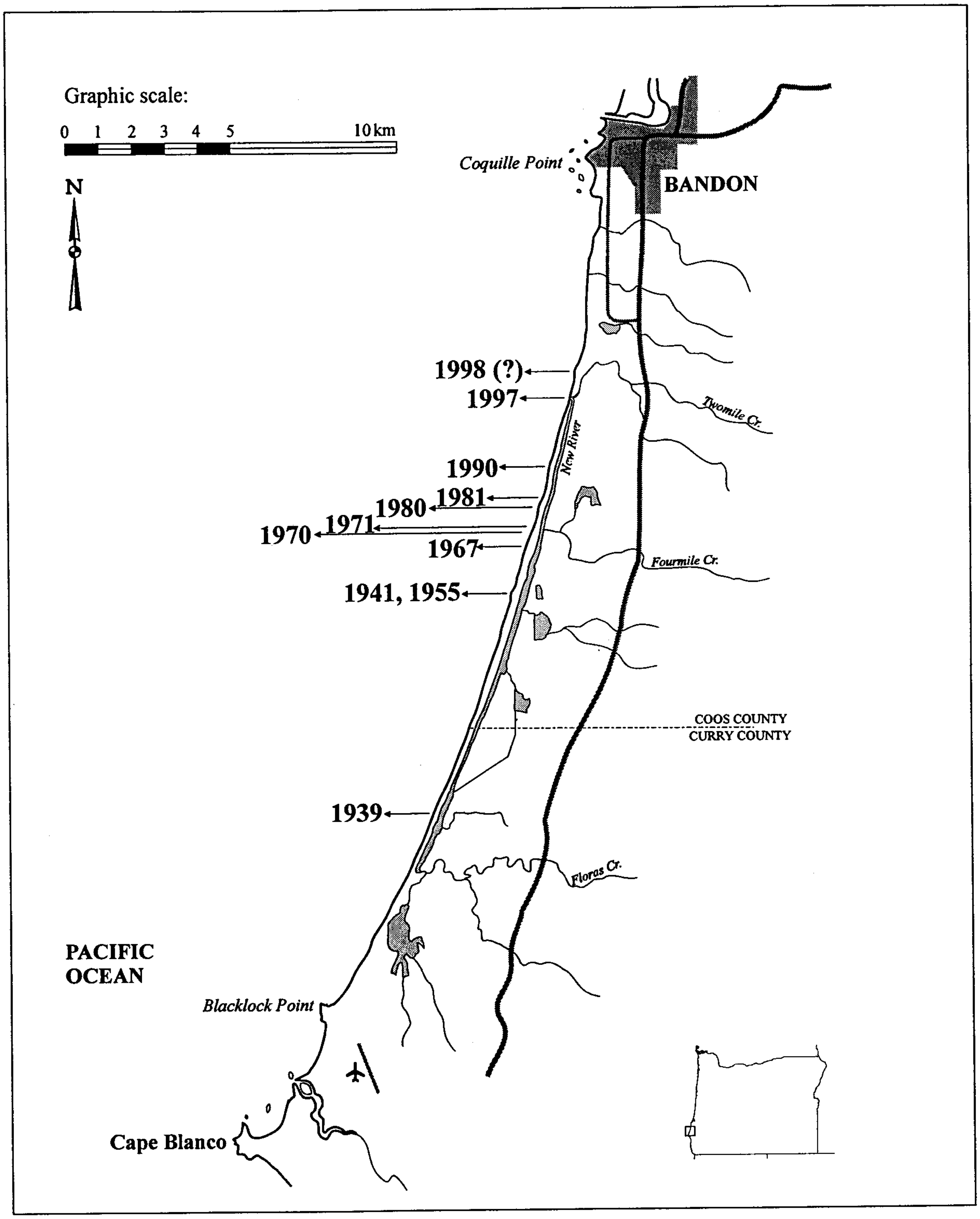

Figure III-7. Historic locations of the New River mouth, recorded from aerial photos, and additional historic documents (Tables II-1 and II-4).

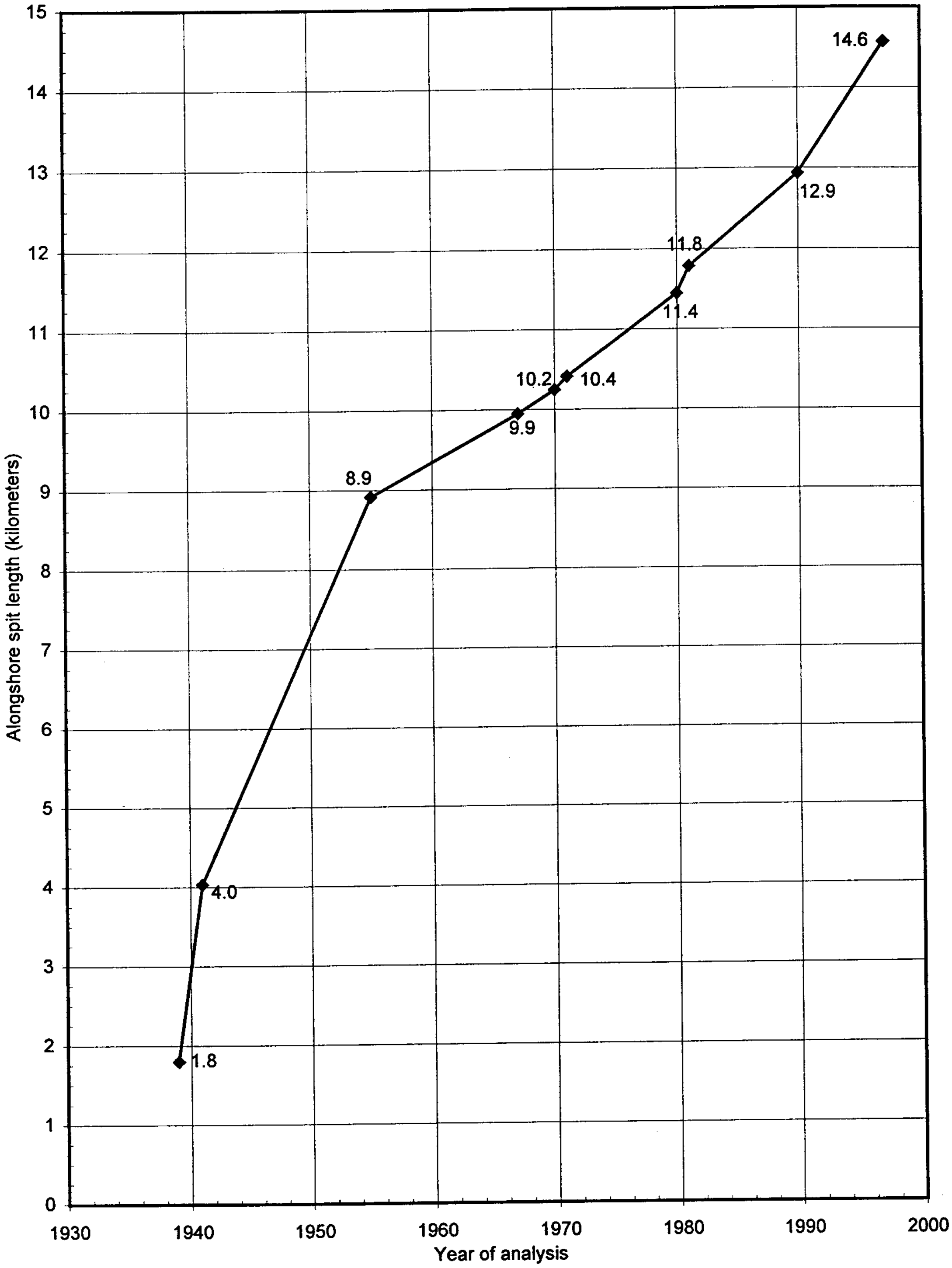

Figure III-8. Northward growth of the New River Spit from 1967 to 1997 approaching Bandon; instead, variations in the slope of the graph represent different Spit extension rates. Thus, the steeper the curve, the higher the rate. According to the figure, the fastest increase occurred in the Spit from 1939 to 1955, with extraordinary high extension rates on the order of 350 to 1,000 m per year. However, it is important to note that these values do not mean that the New River outlet has actually breached the foredune, continuously to the north, at a rate of ~ 3 m per day. Usually during the summer, the combined effects of ocean swell, onshore winds, and little runoff, allow the beach to build and close the river outlet, which opens again in the winter, apparently at a location further to the north. Slower extension rates, from ~ 80 to ~ 200 m per year, characterized the period between 1955 and 1970. However, rates accelerated again during recent years, when the northward flowing New River/Fourmile Creek system reached the southward course of Twomile Creek, yielding extension rates close to 243 m per year. Although the accuracy of the data decreases in the past, an overall comparison of the lengths of the New River Spit in 1939 and 1997, 1.8 and 14.6 km respectively, provides the basis to assert that the Bandon Littoral Cell is a very dynamic environment.

Analysis of Rip current embayments

Rip currents may be critical in the occurrence of beach erosion, particularly when combined with factors such as high wave set up during winter storms. Rip currents tend to erode the shore by carving deep embayments into the face of the beach and transporting the eroded sand offshore, which may significantly reduce the beach width. Some of the largest rip currents may cut back the entire beach berm and reach the backshore, affecting the foredune or the toe of the bluff. In order to analyze the potential for shoreline retreat along the Bandon Littoral Cell, a large number of rip-current embayments were identified and measured (Chapter II) on all sets of historic aerial photos, 1939 through 1997. The basic geometry parameters, length ***l*** and depth ***d***, were recorded for each identified embayment, entered in a computer and organized by year of analysis. Standard statistical parameters such as the average, standard deviation, and extreme values, were estimated for each of these series of measurements, and are reported in Table III-2. A total of 150 rip-embayments were examined, averaging about 21 per set, from as few as 11 on the 1981 set, to as many as 32 on the 1967 set. Overall embayment lengths ***l*** averaged about 300 m, ranging from ~ 250 to ~ 390 m, while individual lengths were observed from 150 up to over 800 m from cusp to cusp. Lengths deviated from the mean by 97 m overall. It was observed in the data that the depth of the rip-embayment ***d*** was independent from its length ***l***, thus the longer embayments were not necessarily the deepest ones. Based on our observations, rip currents carved embayments in the order of 35 to 60 m deep, with an overall average of 42 m. However, individual cases were observed where rip-embayments had dramatic depths of over 100 m.

Previous investigations, where "shoreline rhythm" were measured on the coast of North Carolina, yielded spacings between successive cusps ranging from 150 to 1,000 m, with most between 500 and 600 m [Dolan, 1971; in Komar, 1998a]. The cuspate shoreline projected some 15 to 25 m, on average, seaward from the embayments, almost half the depth of our values.

Once the general geometry of the rip-current embayments was evaluated, their alongshore location with respect to the base of the New River Spit was estimated, in order to determine the section of the cell which could be most susceptible to erosion due

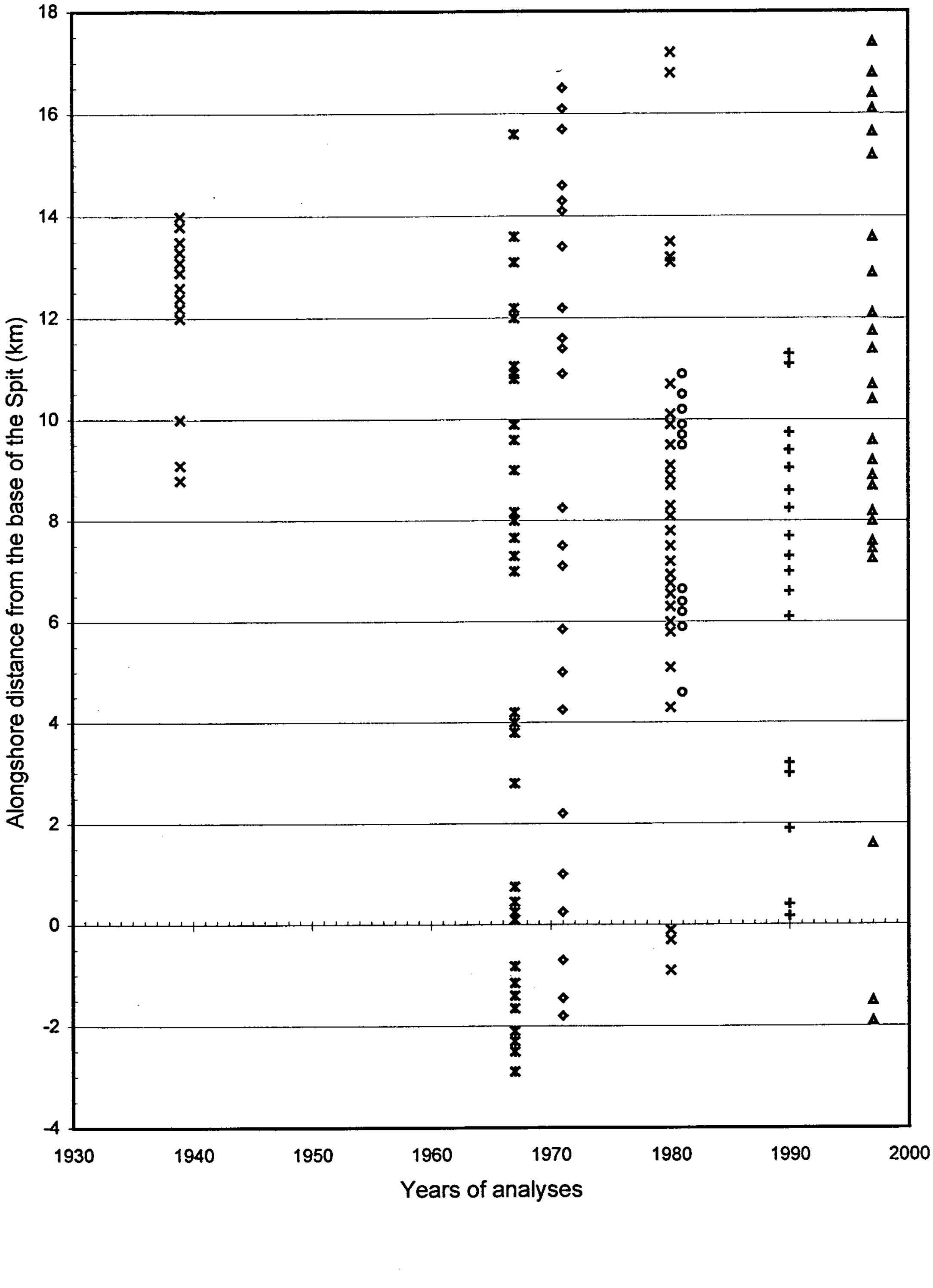

Figure III-9. Distribution of rip-current embayments along the New River sub-cell.

to the presence of rip currents. Figure III-9 shows a series of points representing the approximate longshore distance in kilometers, measured for each individual embayment to the base of the Spit, with respect to time. It appears that, for all the years of analysis, rip embayments occur along most of the littoral cell, following no appreciable pattern, as far south as Floras Lake (-2.5 km), and as far north as the outlet of Bradley Lake (+18 km). However, the approximately 7-km long stretch of beach located from New Lake in the south (km 6) to Laurel Lake in the north (km 13) seem to have the higher concentration of rip-embayments persistently through time. This section corresponds to the central and northern portions of the Spit, a part of which includes the area where the SVL relocation has been requested.

Table III-2. Summary statistics of rip-current embayments observed along the New River sub-cell during all years of analyses 1939 through 1997 (distances in meters).

Year	n	*l*				*d*			
		Mean	SD	Max	Min	Mean	SD	Max	Min
1939	13	315	58	464	248	0	0	0	0
1967	32	247	82	452	150	37	10	61	20
1971	24	394	147	813	163	50	13	75	25
1980	28	300	144	677	149	59	18	106	29
1981	11	317	109	607	234	54	12	70	36
1990	17	333	70	470	228	35	7	46	25
1997	25	296	72	426	207	58	22	103	30
Mean	**21**	**315**	**97**	**558**	**197**	**42**	**12**	**66**	**24**

CHAPTER IV

EVOLUTION OF THE STATUTORY VEGETATION LINE

The Statutory Vegetation Line, SVL or beach zone line, refers to the imaginary line which delineates the landward boundary of Oregon coastal beaches, open to the public, from the mouth of the Columbia River to the Oregon-California boundary. Enacted in 1969, the SVL was created in 1967 for the purpose of identifying lands subject to the Parks and Recreation Department's (OPRD) authority to regulate improvements on the ocean shores. The present Chapter begins with a review of the origin and evolution of the SVL, from the concept of the "public highway" introduced by the turn of the century, to its enactment in 1969. This section is followed by a discussion concerning the process of periodic re-examination and adjustment, and finally, it ends with a discussion of the rancher's request to relocate the SVL, the likelihood of this action based on technical investigations, its effects on public and private interests, and a brief analysis of the consequences, local and statewide, likely to arise from either decision.

Historic development of the SVL

Because of the rugged physiography of western Oregon, dominated by densely forested, magnificent mountain ranges, dissected regularly by powerful rivers or covered with extensive fields of sand dunes, much of the trade that occurred between communities during the early colonization of the Oregon Country was made either by boat or by transporting goods along the wide, gently sloping, ocean beaches. Since communications between settlements were frequently carried by horseback riders using these beaches, the shoreline was quickly adopted as a ready-made roadway (Figure IV-1).

Tourism developed on the Oregon coast in the late 1800s, as newly established railroad lines from inland promoted beach traffic. Beach trains, popular among citizens from the Willamette Valley, carried tourists to the coast, where nearby hotels and tent cities accommodated the visitors. A few years later, as Oregonians entered the automobile age, they used the beaches as a highway (Figure IV-2), a use that continued even after the last segment of Highway 101 was completed in 1932 [Straton, 1977]. After its completion, beaches were no longer needed for transportation, but tradition prevailed and the continuous use of horses, automobiles and even airplanes by sunbathers looking for the "perfect picnic spot", resulted in conflicting recreational uses of the ocean shores.

The influx of tourists gave rise to the creation of shops, restaurants and motels, and with the latter, land acquisition and ownership, which resulted in a severe conflict of interests between the rights of private ownership and public's right of use.

The concept of having a "public highway" easement along the coastline was first introduced by the Oregon Legislature about one-hundred years ago. The 1899 Laws of Oregon, section 4817 B and C, declared that "The shore of the Pacific Ocean, between ordinary high and extreme low tides, and from the Columbia River on the north to the south boundary line of Clatsop county on the south, [is hereby declared] a public highway, and shall forever remain open as such to the public" [55th Legislative Assembly, 1969]. Fourteen years later, Governor Oswald West amended the statutes by introducing the 1913 Beach Bill. It is worthwhile to note that both the 1899 and 1913 laws recognized within the "public highway" easement only the tidal portion of the beach, excluding the adjoining dry sand area. The Beach Bill modified the 1899 law by

Figure IV-1. Barview Beach, Tillamook County, in the 1890s when the beach was used as a ready-made roadway [from Straton, 1977].

Figure IV-2. Nye Beach at Newport, Lincoln County, in the early 1900s [from Straton, 1977].

extending the public right of beach use south to the California border. In its Chapter 47, the 1913 General Laws of Oregon reads as follows:

> "The shore of the Pacific Ocean, between ordinary high tide and extreme low tide, and from the Columbia River on the north to the Oregon and California State line on the south, excepting such portion or portions of such shore as may have heretofore been disposed of by the State, is hereby declared a public highway and shall forever remain open as such to the public" [55th Legislative Assembly, 1969].

Besides extending the easement to the southern ocean shore, the Law also recognized that the State had already sold parts of the beach to private ownership. The Oregon legislature in the late 1800's believed that "what the state owned, the state could sell". Thus, the State Land Board, comprising the Governor, Secretary of State, and State Treasurer, began disposing of state-owned tidelands in 1874 through legislation enacted in 1872, which provided for the alienation of portions of the ocean shore. The first private sale occurred in 1874 and consisted of a ~ 81,000 m^2 (20 acres) conveyance. Thirty-seven additional sales of coastal property were made, until 1923 when the last sale occurred, constituting 37 out of the 571 km of Oregon coastline. No major modification of the legislation took place between 1913 and 1967. Minor modifications included the 1947 Legislature's re-enactment of the 1913 Act, and the 1965 modification of the "public highway" concept of the wet sand area of the beach, to declare such "to be a State Recreational Area" [55th Legislative Assembly, 1969]. It also qualified the clause prohibiting ocean shore sales, by adding "...except as provided by *special* law." [Straton, 1977]. However, much controversy arose among those who already owned beach-front property, and those who felt the right of enjoying the customary, free passage through it. Conflicts began, and in 1966, the Surfsand Motel at Cannon Beach denied public access to the dry sand area of the beach fronting its property, by building a low log barricade and posting signs that read "Surfsand Guests Only, Please". The incident was important in that it raised the question of whether or not private owners could prohibit public access along the beach, and whether they had the right to build seaward of the vegetation line onto the sandy beach without permits [Straton, 1977]. As a result, the 54th Legislative Assembly convened in January 1967 and took on the task of creating a Beach Bill which would insure those owning beach-front property the rights of private ownership and at the same time preserve for the public as much of the beach as possible for their use and enjoyment. Due to tradition, and the wording of the Law, most people believed that the dry sand portion of the beach, seaward of the vegetation line, was public, while in reality the public easement applied to the portion of the beach seaward of the ordinary high tide line [Straton, 1977].

The 1967 Beach Bill originally used the wording of "vegetation line" to define the landward limit of the public concern, since the definition of "ordinary high tide line" varied from one jurisdiction to another; while some defined it as the average of all high tides over a specific span of years, others defined it as the line of vegetation. Subject to much controversy, this "line of vegetation" boundary was later replaced by a ~ 5-m (16-foot) elevation above sea level as established by the U.S. Coast and Geodetic Survey, National Geodetic Vertical Datum (NGVD) of 1929. Although it was the Legislature's intent that this zone line coincided with the line of vegetation, in many cases it did not; and while in some areas the dry sand area extended further above the 16-foot contour, in many low-lying areas, with little elevation over the beach surface, this elevation extended too far inland, through private homes and businesses. As an alternative for these instances, mainly on sand spits, marshes and the mouths of streams, rivers, estuaries and creeks, the Legislature provided that the zone line would be established at an elevation of ~ 1.7 m (5.7 ft) above datum plus 91.5 m (300 ft) inward from the ocean but not to exceed the 16-foot contour of elevation. Two months before Governor Tom McCall signed the Bill into Law, on July 6 1967, the House Highway Committee recommended that the State Highway Commission survey the entire coast to establish a permanent zone line for approval by the next legislative session in 1969. The Commission used survey points integrated within the Oregon Coordinate System, which is a nationwide system of latitudes and longitudes described in ORS 093.330, and connected the adjacent points with a straight line. An advantage of using this method is that the SVL coordinate points are tied to a horizontal control rather than to a vertical elevation above sea level, convenient because the resulting zone line is unaffected by natural changes in the beach terrain. The survey points were introduced to the 1969 legislature in HB 1045, and became law on August 22, 1969. The Bill included an additional amendment which stated that all beach lands subject to public recreational easement would be exempt from taxation.

Periodic reexaminations and adjustment of the SVL

It is important to note that Oregon Statutes include a provision for the evaluation and adjustment of the SVL. ORS 390.755 establishes that the State Parks and Recreation Department (OPRD) is directed to periodically reexamine the SVL in order to preserve private and public rights and interest in the ocean shore. It also sets forth that OPRD may "from time to time" recommend to the Legislative Assembly an adjustment of the SVL described in ORS 390.770. While these Statutes present the fact that the beach zone line is subject to periodic review and relocation, Oregon Administrative Rules (OAR) provide the appropriate guidelines necessary for such action. Division 23 of the Rules, Chapter 736, sets forth the criteria and procedures by which State Parks may recommend adjustments to the Legislature pursuant of the above Statutes. According to the Rules in Chapter 736, it is the Commission's policy to prioritize the public interest, and the 1967 Beach Law, when coming to a decision regarding a SVL adjustment. It further states that reexamination should be accomplished by considering the entire littoral cell, defined as a shoreline segment or reach bounded by a physical feature such as a jetty or headland, of which ORS 390.770 recognizes 22 on the Oregon coast. These Statute differentiate three separate littoral cells between Cape Arago in Coos County and Cape Blanco in Curry County, the first bounded to the south by Coquille Point, the next by Blacklock Point, and the last by Cape Blanco itself, but does not give further information on specific names for any of these units. Section 30 declares that reexamination of the zone line may occur either by OPRD's own initiative or when directed by OPRC, upon request by a county or local governing body, or upon request from property owners who's estates are part or adjacent to that specific littoral cell. In order for the Department to recommend an adjustment of the current location of the SVL, suitable material must include [from OAR 736-023-0030]:

(a) A physical description of the littoral cell in question;

(b) An evaluation of the direction and extent to which the actual line of vegetation has moved with respect to the location of the SVL in 1967;

(c) A statement of the perceived causes of the movement of the actual vegetation and the likelihood that such movement is continuing and/or permanent;

(d) A description of the harm to the public or private use and enjoyment of the specific area caused by the current location of the SVL;

(e) Photographs, affidavits or other documentary evidence supporting the change proposed in the petition;

(f) A history citing changes since 1967 of the littoral cell in question. This shall include but not be limited to a current survey, past surveys and aerial surveys at 5 - 10 year intervals.

As part of the investigation and review process, OPRD is required to consider factors such as the density and location of the vegetation cover near the segment for which the adjustment is requested, the extent of the shift, if any, as well as the apparent causes driving this shift, including shoreline accretion or erosion, vegetative stabilization activities, construction of shore protection structures, sudden natural events and non-natural causes. Potential natural events that might change the configuration of the vegetation line along the Oregon coast include extreme flooding and storm conditions, subduction earthquakes, and tsunami waves. In fact, it is apparent on the 1967 set of beach mosaics analyzed for the present study, that the drift wood, which usually gathers on top of the beach berm, was located further inland –up to 200 m at some locations– presumably a result of the tsunami waves that struck the Oregon coast in December, 1964. Such an event is likely to have had a significant impact on the vegetation cover, as well as on the overall beach configuration even several years later, when the criteria for the location of the SVL were established. Other important factors required to consider relate to the impacts of the petition on the general public, on private landowners, and on the Department itself. These include the location and extent of the area commonly identified by the public as public beach, and customarily used for recreational purposes, the effect of the adjustment on the public's and private landowners' use and enjoyment of the area, the fiscal impact to OPRD of any proposed adjustments, as well as public costs that could be incurred by such a change.

After all required evidence is collected and evaluated, OPRD should hold public hearings, at least in the vicinity of the affected area, where the collected evidence should be presented to the public. Finally, upon obtaining all pertinent information and public comment, OPRD must submit a report to the Commission, including all the data, findings, comments, and a proposed recommendation regarding the adjustment of the SVL specific segment in question.

Relocation of the SVL at New River

As mentioned in the previous section, Oregon Parks and Recreation Department (OPRD) is directed by Law to periodically reexamine the location of the SVL, as quoted in ORS 390.755 "...for the purpose of obtaining information and material suitable for a re-evaluation and re-definition, if necessary, of such line so that the private and public rights and interest in the ocean shore be preserved." According to the Statutes, a reexamination process may be initiated by the Departments own initiative, when directed by the Oregon State Parks and Recreation Commission (OPRC) and upon request, either from a governing body of a county or city, or from at least one property owner whose estate is located within the boundaries of the littoral cell in question. Reexamination of the Beach Zone Line at New River was requested in 1991 by the Curry County Board of Commissioners and, 4 years later, directly by three property owners,.

Current and previous requests

On November 7, 1995, Kevin Q. Davis, Attorney at Law, filed an application with OPRD to adjust a section of the SVL located west of Langlois, Oregon, described by the coordinate points Co-7-257, in Coos County, through Cu-7-12, in Curry County. This SVL section approximately coincides with the east bank of the New River, which runs generally in a northward direction along the area, parallel to the ocean shore. The application was submitted on behalf of Gerald Kamph, Michael Knapp and Rick McKenzie, individuals who own about 3.4 km^2 (832 acres), 1.5 km^2 (359 acres), and 6 km^2 (1,502 acres) respectively, of property west of interstate Highway 101 (Figure IV-3).

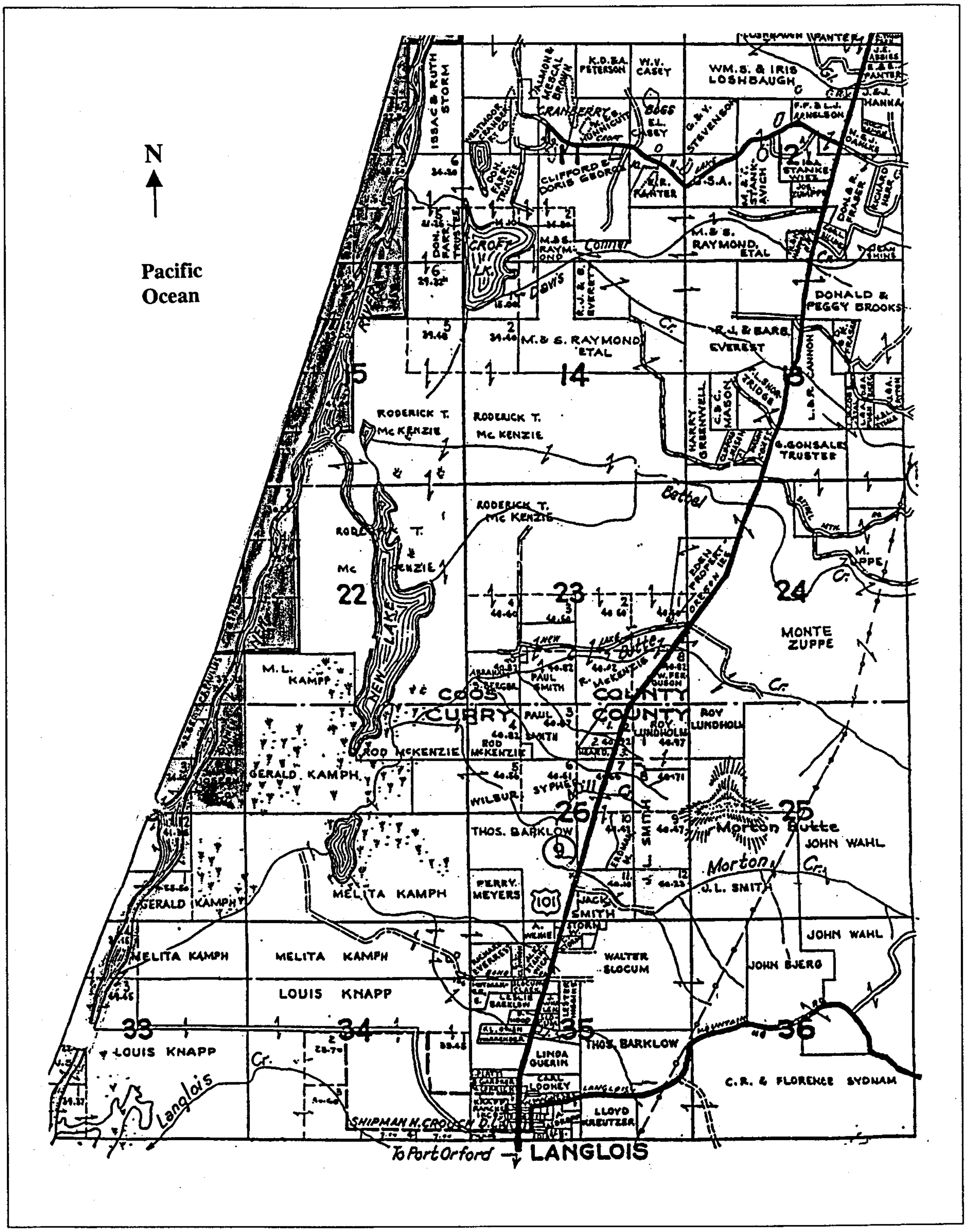

Figure IV-3. Location of the Kamph, Knapp and McKenzie properties, west of Langlois, Oregon.

The application specifically requests that the beach zone line be relocated seaward of its present location, "...to a position that coincides as closely as possible with the visible line of vegetation adjacent to the sandy beach of the actual ocean shore" [Davis, 1995], that is, along the foredune scarp on top of the New River Spit. This proposal, however, does not stand alone but rather, constitutes the most recent attempt to protect private interest at New River. Rod McKenzie, previous owner of the McKenzie Ranch and former Representative on the House Highway Committee, strongly opposed the enactment of the Beach Bill in 1967 [Straton, 1977]. Years later, shortly after the "canoeists incident" in February 1991, the Curry County Board of Commissioners requested State Parks to review the location of the SVL along the New River. They petitioned that the zone line be relocated "where it should have been originally", along the sand spit west of New River. The Commissioner's request was evaluated by State Parks' staff as well as by experts from both Oregon State and Portland State Universities, who concluded that the location of the beach zone line in the New River area was consistent with the rationale and intent of the Legislature in 1969, and since no significant changes in the physical conditions of the area had occurred during the last 22 years, they recommended that no change in the location of the zone line be considered [Bond, *et al.*, 1991].

In its final report submitted to the Parks and Recreation Commission, OPRD's Region 3 Office analyzed and proposed five different alternatives in response to the Board of Commissioners' request. Alternative 1 proposed that no change in the location of the SVL should be considered. Alternative 2 stated that the Beach Zone Line could be moved to the middle of New River. Alternative 3 supported the relocation of the SVL to the west bank of New River, while Alternative 4 recognized that the public should be restricted from the land east of the foredune, where the SVL should be moved. Finally, Alternative 5, which in turn had 3 variables, proposed to (a) move the zone line as presented in alternatives 1, 2, 3, or 4, but seek to protect the integrity of the New River Spit and the public's right to use it through "public purchase of the private lands which are west of the new line established under each alternative", either by OPRD or BLM; (b) ask Coos and Curry Counties to provide additional land use control in the area which would protect the integrity of the Spit; or (c) leave the private lands in private ownership but purchase the development rights for all lands between New River and the zone line.

Analysis of alternatives

Based on the history of events occurred at New River, it seems that Alternative 1, *not to change the current location of the zone line*, is not a very good option, first because it is very likely that the ranchers would renew their relocation application once again and second, because changes in the morphology of the area which determined the location of the SVL in 1967-69 do have occurred and need to be addressed.

Alternative 2, *move the zone line to the middle of the New River*, would allow the ranchers access to the river for livestock watering, while preserving the public's right to navigate and use the New River and the Spit. However, delineation of the SVL and establishment of coordinate points would not be an easy task due to the meandering nature of the New River channel. Also, such a delineation would not correspond to the intend of the 1967 & 1969 Legislature.

Alternative 3, *move the zone line to the west bank of the New River*, does not seem to correspond either with the Legislation; however, it would preserve the Spit for public use and would allow the ranchers access to the river for livestock watering. Furthermore, Division of State Lands and the Oregon State Marine Board have interest in the navigability of the New River and intend to assert jurisdiction over it, so that a navigation easement would protect the public's right of access and use of the river.

Alternative 4, move the zone line to the foredune of the Ocean beach, partially meets the intents of the 1969 Legislation since currently exists a somewhat well defined line of vegetation along most of the top of New River Spit. However, it recognizes that the ranchers do own land west of the New River and that public use should be restricted to the beach seaward of the foredune scarp. Even though this is the alternative supported by the Curry County Board of Commissioners, it would prevent the public from navigating and enjoying the natural resources along the New River.

Alternative 5, *public purchase of the private lands which are west of the new line*, was unsuccessfully implemented by the Bureau of Land Management. Shortly after these alternatives were presented to the Parks and Recreation Commission, the Coos Bay District Office of the BLM developed an acquisition plan for the New River based on biological (wetlands and former wetlands), cultural (prehistoric sites), recreation and access needs, which included the creation of conservation easements west of the New River. Through this plan, the Federal Government designated the public lands along the river as an Area of Critical Environmental Concern (ACEC), and acquired close to 3 km^2 (753 acres) of land through outright purchase from several property owners in the area, except from Messrs. Kamph, Knapp and McKenzie.

Finally, it is important to consider that the section of the SVL subject to review does not correspond to the complete extent of the section which shifts inland and runs through the east bank of the New River channel (Co-7-242 through Cu-7-16). This section, Co-7-257 through Cu-7-12, comprises nearly 8 of the almost 12-km long portion described above (Figure IV-4). In the event that the Commission approves the rancher's petition and the legislature relocates the above described section of the SVL to the top of the New River Spit, a 4 km long section of the SVL (about 3.5 at the north, less than half a kilometer at the south) would remain running along the east bank of the New River. Such a configuration, depicted in Figure IV-5, would not follow the principles of the SVL as established by the 1967 and 1969 Legislatures.

According to the Bond, *et al.* (1991) report, no significant changes were found in the physical conditions of the site, during the 22 years between 1969 and 1991. The present study indicates that some changes have occurred. It has been discussed in Chapter III how the location of the foredune and associated vegetation cover have been shifting, mainly in the alongshore as the river mouth has migrated, but also in the cross-shore direction. Analysis of aerial photos and historic documents show the presence of multiple outlets, natural and man-induced, emptying the New River channel into the ocean. It has been evident that the New River Spit is a very dynamic environment, where foredune failure due to wave overtopping events, rip-current embayments, and even tsunami waves, is not uncommon. Long-term analyses demonstrated that, while there are areas where no permanent vegetation is present on top of the Spit, in other areas European beachgrass has stabilized the foredune. The short-term analysis showed an apparent overall seaward migration of the vegetation line between 1967 and 1980, on the order of 20 m (Figures III-4 and 5). And most important, it has been established that the mouth of the New River has migrated substantially to the north since 1967 (Figure III-7),

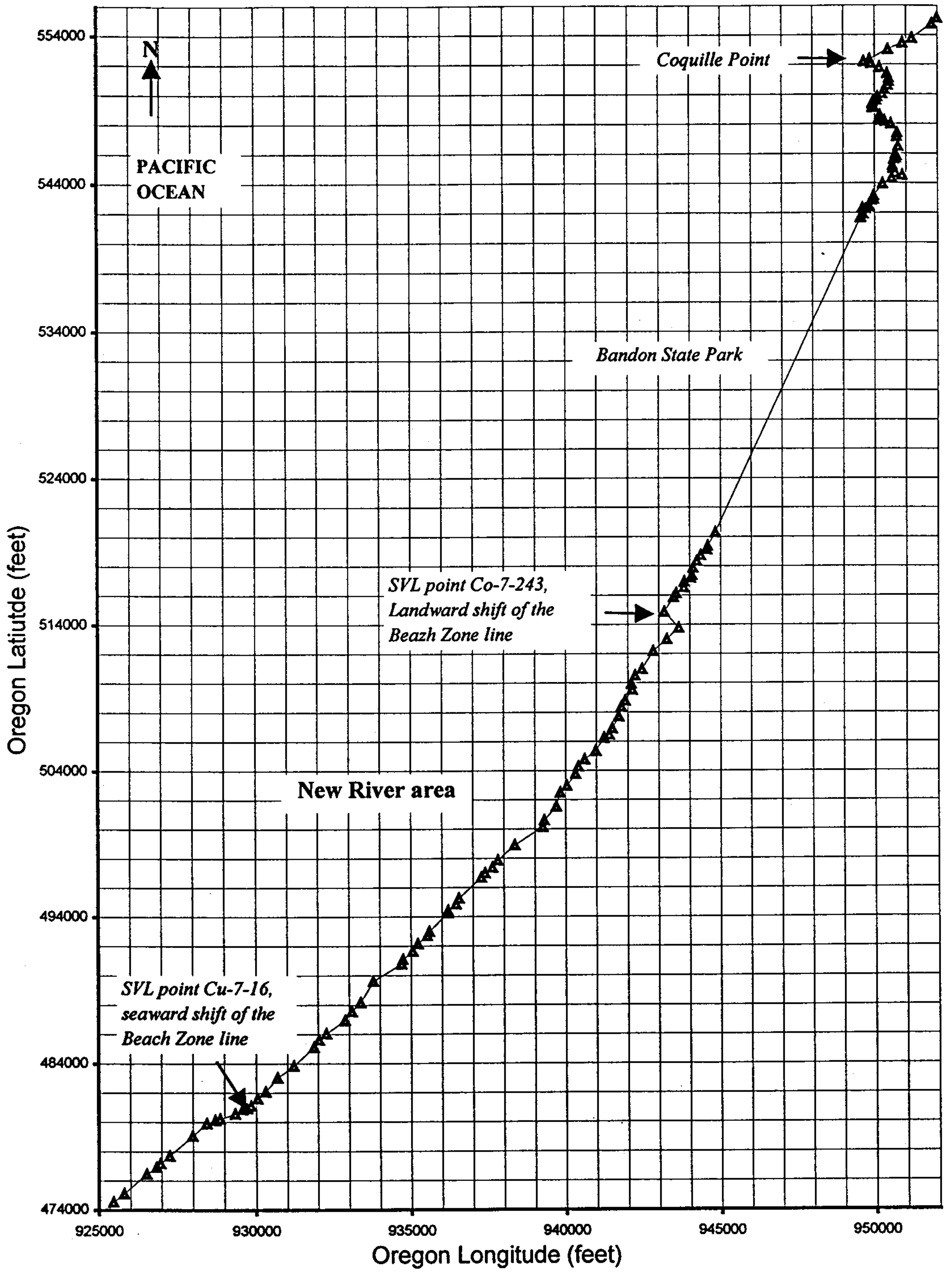

Figure IV-4. SVL stations along the New River sub-cell referenced to the Oregon Coordinate System (ORS 93.310).

such that there is no reason for the SVL to shift inland at station Co-7-242. However, this does not mean it should be relocated along the New River Spit. Relocation should not be considered only for a small section of the zone line, rather, scientific, technical and economic aspects should be considered for the purpose of relocating the line to the west of the New River, from Bandon State Park in the north (SVL station Co-7-230) to the base of the sand Spit at the south of the cell (SVL station Cu-7-16).

CHAPTER V

CONCLUSION

The present report was conducted to provide some of the technical and scientific information required to examine an adjustment of the Statutory Vegetation Line along the New River Spit, and derived from a much larger erosion assessment study performed by Dr. Paul Komar and Dr. John Marra under contract from the Oregon State Parks and Recreation Department. It also provides a review of the origin and evolution of the SVL, as well as analyzes the implications and possible ramifications of adjusting a section of this Beach Zone Line for the first time since its enactment in 1969.

Summary of findings

Aerial photo-interpretation analyses conducted on the New River area, located on the southern Oregon coast within the littoral cell geographically bounded between Coquille Point in the north and Blacklock Point in the south, found it to be a very dynamic environment, subject to strong erosive conditions resulting from the combined effects of extreme water levels, storm-generated waves, and rip-current embayments. Specific analyses demonstrated that:

1. Multiple outlets commonly occurred along the New River, particularly during the first half of the century;
2. The New River Spit presents evidence of periodic wave overtopping events, which at certain locations breached the foredune and washed over into the river channel leaving distinctive sand deposits;

3. Rhythmic shoreline configuration, in the form of rip-current embayments an offshore and transverse bars, are frequently observed along most of the littoral cell;
4. The northernmost outlet of the New River has been migrating towards Bandon at rates of 100 to 1,000 m per year during the last 60 years.
5. The width of the beach and the location of the vegetation line have varied significantly in the alongshore, and also in the cross-shore direction, but short-term analyses have found that an overall seaward migration of the vegetation line occurred from 1967 to 1980.

Furthermore, literature reviews indicated that conflict of interests between the public's right of use and enjoyment of the dry sand area of the beach, and private right of ownership, have always been an issue along the Oregon coast. Thus, Messrs. Kamph, Knapp and McKenzie's request to re-adjust the location of the SVL is a significant example of such conflicts. According to evidence discussed in this report, there seems not to be a simple and clear solution to the conflict: Whatever the decision made by the Oregon State Parks and Recreation Commission for the SVL relocation request at the New River, it will set a precedent for similar requests elsewhere, in an attempt to resolve the conflicts arising over the use and enjoyment of the Oregon beaches.

Recommendation for future investigations

The present study constitutes an important review of the morphologic evolution of the New River Spit, sub-cell and the Bandon Littoral Cell during the recent past; however, technical investigations focusing on the current conditions, as well as investigations on the long-term stability of the Spit, should be continued. Research currently being performed includes the development of a budget of sediments, which analyzes the sources and losses of sediment to the coastal environment, an analysis that is particularly useful when working on isolated coastal units such as the littoral cells common to Oregon. Further investigations will be targeted towards evaluating extreme oceanographic conditions to assess the maximum extent of dune erosion on the New River Spit, and to establish whether or not the New River Spit might breach during such extreme events.

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