State of Oregon
Oregon Department of Geology and Mineral Industries
Ruarri J. Day-Stirrat, State Geologist

OPEN-FILE REPORT O-24-13

BEACHES AND DUNES OF COOS COUNTY, OREGON: 1975 TO 2022

by Jonathan C. Allan[1], Fletcher E. O'Brien[2] and Laura L. S. Gabel[1]

2024

[1]Oregon Department of Geology and Mineral Industries, Coastal Field Office, P.O. Box 1033, Newport, OR 97365
[2]Oregon Department of Geology and Mineral Industries, 800 NE Oregon Street, Suite 965, Portland, OR 97232

DISCLAIMER

WHAT'S IN THIS REPORT?

New lidar based mapping along the Coos County coast provides updated spatial extents of beach and dune features exposed to existing and future storm-induced wave erosion, runup, overtopping, and coastal flooding. Side-by-side comparisons between 1975 and the latest mapping of beach and dune features highlight important spatial changes in coastal geomorphology that have taken place.

Cover photo: View looking east toward the Bandon 'triangle,' an area of dune development that formed adjacent to, and in response to, the construction of the Coquille River jetties. Marine terraces formed at sea level ~80,000 years ago can be seen immediately landward of the 'triangle.' Photo taken by J. Allan, 08/13/2011.

Expires: 11/30/2025

Oregon Department of Geology and Mineral Industries Open File Report O-24-13
Published in conformance with ORS 516.030

DOGAMI Administrative Offices
800 NE Oregon Street, Suite 965
Portland, OR 97232
Telephone (971) 673-1555
https://www.oregon.gov/DOGAMI/

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GEOGRAPHIC INFORMATION SYSTEM (GIS) DATA

See the digital publication folder for files.
Geodatabase is Esri® version 10.7 format. Metadata is embedded in the geodatabase and is also provided as a separate .xml format file.

Original_Dune_Mapping.gdb:
    ***Feature class*:** O*riginal_Dune_mapping_Coos (polygon)*
Coos_Dune_Revised_2024.gdb:
    ***Feature class*:** *Beaches_and_Dunes (polygon)*

Layer file providing symbology for the feature class
Coos_Beaches&Dunes_Original.lyrx
Coos_Beaches&Dunes_2024.lyrx

UNIT CONVERSION TABLE

Units of Measurements in this Report: The intended audience for this report is local Government and the public. Therefore, we selected English units as the primary units. A conversion table for English to Metric units is included for easier conversion.

	Multiply	By	To obtain
Length:	inch (in)	25.4	millimeter (mm)
	inch (in)	2.54	centimeter (cm)
	foot (ft)	0.305	meter (m)
	yard (yd)	0.914	meter (m)
	mile (mi)	1.609	kilometer (km)
Area:	square foot (ft^2)	0.093	square meter (m^2)
	square mile (mi^2)	2.590	square kilometer (km^2)
	acres	0.405	hectares (ha)
Volume:	cubic ft (ft3)	0.028	cubic meter (m^3)
	cubic yard (yd3)	0.765	cubic meter (m^3)
	cubic mile (mi3)	4.168	cubic kilometer (km^3)

EXECUTIVE SUMMARY

The objective of this study was to produce updated information on the spatial extent of beach and dune geomorphology in Coos County, Oregon that may be subject to existing and future storm-induced wave erosion, runup, overtopping, and coastal flooding. These data are of importance to the Department of Land Conservation and Development and the seven coastal counties of Oregon in order to implement Statewide Planning Goal 18: Beaches and Dunes (Goal 18 (DLCD, 2024)). Goal 18 requires local jurisdictions to adopt a beach and dune overlay zone in their comprehensive plan, which may be used to manage development on or near beaches and dunes.

Between 1972 and 1975, the U.S. Department of Agriculture (USDA) Soil Conservation Service conducted regional mapping of Oregon's coastal geomorphology to define the extent of its beaches and dunes (USDA, 1975). However, in the intervening 45 years, much has changed on the coast. Of particular importance has been the proliferation of European beach grasses that have stabilized many coastal dune systems, and the growth and northward extension of the New River Spit. Other areas, including Bastendorff Beach and the North Coos Spit have experienced significant erosion since the late 1970s. In addition, new technologies such as light detection and ranging data (lidar) and aerial imagery are now providing unprecedented levels of detail about the elevation and shape of the ground surface, enabling scientists to map the spatial extents of both the contemporary and historical foredune systems more accurately as well as much older inland dunes (IDN). These three factors combined necessitate that the USDA (1975) mapping be updated to reflect contemporary conditions. As a result of the updated mapping, our analyses indicate the following broad-scale changes:

- Overall, areas defined as open sand (OS) have decreased by about 52% since the 1970s, from 9,512 acres to 4,973 acres (3,849 ha to 2,013 ha).
- Accompanying the decrease in OS areas has been an increase in areas classified as younger stabilized dunes (DS). Most of this change can be directly attributed to anthropogenic effects, particularly the introduction of European beach grass (*Ammophila arenaria*) as well as stabilization from shore pine (*Pinus contorta*) and other native plant species.
- Areas subject to existing coastal hazards, which include active foredunes (FDA) and reactivated foredunes (FDR) were found to have increased their spatial extent by 482%; the largest change within this category occurred in the Coos littoral cell (i.e., beaches north of Cape Arago).
- Areas classified as recently stabilized foredune (FD) have seen a marked (~40%) decrease in spatial coverage, decreasing from 627 acres (254 ha) in the 1970s to ~254 acres (103 ha) in 2024.

1.0 INTRODUCTION

The Oregon Department of Land Conservation and Development (DLCD) and Oregon Department of Geology and Mineral Industries (DOGAMI) are collaborating through a National Oceanic and Atmospheric Administration (NOAA) Project of Special Merit study to undertake detailed mapping of beach and dune features along the Oregon Coast. The objective of this report is to describe and document recent (post 1975) changes in beach and dune areas along the Coos County coastline (**Figure 1.1**) that may be subject to future storm-induced erosion, runup, overtopping, and coastal flooding. A secondary objective is to map the spatial distribution of unique coastal geomorphological and eolian features in coastal Coos County. These data are of importance to DLCD and the county in order to improve implementation of Oregon Statewide Planning Goal 18 (DLCD, 2024). Specifically, Goal 18 requires that local jurisdictions adopt a beach and dune overlay zone in their comprehensive plan, which may be used to manage development on or near such features.

Regional mapping of the beaches and dunes of the Oregon coast was originally undertaken between 1972 and 1975 by the USDA Soil Conservation Service (USDA, 1975). The purpose of this mapping was to:

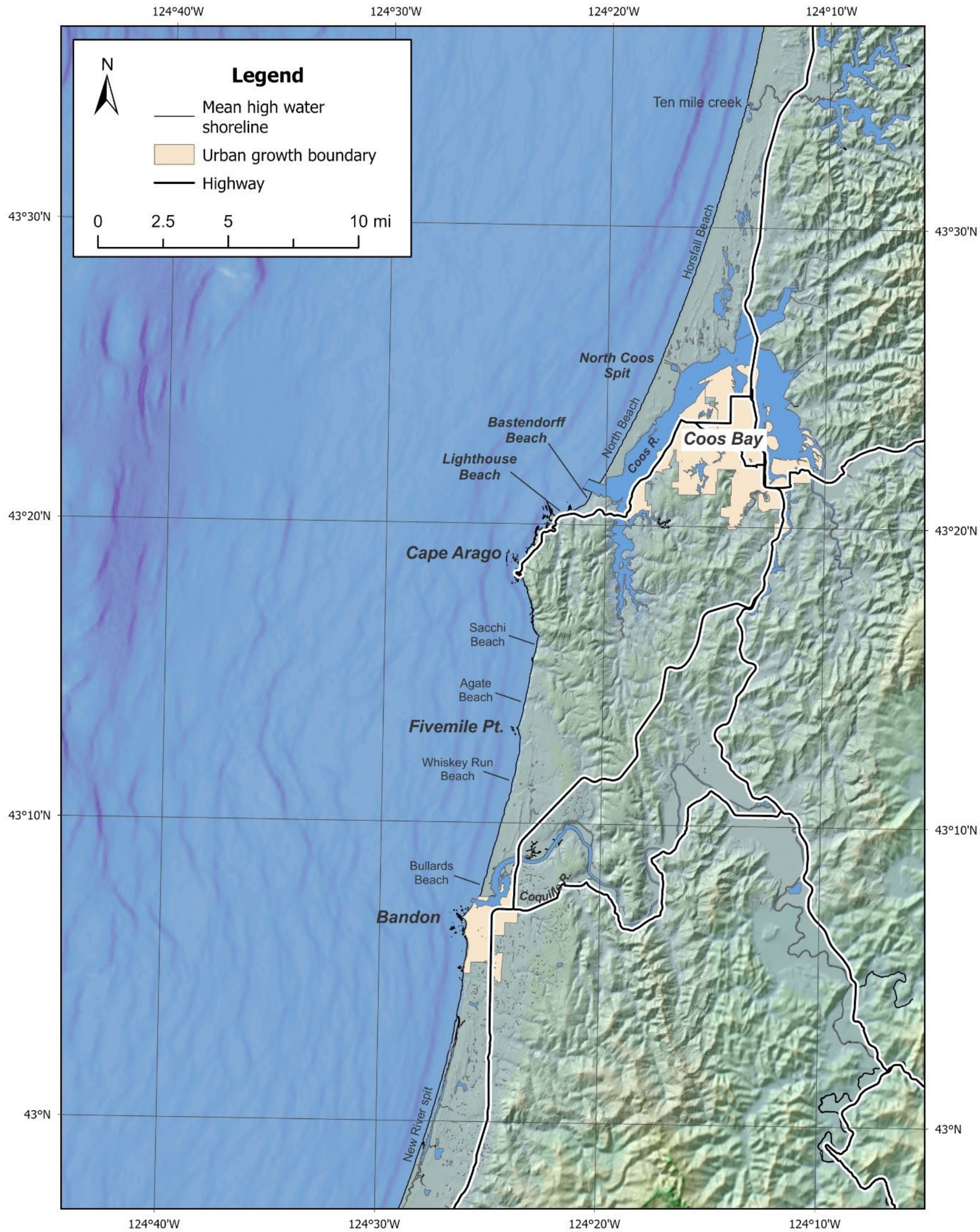
1. Produce inventory resource maps of beaches, sand dunes, and interdune areas along the Oregon Coast
2. Explain components of the inventory
3. Present illustrations and tables summarizing the various mapping dune units
4. Provide interpretations of the map units and their potential use characteristics

The mapping was undertaken using stereoscopic investigations of available aerial imagery, accompanied by extensive fieldwork (USDA, 1975).

Over the past 45 years, much has changed in the landscape along the Oregon Coast, while technologies such as lidar and aerial imagery enable us to visualize the ground surface in unprecedented detail. Accordingly, the original maps are both out of date and lack sufficient spatial resolution to resolve and support current land use planning efforts. Some of the largest changes to have taken place along the Coos County coast include:

- The rapid expansion of European beach grass (*Ammophila arenaria*) has helped to stabilize many dune systems along the outer coast while fundamentally changing the morphology of dunes on the Oregon Coast (Allan 2004; Allan and others, 2009; Zarnetske and others, 2012)
- Shoreline changes at the mouths of estuaries controlled by jetties (Lizarraga-Arciniega and Komar, 1975)
- Spit breaching and dune grading for the purpose of Snowy Plover habitat restoration (Komar and others, 1991)
- Encroachment of human development into foredune and other flood-prone areas (Allan and others, 2009)
- Dune management activities such as foredune grading and planting
- Long-term changes in beach and dune morphology due to coastal erosion and/or accretion (Komar and others, 2001; Ruggiero and others, 2013; Burgette and others, 2023)
- Construction of coastal engineering to mitigate erosion hazards

Figure 1.1. Location map of the Coos County coastline, including key place names.



This report presents summary information and modern maps of beach and dune features along the Coos County coastline, defined in a geographical information system (GIS) and informed by historical and contemporary aerial photographs (e.g., 1939, 1967, and 1998 to 2022), airborne lidar (multiple lidar collections since 1997), coastal erosion mapping (Marra, 2002), FEMA flood modeling (Allan and others, 2012), recent (1997 to 2016) coastal change analyses derived from lidar data (Burgette and others, 2023) and some initial monitoring undertaken in Bandon and Bastendorff Beach by Allan and others (2012). Comprehensive dune mapping by Cooper (1958) and Peterson and others (2007) to map and date Pleistocene and Holocene dunes on the Oregon Coast were also evaluated, and where applicable, used here. Recent geologic mapping of the southern Oregon Coast by Wiley and others (2015) and McClaughry and others (*in press*) provided an important foundation to the updated geomorphic mapping presented in this report and accompanying GIS data. Although the geospatial data used today to define the various mapping units are much improved, the original USDA (1975) nomenclature consisting of 12 core mapping units were retained, and in some cases modified or refined.

2.0 COASTAL GEOLOGY AND GEOMORPHOLOGY

Coos County is located on the southcentral Oregon Coast, between latitudes 43°36′39.33″N (North Coos Spit) and 42°57′15.67″N (central portion of New River Spit), and longitudes 124°29′3.29″W and 123°42′3.04″W. (**Figure 1.1**). The terrain varies from low-elevation sandy beaches and dunes along the coast to elevations over 1,100 m (3,609 ft) inland.

2.1 Geology

The geology of the region is characterized by a wide variety of lithologic units. Along the outer coast the predominant units consist of reworked Late Pleistocene and Holocene surficial sediments (alluvial and marine) that make up the bulk of the shoreline (Beaulieu and Hughes, 1975; Peterson and others, 2007; McClaughry and others, *in press*). Adjacent to these features are a variety of sedimentary bedrock units that are of Tertiary Age (~30–40 million years old (Mya)). These include marine deltaic sandstone and slope mudstone of the Coaledo-Cowlitz Group (e.g., Cape Arago and much of western Coos County), siltstone and mudstone of the Elkton-Yamhill Group (e.g., north of Five Mile Point and adjacent to Cape Arago), mudstone and sandstone of the Nestucca-Hamlet group (e.g., Bastendorff Beach area) (Beaulieu and others, 1975; McClaughry and others, *in press*). Older rocks, characterized by a complex mix of bedded graywacke and sheared mélange of the Jurassic Otter Point Formation of varying thickness make up the shoreline at Bandon (Beaulieu and others, 1975). The ocean-facing bluffs in the vicinity of Bandon are 40 ft–85 ft (12 m–26 m) high and were formed from erosion into the Jurassic Otter Point Formation, are described by Beaulieu and others (1975) as a thick assemblage of resistant sandstone, siltstone, conglomerate, and volcanic rocks with random blocks of blueschist (e.g., the north end of Bandon). Along the western flanks of the Coast Range are a series of marine terraces (Baldwin and others, 1973) with ages that range from ~80 ka to >200 ka (thousand years) (Muhs and others, 1990; Kelsey and others, 1996).

Between Five Mile Point and Cape Arago, the beaches are backed by a sequence of marine terraces formed from erosion into sandstone units (Coaledo Formation) and siltstone (Elkton Formation). The marine terraces range in height from 66 ft–150 ft (20 m–46 m) and have ages that range from 80 ka to 105 ka. Midway along this stretch of coast, Cape Arago formed from wave erosion into the Coaledo Formation. North of Cape Arago (**Figure 1.1**) the shoreline is also composed of Late Pleistocene sand that makes up the North Coos Spit and Horsfall Beach. Landward of the Coos estuary mouth in the communities of Barview and Empire, the area is characterized by marine terraces that have been cut into sandstones of the Coaledo Formation. Abutting against or overlying the marine terraces are a series of dune fields that were deposited between 70 ka and 30 ka, while still younger dunes formed between 8 ka to 3 ka (Peterson and others, 2007).

2.2 Coastal Geomorphology

The Coos County coastline is approximately 59 mi (95 km) in length (**Figure 1.1**) and varies in its geomorphology from broad, low-sloping sandy beaches backed by dunes (North Coos Spit), mixed sand and gravel barrier beaches (e.g., New River Spit), bluff-backed beaches and dunes (e.g., Whiskey Run) and the cliffs of Cape Arago (Komar and others, 2001; Allan and others, 2012). Within the study area, the Cape Arago headland provides a natural barrier to alongshore sediment transport (Komar, 1997), effectively dividing the Coos County coastline into two dominant littoral cells within which sediment transport is constrained (**Figure 1**). These include:

- Bandon Cell (~31 mi (~51 km)) extends from Cape Blanco in the south (northern Curry County) to Cape Arago in the north.
- Coos Cell (~55 mi (~ 88 km)) extends from Cape Arago north to Heceta Head.

Of note, the Coos Cell is the largest littoral cell on the Oregon coast, spanning the northern half of Coos County, all of Douglas County, and much of the southern half of the Lane County shoreline. Both littoral cells may be further divided into a series of smaller subcells due to the presence of the Coquille and Coos estuaries, both of which have been stabilized with jetties (**Figure 1.1**).

2.3 Sediment Sources and Budgets

The formation of beaches and dunes is dependent on three requirements: a sufficient supply of sediment, a prevailing wind, and obstacles to trap the sand, such as woody debris, vegetation, and microtopography. The speed and direction of the wind is especially important. Strong winds (>9.7 knots (>5 m/s)) are capable of entraining and mobilizing dry sand (Bauer and others, 1990), which are then transported across the beach and upslope into the developing dunes or onto older marine terraces where the sand becomes trapped by plants; stronger winds >29 knots (>15 m/s) are required to entrain wet sand (Bauer and others, 1990). The removal of sand onto marine terraces constitutes a net loss of sediment from the littoral system. Where vegetation is absent or sparse, the dunes drift about in response to the prevailing wind, where they form a variety of aeolian landforms, including transverse, parabolic, and longitudinal dunes. Accordingly, wind direction is critically important as it governs the types of dunes that could develop.

Whether a shoreline is eroding or accreting is dependent on the budget of sediments within the littoral system (Komar, 1998). This concept reflects a balance between sediment inputs and losses. Sediment inputs may be derived from a variety of potential sources, including the erosion of coastal bluffs and dunes, long-shore sediment transport, as well as from rivers. Sediment may be removed or lost from the littoral system through a variety of factors, including anthropogenic extraction of sand (e.g., dredging and/or mining) and the erosion of sediment from beaches and their removal into deeper water in response to the effects of extreme storm waves and in the long-term because of sea level rise. Where net sediment inputs exceed losses, beach and dune aggradation may occur and the coast tends to advance seaward. Conversely, where sediment losses exceed inputs, the coastline retreats. Hence, in areas subject to a net gain in sediment, the development of broad beaches and dunes tends to provide a natural and effective coastal protection, and at a significantly lower cost when compared with coastal engineering structures (Woodhouse, 1978; Komar, 1998).

Two major river systems traverse the county, eventually reaching the coast. The southern part of the county (south of Cape Arago) is drained by the Coquille River, which reaches the coast at Bandon, while the northern part of the county is drained by the Coos River (**Figure 1.1**). Both of these river systems have the potential to carry relatively large amounts of sediment to the coast. Smaller creeks and rivers are interspersed between the major rivers, including New River and Ten Mile Creek. However, due to their negligible river flows neither the New River nor Ten Mile Creek contribute much "beach" sand to the coastal environment.

Much of the sand present on the beaches of Oregon consists of grains of quartz and feldspar, with smaller quantities of heavier minerals, including pink garnet, hypersthene, hornblende, and augite (Clemens and Komar, 1988). In Coos County, the concentrations of augite and hornblende are likely due to erosion into Tyee Formation sandstone that makes up much of eastern Coos County. This suggests that at the time of deposition, rivers and streams were actively carrying these sediments out to the coast where they mixed with other sediments. The garnet in the beach sand is sourced from the Klamath Mountains in southern Oregon/northern California (Clemens and Komar, 1988).

The contemporary beach and dune system of Coos County is young in geologic terms, having begun to form ~5,000 years ago, as the rate of post-glacial sea level rise slowed as it approached its current level (Komar, 1997; Peterson and others, 2007). As the ocean approached its present level, the prominent headlands would have begun to interrupt sediment transport, leading to the formation of barrier spits and beaches within the headland-bounded littoral cells.

Prior to the 1940s, many of the barrier spits were devoid of significant vegetation. With the introduction of European beach grass (*Ammophila arenaria*) and its subsequent proliferation along the Oregon Coast, the dunes and barrier spits eventually stabilized. The product today is an extensive foredune system, which consists of large, stable dunes containing significant volumes of sand. According to the Bureau of Land Management (BLM, 1995), European beach grass was introduced to the Bandon area in ~1940. Accompanying the stabilization of the dunes, humans have settled on them, building in the most desirable locations, typically on the most seaward foredune or along the edges of cliffs.

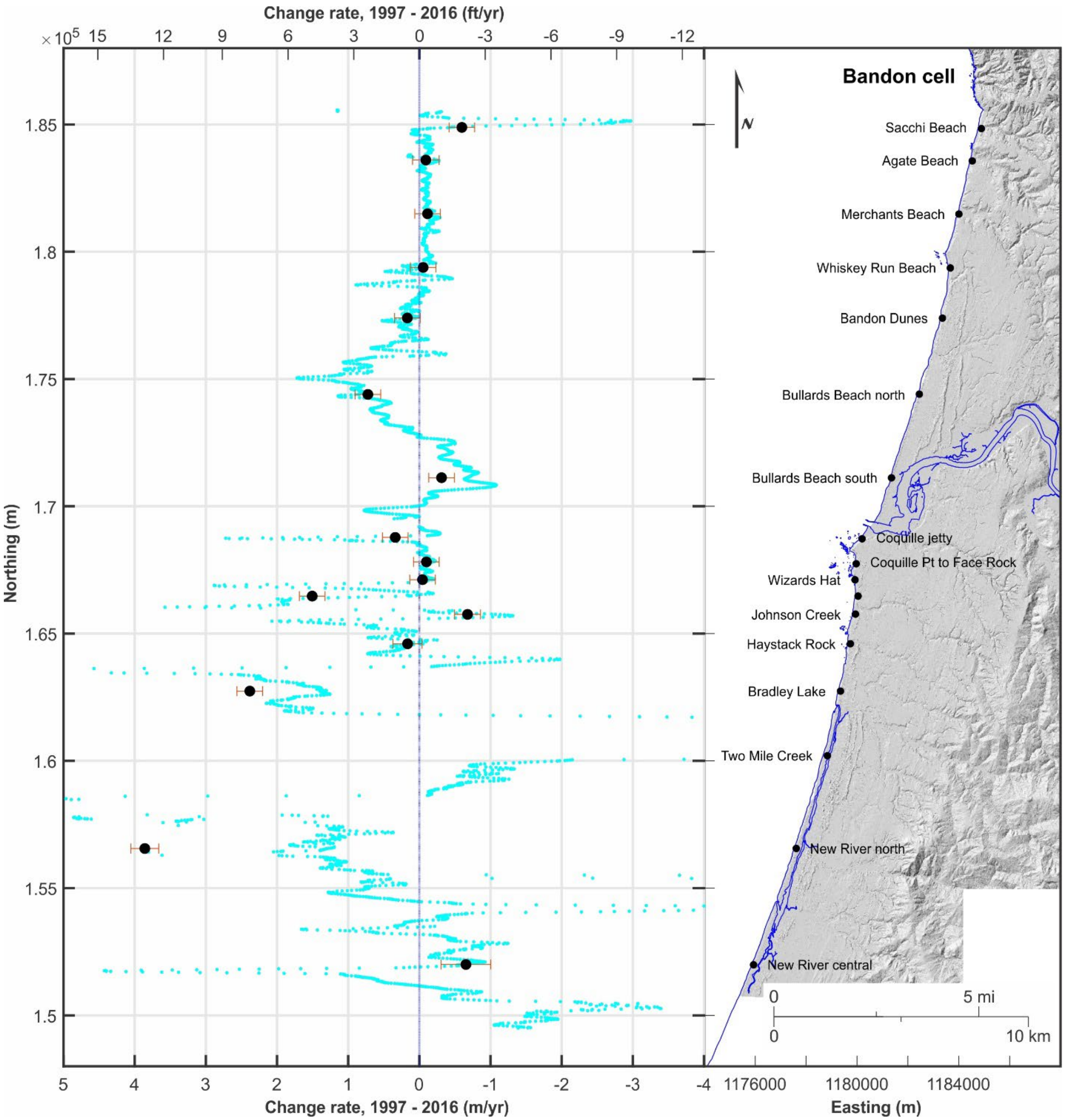
An assessment of the coastal sediment budget in Coos County has never been undertaken. Nevertheless, we can speculate on aspects of the sand budget using coastal change data. **Figure 2.1** is from Burgette and others (2023) and depicts coastal changes in Coos County derived from lidar measurements made between 1997 and 2016. The changes shown in **Figure 2.1** are measured near the bluff/dune toe at an elevation of 20ft (6 m).

In the far south on the New River Spit (**Figure 2.1**), the coastal response exhibits large fluctuations between erosion (-1.6 to -9.8 ft/year (~-0.5 to -3 m/year)) and accretion (1.6 to >13 ft/year (~0.5 to >4m/year)). Such fluctuations are likely due to management activities along the New River Spit that include periodic dune grading for Snowy Plover habitat, as well as breaching of the barrier to allow the river to drain. Furthermore, because the beach is composed of mixed sand and gravel, it produces a steeper, reflective beach that tends to be more responsive to storm waves, resulting in large horizontal excursions of the shoreface.

North of Two Mile Creek (**Figure 2.1**) the beach is mostly dominated by accretion, which decreases northward toward Coquille Point at Bandon. Within this subcell, the sediments are derived from two predominant sediment sources: erosion of Quaternary alluvial terraces at Blacklock Point, north of Cape Blanco (generally yielding gravel to coarse sand), and from the Coquille River (predominantly sand) (Komar and others, 2001). According to Komar and others (2001), the erosion of alluvial sediments at

Blacklock Point, and its northward transport, accounts for the migration of the New River mouth, which migrated northward between 1967 and ~2000 at a rate of ~0.1 mi/year (~0.16 km/year). Accretion also dominates the area north of Face Rock and south of the Coquille South Jetty (**Figure 2.1**), where the shoreline has advanced seaward following construction of the Coquille jetties (Lizarraga-Arciniega and Komar, 1975; Komar and others, 1991).

Figure 2.1. Coastal change rates and patterns for the period 1997 to 2016 for the Bandon littoral cell, Coos County. Cyan line reflects a 164 ft (50 m) smoothing of the individual transects, while the solid circles (with uncertainty) depicts the mean change for the identified study reach. Negative values indicate erosion, while positive values denote accretion. Figure includes both English and Metric units.

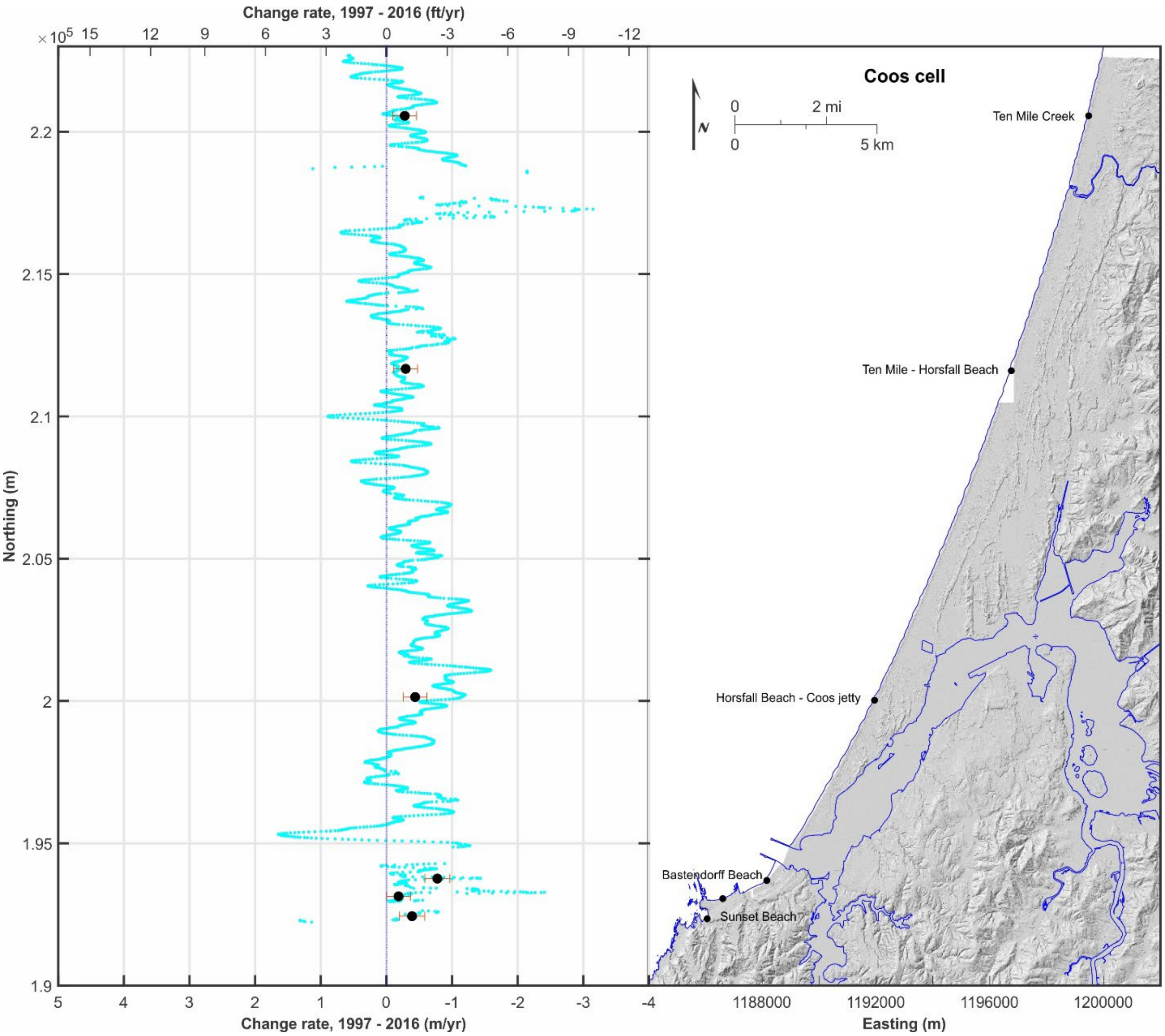


North of the Coquille River mouth (**Figure 2.1**), a 4.3 mi-long (7 km) spit has formed (Bullards Beach) that abuts against the 80-ka terrace in the north along Whiskey Run Beach. Beach sediments present here are probably mostly derived from the Coquille River and, to a lesser degree, from Blacklock Point in the far south. Dune erosion dominates the southern 2.2 mi (3.5 km) of Bullards Beach before transitioning to accretion, which progressively increases northward for another 1.2 mi (2 km). From Bullards Beach north (**Figure 2.1**), the rate of accretion begins to progressively decrease toward the Bandon Dunes area. From Whiskey Run Beach to Cape Arago, the lidar analysis indicates relatively slow rates of erosion, calculated at ~-0.33 ft/year (~-0.1 m/year). From the patterns of coastal change and a sediment budget perspective, these data suggest that the south end of Bullards Beach is presently supplying sediment to areas to its north. Hence, this would indicate that the Coquille River is presently not supplying much sediment to the Bandon littoral cell.

North of Cape Arago (**Figure 2.2**), the coastline is mostly dominated by erosion, which vary from average rates of ~-1.3 ft/year (~-0.4 m/year) to rates exceeding -3.3 ft/year (-1 m/year). These data strongly point to a lack of sediment input from the Coos River (the primary sediment source) that could have future implications for management of the North Coos Spit. The US Army Corps of Engineers (USACE) presently dredges sand from the navigation channel within Coos Bay, which is then disposed of in deep water west of the Coos Bay entrance. Given ongoing efforts by the USACE, state agencies, and local partners to address sediment losses in the Columbia River littoral cell via Regional Sediment Management (Greenwood and others, 2011), consideration of this approach in the Coos littoral cell may also be warranted.

In summary, the contemporary beaches of Coos County are thought to receive little riverine sediment at the open coast today; most of the sediment input is likely derived from erosion of select backshore areas along the coastline. Although coastal erosion is evident throughout the area, development on active foredunes is fortunately limited, and, as a result, the use of coastal engineering in Coos County to protect property and infrastructure is relatively minor when compared with other coastal counties (e.g., Tillamook County).

Figure 2.2. Coastal change rates and patterns for the period 1997 to 2016 for the Coos littoral cell, Coos County. Cyan line reflects a 164 ft (50 m) smoothing of the individual transects, while the solid circles (with uncertainty) depicts the mean change for the identified study reach. Negative values indicate erosion, while positive values denote accretion. Figure includes both English and Metric units.



3.0 METHODS

Our approach to mapping beaches and dunes in Coos County closely follows the work of Allan (2020) in Tillamook County. We used GIS to evaluate the existing beach and dune overlay zone compiled by DLCD from the original USDA (1975) mapping. These data were used to establish the baseline on which the updated GIS layer was developed. **Table 3.1** identifies the key beach and dune classifications developed by the USDA (1975) and retained in our updated mapping. **Table 3.1** also includes their accompanying DLCD classification (where applicable). Allan (2020) defined six new classifications that are included in **Table 3.1**:

- Artificial Active Foredune (AFDA) – An artificial foredune constructed from geotextile sand bags and planted with dune grass. This category is not relevant in Coos County.
- Reactivated foredune (FDR) – These include areas where coastal processes are presently eroding into the previously stabilized foredune (FD). We identify a few sites south of Bandon that fall into this category.
- Coastal Landslides (LD) – No new landslide features were mapped in Coos County.
- Fluvial and Estuarine Deposits (FED) – Defined from geologic mapping compiled in the digital Oregon Geologic Database Compilation (OGDC-7) (Franczyk and others, 2020; McClaughry and others, *in press*), and from lidar mapping presented as part of this report.
- Coastal Lakes (LK).
- Wetlands (WL) – These data stem from the National Wetlands Inventory (https://www.fws.gov/wetlands/) compiled by the U.S. Fish and Wildlife Service (USFWS).

In addition to the above, we developed several additional classifications from our Coos County mapping. These include the following:

- Coastal terrace (CT) – Although we retain the original coastal terrace classification (CT), we have expanded this to better define different coastal terrace groups (e.g., CT, CT2, CT3, and CT4) based on previous geological mapping and age dating.
- Inland dunes (IDN) – These sites reflect dune features that have formed inland from the coast, without any prior assumptions on how they formed.
- Pond (POND) – We include a pond designation to capture smaller water bodies, particularly those water features that are probably ephemeral in nature (e.g., the many ponds present in open sand areas out on the North Coos Spit).
- Developed lands (DEV) – There are several areas in Coos County where significant development has occurred by reclaiming fill areas, major roads, the Coos airport, and several large industrial development sites on the north Coos Spit.
- Rock (ROCK) – We include this to better capture areas characterized by sea stacks or resistant rocks, such as basalt outcrops.

These latter classifications simply help to better define additional geographic and geologic features evident along the Coos County coastline but not explicitly addressed by USDA (1975). Definitions of the original mapping nomenclature are described by USDA (1975) and are not repeated here.

Table 3.1. Beach and dune overlay zone nomenclature (after USDA, 1975).

Associated Dune Category	Inventory Classification	DLCD Classification	Mapping Unit
Active Beach and Foredune	Beach	Beach	B
	Active foredune	Foredune, Active	FDA
	Active dune hummocks	Hummocks, Active	H
Recently Stabilized Dunes	Recently stabilized foredune	Foredune, Conditionally Stable	FD
	Inland foredune/inland stabilized dune		IFD
	Dune complex	Dune Complex	DC
	Younger stabilized dunes	Dune, Younger Stabilized	DS
Older Stabilized Dunes	Older stabilized dunes	Dune, Older Stabilized	ODS
Inland Dunes	Open dune sand	Dune, Active/Dune, Parabolic	OS
	Open dune sand conditionally stable	Dune, Conditional Stable	OSC
	Active inland dune	Dune, Active	AID
Interdune Forms	Wet interdune	Interdune	W
	Wet deflation plain	Deflation Plain	WDP
	Wet mountain front		WMF
Estuary	Wet surge plain		WSP
	Wet flood plain		WFP
Other	Coastal terrace		CT, CT2, CT3, CT4
	New:		
	Artificial active foredune		AFDA
	Developed areas		DEV
	Reactivated foredune (subject to erosion/flooding)		FDR
	Fluvial and estuarine deposits		FED
	Coastal landslide		LD
	Inland dunes		IDN
	Lake		LK
	Pond		POND
	Rock		ROCK
	Jetty		JT
	Wetland		WL

3.1 Previous Coastal Hazard Studies

Because the foundation of the beach and dune overlay zone reflects those areas subject to active coastal change (either erosion or accretion) and/or may be impacted by storm wave runup, overtopping, and flooding, the revised mapping undertaken here was strongly guided by existing information available from a number of recent coastal investigations. These include coastal erosion hazard studies (Marra, 2002), recently completed geomorphic analyses, erosion analyses, coastal flood modeling, and mapping (Allan and others, 2012; Burgette and others, 2023).

3.2 Lidar

We mapped beach and dune morphology largely from lidar data collected by DOGAMI in 2008-2009. Lidar is a remote sensing technique consisting of x, y, and z values of land topography that are derived using a laser ranging system and geo-located using an onboard Real-Time Kinematic Differential Global Positioning System (RTK-DGPS). The lidar data have a vertical accuracy of ~0.3 ft (~0.1 m), while the horizontal accuracy is ~3 ft (~1 m). Because lidar collected by DOGAMI consisted of multiple laser returns, processing of these data enabled the production of bare-earth rasters of the ground surface; i.e., the vegetation was able to be stripped off, leaving just the ground elevation.

Analyses of these data were previously undertaken by Allan and others (2012) to define various beach, dune, and bluff morphological characteristics (e.g., tidal datum-based shorelines, cross sections, and a variety of geomorphic features, including the beach-dune toe, foredune toe, dune crest, dune heal, bluff toe, and bluff crest). Additional information concerning post-2009 beach and shoreline changes were determined from lidar collected in 2016 on behalf of the U.S. Geological Survey and from modern (2022) National Agriculture Imagery Program (NAIP) aerial images of the coastline.

3.3 Aerial Imagery

Although lidar is the foundation on which the geomorphic mapping is based, valuable geomorphic information may also be gleaned from analyses of repeat aerial photographic imagery of the coast collected over the last century.

The earliest compilation of aerial photographs of the Oregon Coast was undertaken in 1939 by the USASCE. Unfortunately, the images are simply stereo (pairs) images that have never been rubber sheeted or orthorectified. Orthorectification is an approach used to process imagery to account for optical distortions (e.g., tilt or relief) with the goal of yielding a planimetrically correct image that is fixed to a geospatial coordinate system, enabling the data to be viewed and analyzed in GIS. However, this process is expensive to perform and is very time intensive. To that end, we used simple tools in GIS to rubbersheet the images to their approximate position.

In order to rubber-sheet the images, we processed the 1939 aerial photographs using the georeferenced tools within Esri® ArcGIS. This was accomplished by identifying common ground control points (e.g., road junctions, bridges, buildings, rock outcrops) that can be identified in the 1939 images and in contemporary (1994, 2000, 2004, 2009, 2014, 2016, 2018, 2020, and 2022) orthorectified images (or lidar) collected for the State of Oregon. Using this approach, seven 1939 photos were able to be georeferenced for Coos County, enabling comparisons to be made against modern images of the coastline and from lidar. These data were extremely useful for understanding early historical changes in the morphology of the barrier spits, including the proliferation of dune grasses on the dunes and the subsequent stabilization of the dunes.

Imagery acquired by the Oregon Department of Transportation (ODOT) in 1967 (Ruggiero and others, 2013) was also examined. These aerial photographs extend along the entire coast of Oregon and consist of 1,611 photographs along roughly 50 to 60 flight paths for the open ocean beaches (no bays). The photographs were taken at 1:6,000 scale, such that 1 inch (2.5 cm) on the photographs is 500 ft (152 m) on the ground. The images were originally processed and orthorectified for DOGAMI by the Washington Department of Ecology using Leica Photogrammetry Suite, controlled by a digital elevation model (DEM) developed from 2002 lidar data.

3.4 'Wet' Areas

The USDA (1975) beach and dune mapping identified many areas among the dunes as either *Wet Deflation Plain*, *Wet Mountain Front*, or *Wet Interdune*. These sites reflect areas characterized by high water tables such that the areas are either underwater or are seasonally covered in water. In the large majority of cases, these classifications are analogous to areas delineated as "wetland." To that end, we downloaded the USFWS National Wetland Inventory (USFWS, 2025) for Oregon, which were then examined in a GIS. Identified wetlands were added to the revised beach and dune overlay, since these areas delineate many of the areas that contain high water tables or are permanently wet.

3.5 Estuary Shoreline and Storm Flood Water Level

The USDA (1975) beach and dune mapping includes two additional geospatial attributes defined as the *Wet Surge Plain* and *Wet Flood Plain*. The *Wet Surge Plain* was defined by USDA (1975) as the area between the lowest and highest tides within an estuary and delineated as the drift line; no additional explanation is provided as to how the drift line was identified, such as from aerial imagery or early National Ocean Service (NOS) topographic "T" Sheets. The *Wet Flood Plain* is essentially that area that can be reasonably expected to be inundated under a flood condition. Again, the USDA did not provide specific information as to how it was mapped.

For the purposes of the revised mapping, a more refined approach involved adopting a tidal datum-based shoreline and then extrapolating the defined tidal shorelines from lidar. For the *Wet Surge Plain*, we used an elevation of 7.0 ft (2.13 m, relative to NAVD88), which equates to the Mean Higher High Water (MHHW) tidal datum defined for the Charleston tide gauge station by NOAA NOS. The NOS (2023) defines MHHW as "the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch (NTDE)" and is a reasonable approximation for the *Wet Surge Plain*. The NTDE is a 19-year period used by NOAA over which tide observations are taken and reduced to obtain mean values (e.g., MHHW) for various tidal datums. The current NTDE spans the period from 1983 through 2001 and is revised every 20 to 25 years to account for sea level changes (NOS 2023). For the *Wet Flood Plain*, we used an elevation of 10.7 ft (3.26 m, relative to NAVD88), which equates to the highest observed tidal[1] elevation at the same gauge. This latter elevation reflects a storm flood, whereby the elevated water levels are a function of the combined effects of high tide, storm surge, and riverine flooding. In both cases, contours for the predefined elevations were extracted from 2009 DOGAMI lidar data.

In a number of areas, changes in the configuration of the estuary have occurred since the lidar data were collected in 2009, necessitating a need to adjust the boundary of the *Wet Surge Plain*. This was achieved by using recently collected digital orthoimagery (e.g., 2022) to evaluate any spatial changes that may have ensued in the estuary shoreline between 2009 and 2022.

3.6 Marine Terrace Mapping

A series of uplifted marine terraces have been mapped and described for many areas along the Oregon Coast, while detailed investigations of uplift rates and terrace ages include work undertaken by Muhs and others (1990) between Cape Blanco and Coquille Point, Kelsey and others (1996) on the central Oregon Coast, recent work by McKenzie and others (2022) in the Newport area, and work by Padgett and others (2019) in northern California at Trinidad Head. The terraces capture the effects of global eustatic changes

[1] At Ten Mile Creek in northern Coos County, we used a 10.9 ft (3.31 m) extreme tide level contour.

in sea level that is superimposed on long-term tectonic uplift and local faulting (McKenzie and others, 2022). Kelsey and others (1996) dated several of the marine terraces and identified ages of 80 ka, 105 ka, and 125 ka, respectively. Inclusion of information on the spatial extent of marine terraces in the Coos County beaches and dunes updated mapping is relevant because the terraces are such a major geomorphic feature in this part of the coast. Furthermore, the terraces include areas where many of the older stabilized dunes have formed.

To assist with delineating potential marine terraces and boundaries, we used the semi-automated classification model (SCM) approach of Bowles and Cowgill (2012). Since marine terraces are characterized by relatively low slopes (1°–6°, but may be as high as 15° as the terraces age) and relatively smooth surfaces, the SCM approach was developed to evaluate both topographic components. Hence, the goal of the SCM processing is to broadly delineate those areas characterized by both low slope and relief (Bowles and Cowgill, 2012), which may be evaluated further using more rigorous field-based mapping techniques.

For this study, we used bare earth lidar collected by DOGAMI in 2008–2009. The data were initially regridded using a 6 ft (1.8 m) cell size consistent with Bowles and Cowgill (2012) and McKenzie and others (2022); a cell size of 12 ft (3.6 m) was also used to evaluate a smoother product. A slope map was first generated using a 3 x 3 window, producing slope values for each DEM cell. The slope map was then clipped by setting all slopes >15° to null, and then normalized by dividing the slope values by 15°, producing a DEM with values ranging from zero to one. Having performed the initial slope calculations, the surface roughness (standard deviation of the slope) was then determined using the same 3x3 window; note that larger values are synonymous with greater roughness. We clipped our roughness maps by setting all values >4 to null, consistent with Bowles and Cowgill (2012) and McKenzie and others (2022), and then normalized these data by dividing the values by four. Finally, the SCM was calculated by multiplying both the slope and roughness DEMs by 0.5 and then combining the results (Equation 1 in Bowles and Cowgill, 2012) to yield values that range from zero to one. Using this approach, SCM values close to zero indicate both low slope and roughness, with values <0.3 found to most closely approximate known marine terraces (Bowles and Cowgill, 2012; McKenzie and others, 2022).

Final mapping of the marine terraces was undertaken manually, guided by the SCM approach, a hillshade image from the bare-earth DEM, orthorectified aerial images of Coos County, and previous geologic mapping of the area (e.g., Newton and others, 1980; McClaughry and others, *in press*).

4.0 RESULTS

The primary results associated with this latest mapping effort are contained in an Esri geodatabase "Coos_Dune_Revised_2024.gdb". The feature dataset file "Beaches_and_Dunes" contains the updated geospatial information and includes the following key attributes: "Codes", "Feature", "Notes", "Notes_additional", "Coastal_hazard", "Location", and "Cell". This contrasts with the original geospatial overlay, which only included information specific to the codes and feature class. In the updated overlay, "Codes" and "Features" (**Table 3.1**) are identical to information included in the original USDA (1975) mapping. The "Notes" attribute includes generalized information about the respective feature (e.g., pre- or post-jetty foredunes), coastal geomorphic notes (e.g., former foredune), Quaternary coastal terrace designation (Qmtw (Whiskey Creek terrace), Qmtp (Pioneer terrace), Qmtd (Seven Devils terrace), Qmtm (Metcalf terrace)), and ephemeral ponding. The "Notes_additional" attribute contains secondary information mainly relating to the Quaternary marine terrace features. The "Coastal_hazard" attribute includes specific hazard information unique to that feature, including whether it is subject to current wave erosion, runup, and overwash and inundation processes; may be impacted in the future due to sea level rise (either erosion and/or flooding) associated with climate change; or is subject to aeolian wind processes. Location names are included where relevant in the "Location" attribute. The "Cell" attribute categorizes the geomorphic units by littoral cell or subcell. Finally, source information (e.g., mapping data from McClaughry and others (*in press*) or from mapping as part of this study) is also provided in the GIS.

Here, we will briefly describe and summarize some of the key changes that have taken place along the Coos County shore. The approach taken is to focus initially on broad scale changes that can be observed in the landscape, followed by a series of brief qualitative descriptions of changes identified within the Bandon and Coos littoral cells identified in **Figure 1.1**.

4.1 Countywide Beach and Dune Changes

Figure 4.1 presents pie charts depicting changes in the coastal geomorphology of Coos County from the 1970s to the present. Data inputs used to generate the pie charts are derived from the change in surface area of the respective geomorphic unit over time; note that USDA (1975) defined "Beach" for only a small area adjacent to Charleston Harbor and ignored all other areas. The overall focus of **Figure 4.1** is a subset of the suite of USDA classifications identified in **Table 3.1**, with emphasis on those geomorphic units closest to the beach and, as such, directly dependent on coastal and aeolian processes for their formation and evolution. These units include the active foredune (FDA), reactivated foredune (FDR), and recently stabilized foredune (FD). The reason for focusing on these specific units is that they are of greatest significance under Goal 18.

Allan (2020) evaluated changes in dune complexes (DC), hummocks (H), and areas characterized as having open sand (OS) in Tillamook County. Since dune complexes and hummock terrain are not present in the updated Coos County mapping, we compare changes in the acreage of recently stabilized dunes (DS), areas characterized as 'wet' (interdune (W), deflation plain (WDF), mountain front (WMF) and wetlands (WL)) and open sand (OS). The values listed for each pie chart in **Figure 4.1** reflect the acreage associated with the six units used here, while the proportions of each pie graphic are based on the sum of the combined acreage of the six units. Thus, **Figure 4.1**'s significance is less about the actual proportions (which may be of interest), and more about the degree of change that has taken place from one time to the next. **Table 4.1** includes cell-specific information of the actual change in acreage over the time period for each unit, and expressed as a summary total for the entire county; results shown in **Table 4.1** reflect a smaller subset of the suite of units defined in **Table 3.1**. It is important to note that the total area mapped in this study decreased by ~3,600 acres (1,456 hectare (ha)) when compared with the USDA (1975) mapping. This change mainly reflects a larger area defined as older stabilized dunes (ODS) mapped by the USDA that are located on marine terraces farther landward of the latest mapping. Most of this is accounted for south of Bandon and in the populated areas that include Barview, Empire, and North Bend, adjacent to Coos Bay.

A few notable changes are worth mentioning that stand out in **Figure 4.1** and **Table 4.1**. The largest change is the significant decrease (52%) in areas characterized as open sand (OS). Conversely, recently stabilized dune areas expanded by 226%. However, much of this change is likely due to the 40% decrease in areas classified as 'wet' (interdune (W), deflation plain (WDP), mountain front (WMF) and wetlands (WL)). Finally, it is worth noting that active foredune areas expanded significantly (~480%) between the 1970s and 2024.

We can perform the same comparison as shown in **Figure 4.1** but now focused on the two littoral cells (**Figure 4.2**). Focusing first on the Bandon cell, we can see that there has been a significant increase (313%) in areas characterized by active foredunes (147 acres to 459 acres (60 ha to 186 ha)). Conversely, areas defined as open sand and 'wet' have seen a dramatic decrease (2,536 acres to 305 acres (1,026 ha to 123 ha) and 3,558 to 685 acres (1,440 ha to 277 ha) respectively) over the past 50 years. With losses in areas characterized by open sand, the Bandon cell has seen a 212% increase in younger stabilized dune areas.

In the case of the Coos cell, **Figure 4.2** indicates that there has also been a considerable increase (1,400%) in areas characterized by active foredunes (25 acres to 364 acres (10 ha to 147 ha)). Areas defined as open sand and 'wet' have decreased by 33% and 50% respectively, while younger stabilized dune areas have increased by 233%.

Figure 4.1. Pie charts depicting Coos County countywide changes over time for select coastal geomorphic units. Values shown for each pie reflect the acreage of that unit. Note: Total mapped areas for the 1970s (45,497 acres (18,411 ha)) and for 2024 (41,849 acres (16,935 ha)) differ by 3,648 acres (1,476 ha).

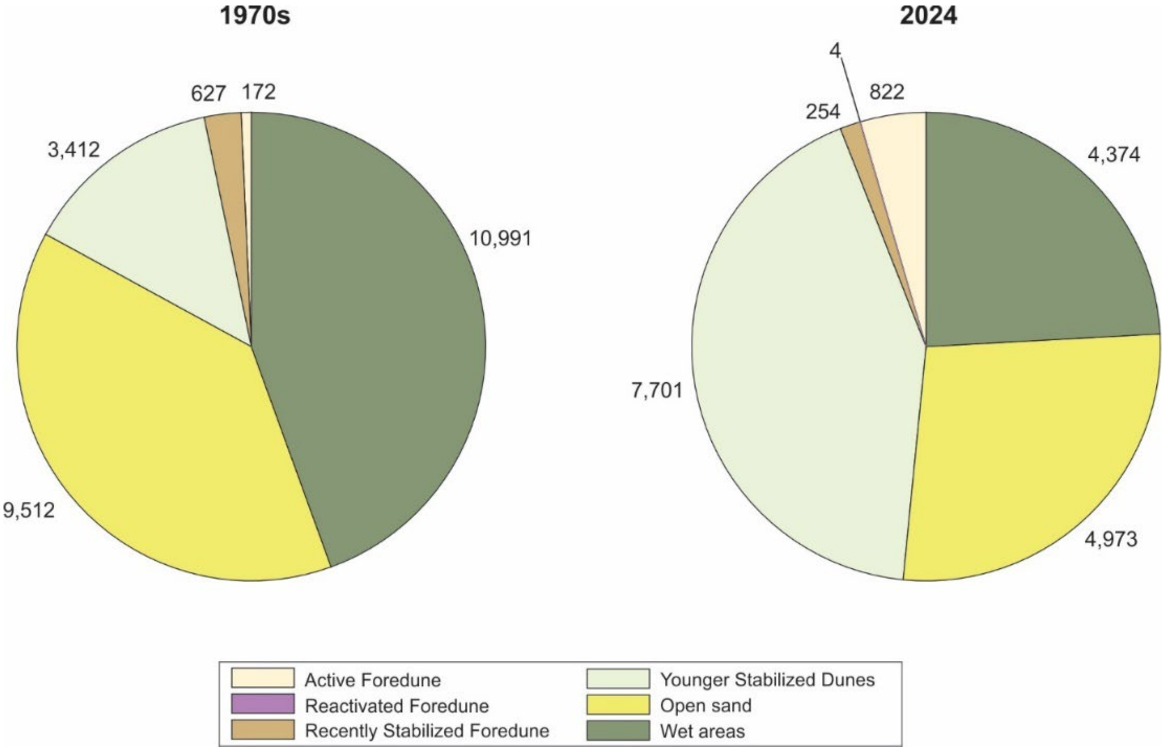
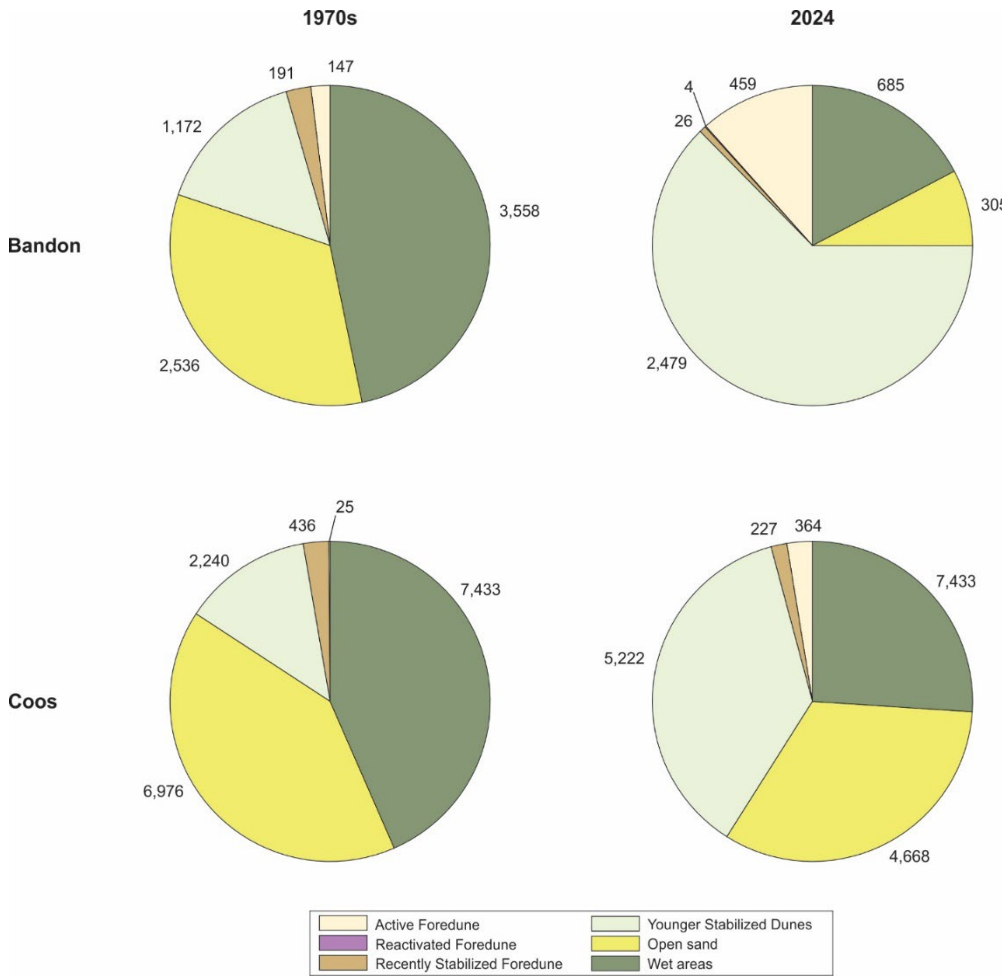


Table 4.1. Change in acreage of various coastal geomorphic units identified in Coos County from the 1970s to 2022.

Code	Description	Bandon	Coos	Total
B	Beach	1,588.4	1,356.7	2,945.1
FDA	Active Foredune	312.6	338.6	651.2
FDR	Reactivated Foredune	4.2	0	4.2
FD	Recently Stabilized Foredune	-164.8	-208.9	-373.7
DC	Dune Complex	-75.8	-67.6	-143.4
H	Hummocks	-10.0	-257.5	-267.5
DS	Younger Stabilized Dunes	1,306.7	2,982.6	4,289.3
OS	Open Sand	-2,231.2	-2,308.6	-4,539.9
W	Interdune	-1,090.6	-3,744.8	-4,835.4
WDP	Wet Deflation Plain	-1,781.7	-3,024.9	-4,806.6
WMF	Wet Mountain Front	0	-196.7	-196.7
WL	Wetland	0	3,222.4	3,222.4

Figure 4.2. Pie charts depicting coastal geomorphic unit changes defined for each Coos County littoral cell. Values shown for each pie reflect acres of land, drawn from Table 4.1. Pie proportions are a function of the combined value of the six units presented in the figure and their sums are not necessarily the same from 1970 to 2022.



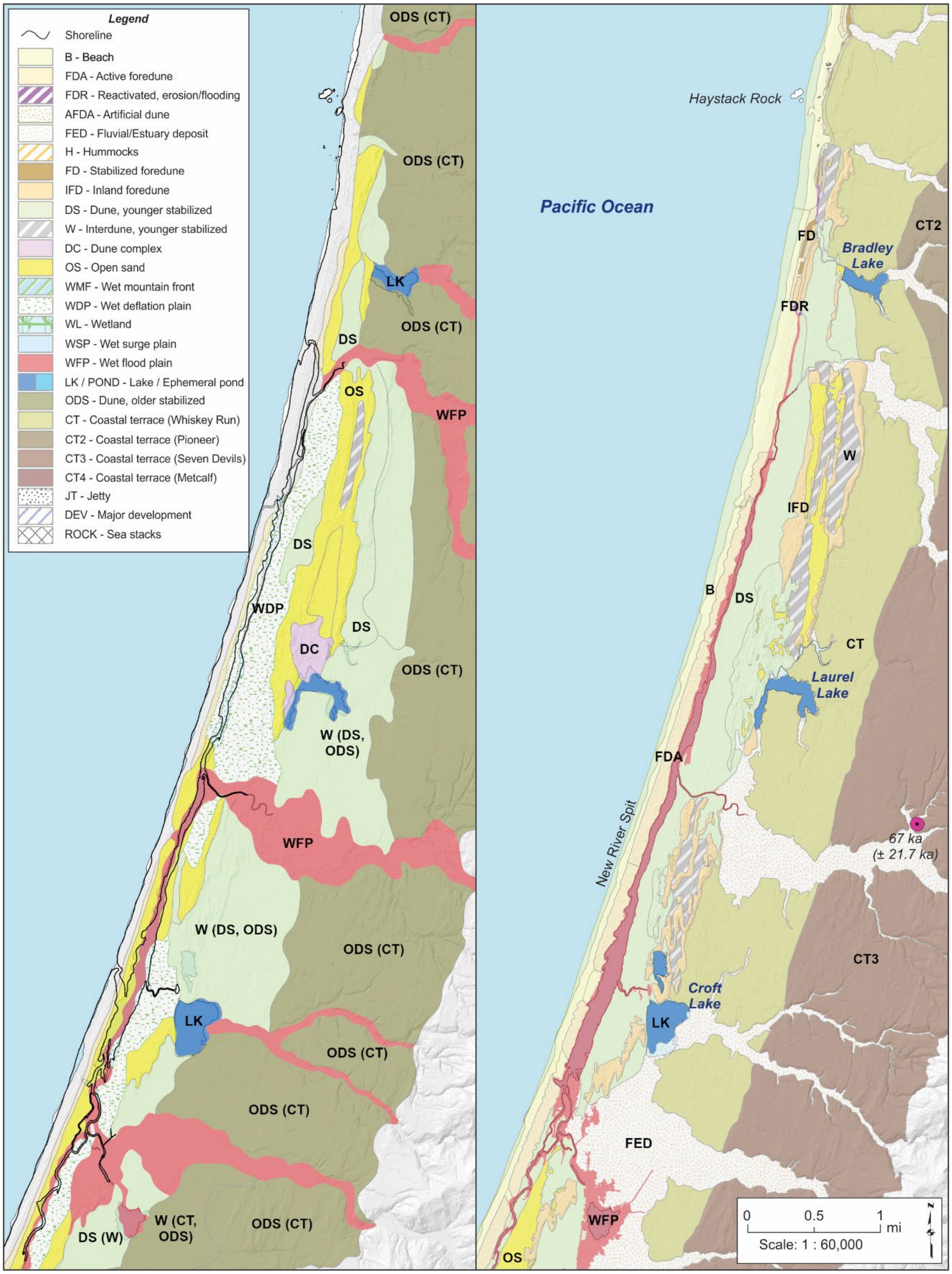
4.2 New River Spit

Figure 4.3 is a map showing the suite of coastal geomorphic units based on the original USDA (1975) mapping (*left*) compared with present-day conditions (*right*) for the New River Spit. The barrier beach is partially isolated from inland areas by the New River channel. The river reaches the coast in northern Curry County (~2.9 mi (~4.7 km)) south of Coos County) close to the beach, before taking a right turn where it flows northward for another 10.6 mi (17 km). Dune grading and barrier beach breaching are evident along sections of the shore, in part to alleviate periodic riverine flooding (Komar and others, 2001) and for developing habitat for Snowy Plover. As noted by Komar and others, the breached sections inevitably fills with sand during the quieter summer months following breaching events. This response is driven entirely by the dominance of coastal sediment transport processes and the low flows of the New River. Several changes are noteworthy in the New River area. First, as described previously, areas of open sand have largely disappeared in the Bandon Cell, with a few small remnant pockets located just south of Bradley Lake and in the south near the Coos/Curry county border (**Figure 4.3**, *right*).

An extensive barrier beach and foredune system has developed along the length of this shore. As mentioned earlier, a major sediment source in the Bandon littoral cell is erosion of coastal bluffs in the vicinity of Blacklock Point (northern end of Curry County). Using lidar data processed by Burgette and others (2023), we note here that the Blacklock Point bluffs are eroding at rates of ~-4.9 to -8 ft/year (~-1.5 to -2.5 m/year); the time period here is 18 years. Given that the bluffs have relative heights of 20 to 46 ft (~6 to 14 m) measured from the bluff toe, we can estimate an annual sediment yield of ~146,500 yd^3/year (~112,000 m^3/year) from this section of shore. However, because the lower portion of the bluffs is composed of Tertiary siltstone, which produces fine sediment, Komar and others (2001) estimated that only 25% of the sediment eroded from the bluffs is coarse enough to remain within the littoral system, with the fines removed offshore into deeper water. Accordingly, we estimate that the bluffs probably yield ~36,600 yd^3/year (~28,000 m^3/year) of mixed sand and gravel to the Bandon littoral cell and are almost certainly a dominant factor driving the northward migration of the mouth of the New River. For interest, we re-examined the locations of the river mouth from 1928 (using an early 1928 National Ocean Service Topographic "T-sheet" of the shoreline) to the present (2022) using aerial imagery. From these data, we calculate a net alongshore rate of 0.09 mi/year (~0.14 km/year), which is slightly slower than the rate of 0.1 mi/year (~0.16 km/year) measured by Komar and others (2001). Also evident in **Figure 4.3** (*left*), areas defined as wet deflation plain (WDP) west of Laurel Lake have now been stabilized with shorepine and other indigenous plants and hence, have been reclassified as younger stabilized dunes (DS).

Figure 4.3 (*right*) includes larger areas mapped as interdune (W) compared with the original USDA (1975) mapping. This change is largely due to our ability to better distinguish such areas using airborne lidar. Accompanying the interdune areas is new mapping showing the locations of at least two to three former foredunes (e.g., just south of Laurel Lake and north of Croft Lake), now stabilized, that run parallel with the coast. The age and processes driving the formation of many of these older dune features have yet to be studied, especially in the context of Cascadia Subduction Zone events that coseismically lower the coast during the earthquake, while the tsunami inundates the coastal shorelands. Significant changes can also be seen in the coverage of areas defined as wet flood plain (WFP), which now cover a smaller area within this portion of the coast and are now defined using the fluvial/estuary deposit (FED) classification. This change is the product of our tidal datum-based approach, which focuses on ocean flooding potential. As a result, areas defined as fluvial/estuary deposit (FED) may still experience periodic riverine/creek flooding.

Figure 4.3. Beach and dune geomorphic mapping classifications for the New River Spit. (*left*) original USDA (1975), (*right*) updated version. Green and pink circles, respectively, denote ^{14}C and thermoluminescence (TL) dates determined by Peterson and others (2007).



Finally, a major difference in **Figure 4.3** (*right*) is the delineation of several coastal terrace (CT) features throughout the area as opposed to the approach used by the USDA (1975), where the suite of terraces are merged into a single feature, termed older stabilized dunes on coastal terraces (ODS (CT) in **Figure 4.3**, *left*). Delineating the spatial extents of marine terraces in Coos County is described in **Section 3.6**. Within the GIS attributes, we include terrace ages where available, that are derived from previous geologic mapping (e.g., Newton and others, 1980; Muhs and others, 1990; McClaughry and others, *in press*). As seen in **Figure 4.3** (*right*), we are able to broadly map the flight of terraces, including the lowest 80-ka year terrace (CT), terrace 2 (CT2, 105 ka), terrace 3 (CT3, 125 ka), and terrace 4 (CT4, 240 ka). We argue that mapping the marine terraces in this way better characterizes the overall evolution of the coast over the past 200 ka. Soil development in these areas is considered to be well advanced (USDA, 1975) and hence, has the dual classification of being both older stabilized dunes and coastal terraces.

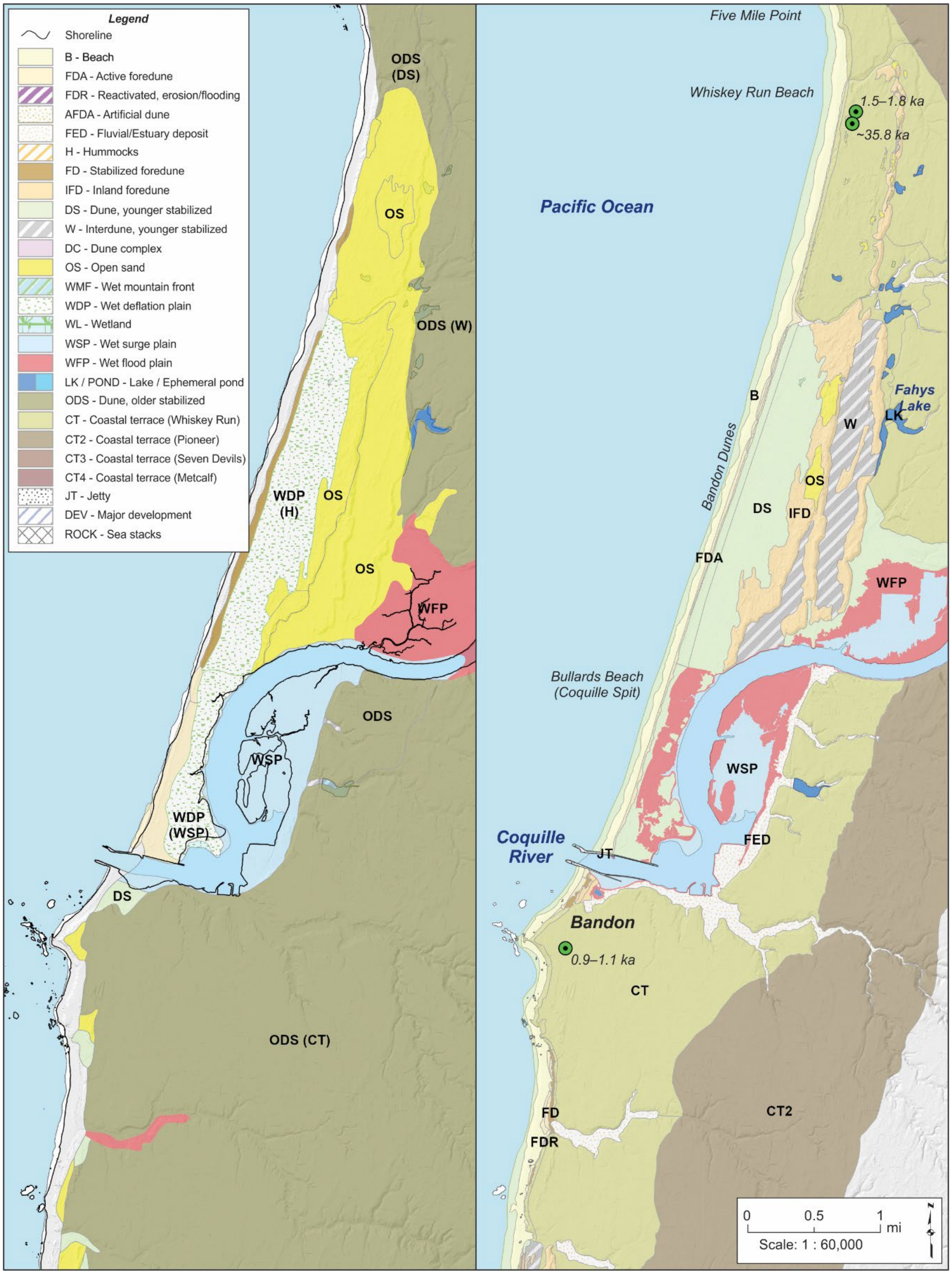
4.3 Bandon

The suite of coastal geomorphic units in the Bandon area is shown in **Figure 4.4** and compares the original mapping (*left*) with the updated mapping (*right*). Several major changes stand out. Most notably, the presence of open sand has shrunk considerably over the past 50 years, with a few small pockets now remaining west of Fahys Lake and landward of Whiskey Run Beach. Carbon 14 ($^{14}C \pm 1\sigma$) dating of dune deposits by Peterson and others (2007) south of Five Mile Point (**Figure 4.4** *right*, green circles) adjacent to the 80-ka (CT) marine terrace, reveal ages from 35 ka to 1.5 ka. The different ages are indicative of younger late Holocene dune sheet development, that in some cases, either overlie or abut against much older Pleistocene dunes. In both cases, the conditions for their development are significantly different from conditions today, with sea level being about 164 ft (50 m) lower at ~35 ka, exposing a larger portion of the continental shelf offshore present-day Oregon (Peterson and others, 2007). Westerly (onshore-directed) winds at the time entrained the sand and carried the sand inland across the coast, where they have ramped up and onto the older marine terraces identified in **Figure 4.4**.

Also evident in **Figure 4.4** (*right*), areas defined as wet deflation plane (WDP) have effectively disappeared, having been subsequently stabilized by vegetation, including European beach grass, shore pine and other indigenous (and introduced) plant species. East of the wet deflation plane area, our updated mapping reveals the presence of a series older inland foredunes (IFD) located west of Fahys Lake. These older foredunes can be distinguished by broad interdune (W) areas that may be synonymous with an increase in sediment supply, effectively causing the shoreline to prograde rapidly seaward. Unfortunately, we do not have any dates associated with these geomorphic features and accordingly the age and processes driving the formation of many of these older dune features have yet to be studied.

Finally, we are better able to define the locations of marine terraces in the area, differentiating the 80-ka terrace (CT) from the older 105-ka terrace (CT2), both of which comprise the bulk of the Bandon coastal geomorphology.

Figure 4.4. Beach and dune geomorphic mapping classifications for Bandon. (*left*) original USDA (1975), (*right*) updated version. Green and pink circles, respectively, denote ^{14}C and thermoluminescence (TL) dates determined by Peterson and others (2007).



4.4 Cape Arago

Figure 4.5 presents the updated mapping results for the northern end of the Bandon Cell (Five Mile Point to Cape Arago) and Cape Arago. The most significant change in our updated mapping is refinement of the spatial extent of marine terraces in the northern Bandon Cell and out on Cape Arago, guided by the recent geologic mapping compilation work of McClaughry and others (*in press*). As can be seen in **Figure 4.5** Peterson and others (2007) provide a single date (~54.3 ka) for a Pleistocene dune that ramped up onto the 80-ka marine terrace (CT) near Five Mile Point; the date was taken near the base of the dune. Hart and Peterson (2007) note that Holocene dunes have built up on top of the Pleistocene dunes present in this area.

4.5 Coos Bay

Changes in beach and dune mapping near Charleston and the entrance to Coos Bay is presented in **Figure 4.6**. The most significant differences are observed out on the North Coos Spit where interdune (W) areas have been removed (**Figure 4.6**, *left*) and replaced with stabilized dunes (DS). Areas characterized as open sand (OS) have decreased in size, consistent with changes in the Bandon Cell. The exception is a new area of open sand that has formed at the south end of the spit, 0.6 mi (~1 km) north of the estuary mouth that is a designated Snowy Plover habitat site that is being managed by the BLM. The updated mapping indicates that stabilized foredunes (FD) have decreased from 436 acres (176 ha) in the 1970s to 227 acres (92 ha) in the latest mapping. Conversely, defining active foredunes (FDA) along the spit have expanded from 25 acres to 364 acres (10 ha to 147 ha). Coverage of inland dune features (IFD) expanded over the 50-year period and is entirely due to the benefits of airborne lidar in penetrating the vegetation canopy. Nevertheless, it should be noted that, although mapping inland dune features using lidar was straightforward and in many cases the processes governing their formation appear obvious (e.g., coastal foredunes), other aeolian geomorphic features were less obvious. Hence, in the absence of actual fieldwork, the classification of some of these features remains somewhat speculative.

4.6 North Coos Spit

Figure 4.7 shows the suite of coastal geomorphic units based on the original USDA (1975) mapping (left) compared with present-day conditions (right) for the northern Coos Spit. By far the largest and most significant mapping changes occur along the North Coos Spit. This includes a substantive decrease in the coverage of wet deflation plains (WDP), with most of this now reclassified as either wetlands (WL) or stabilized dunes (DS). This change does not necessarily reflect a shift in the original interpretation of how these features formed, instead it indicates a succession change that is mostly due to the proliferation of vegetation throughout the various areas. Areas defined as interdune have also decreased in coverage since the 1970s, with most areas now having shifted toward stabilized dunes (DS). **Figure 4.7** includes improved mapping of many inland foredune features (IFD). For example, the presence of numerous older dunes east of Horsfall Beach imply a complex history of development that reflect changes in sediment transport patterns, possible spit breaching, potential shifts in the position of the mouth of Coos Bay, and even the likely effects of past Cascadia Subduction Zone events. These processes demonstrate a real need for more thorough investigations to better constrain the ages of these features, improving our overall understanding of the evolution of the coast over the past several thousand years.

Figure 4.5. Beach and dune geomorphic mapping classifications for the northern Bandon littoral cell and Cape Arago headland. (*left*) original USDA (1975), (*right*) updated version. Green and pink circles, respectively, denote ^{14}C and thermoluminescence (TL) dates determined by Peterson and others (2007).

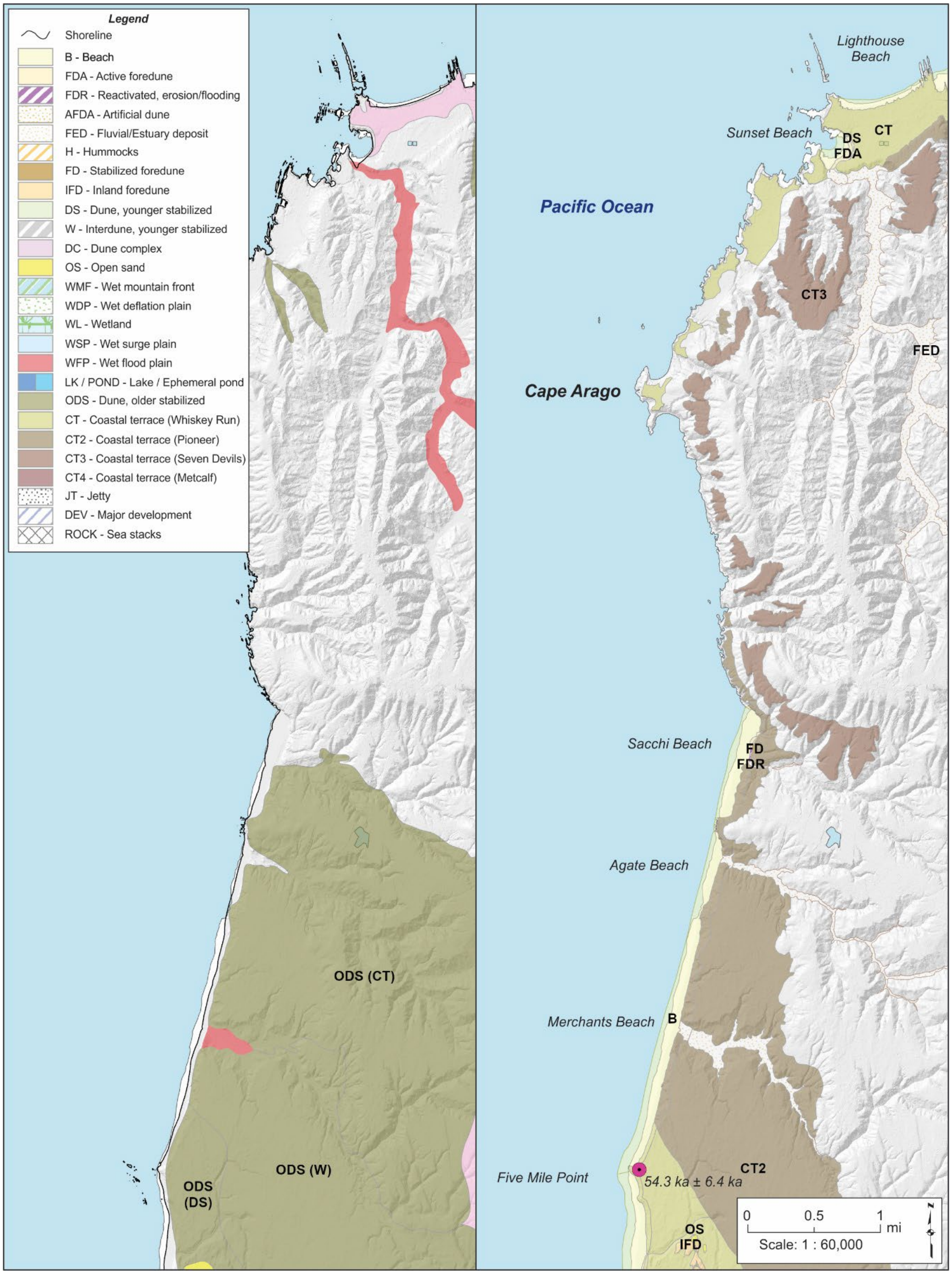
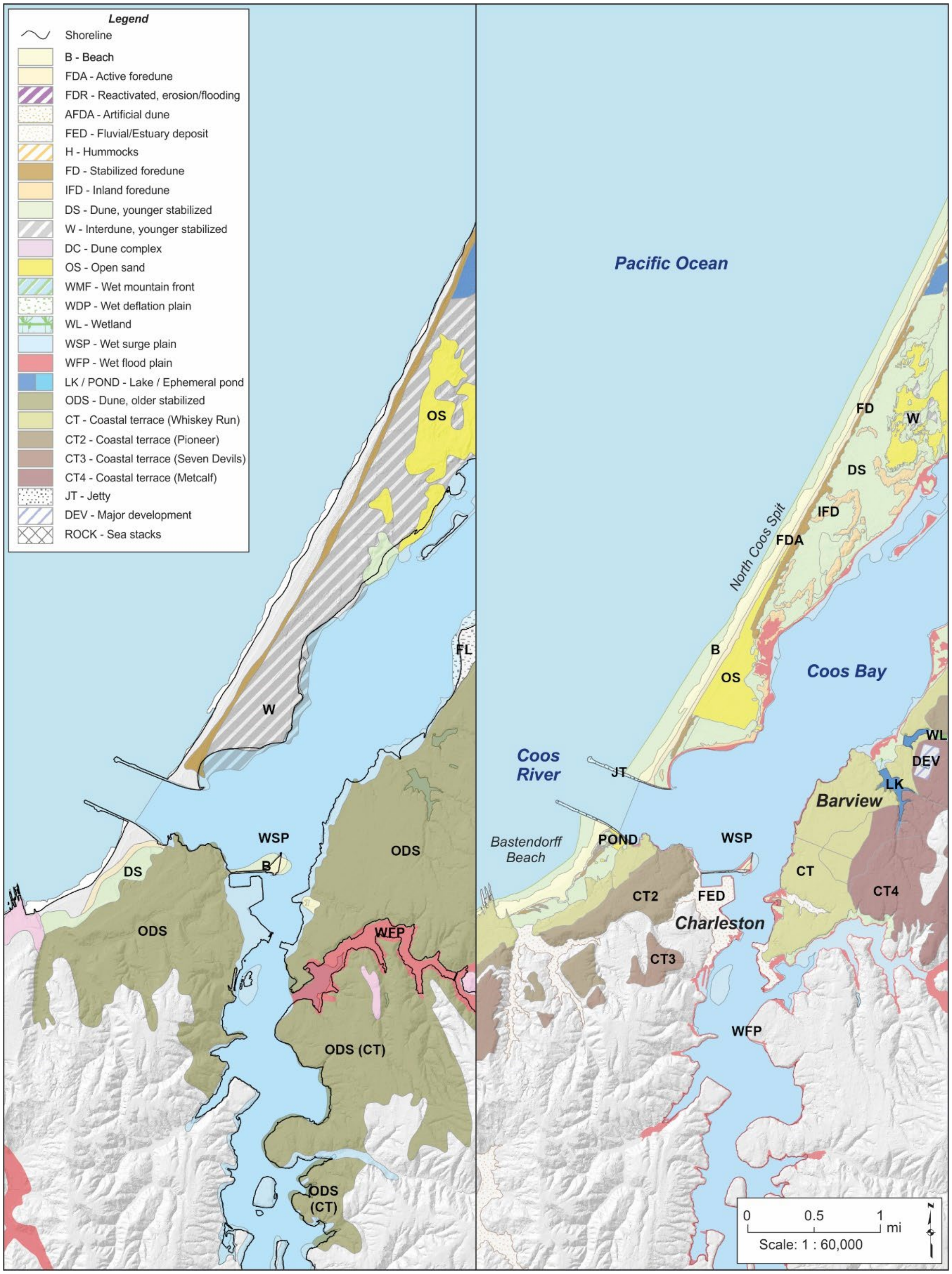


Figure 4.6. Beach and dune geomorphic mapping classifications for Coos Bay. (*left*) original USDA (1975), (*right*) updated version. Green and pink circles respectively denote ^{14}C and thermoluminescence (TL) dates determined by Peterson and others (2007).



Areas classified as fill in the 1970s mapping (**Figure 4.7**, *left*), while probably correct (i.e., consistent with observations in original geologic mapping), have simply been reclassified as developed (DEV) lands since these areas tend to be associated with sites experiencing major industrial/commercial change that has led to significant modifications to the landscape. Consistent with changes elsewhere in Coos County, we find a significant reduction in areas classified as open sand (OS) on the north Coos Spit. **Figure 4.7** (*right*) includes a single thermoluminescence date (~20.9 ka) for the top of a Pleistocene dune adjacent to the CT2 (Pioneer(?)) terrace. As noted earlier, Peterson and others (2007) have used these data to infer that onshore-directed winds entrained sand exposed across the inner continental shelf, carrying the sand landward where they ramped up and onto older marine terraces present along the coast. Finally, mapped extents of marine terraces at Coos Bay using the SCV approach have the greatest level of uncertainty, due to the highly dissected and eroded landscape and in response to extensive development throughout the area.

4.7 Hauser

Figure 4.8 shows the change in coastal geomorphic units based on the original USDA (1975) mapping (left) compared with present-day conditions (right) for the very northern end of Coos County. Changes in the Hauser area are entirely consistent with what was described previously for the North Coos Spit in **Section 4.6**. Consistent with what we have observed elsewhere in Coos County, areas defined as open sand have decreased substantially in size since the 1950s. Areas defined as wet deflation plane (WDP) and interdune (W) have been reclassified to wetland (WL) and younger stabilized dunes (DS). Finally, our latest mapping better constrains the extents of many lakes and water bodies, including the presence of numerous ponds present out on the dunes. Many of these pond features are almost certainly ephemeral in nature, such that they respond to changes in water tables. Furthermore, many of these pond features may be formed in response to the migration and erosion of existing dune sheets where they subsequently leave behind wet deflation plains (WDP).

Figure 4.7. Beach and dune geomorphic mapping classifications for the North Coos Spit. (*left*) original USDA (1975), (*right*) updated version. Green and pink circles respectively denote ^{14}C and thermoluminescence (TL) dates determined by Peterson and others (2007).

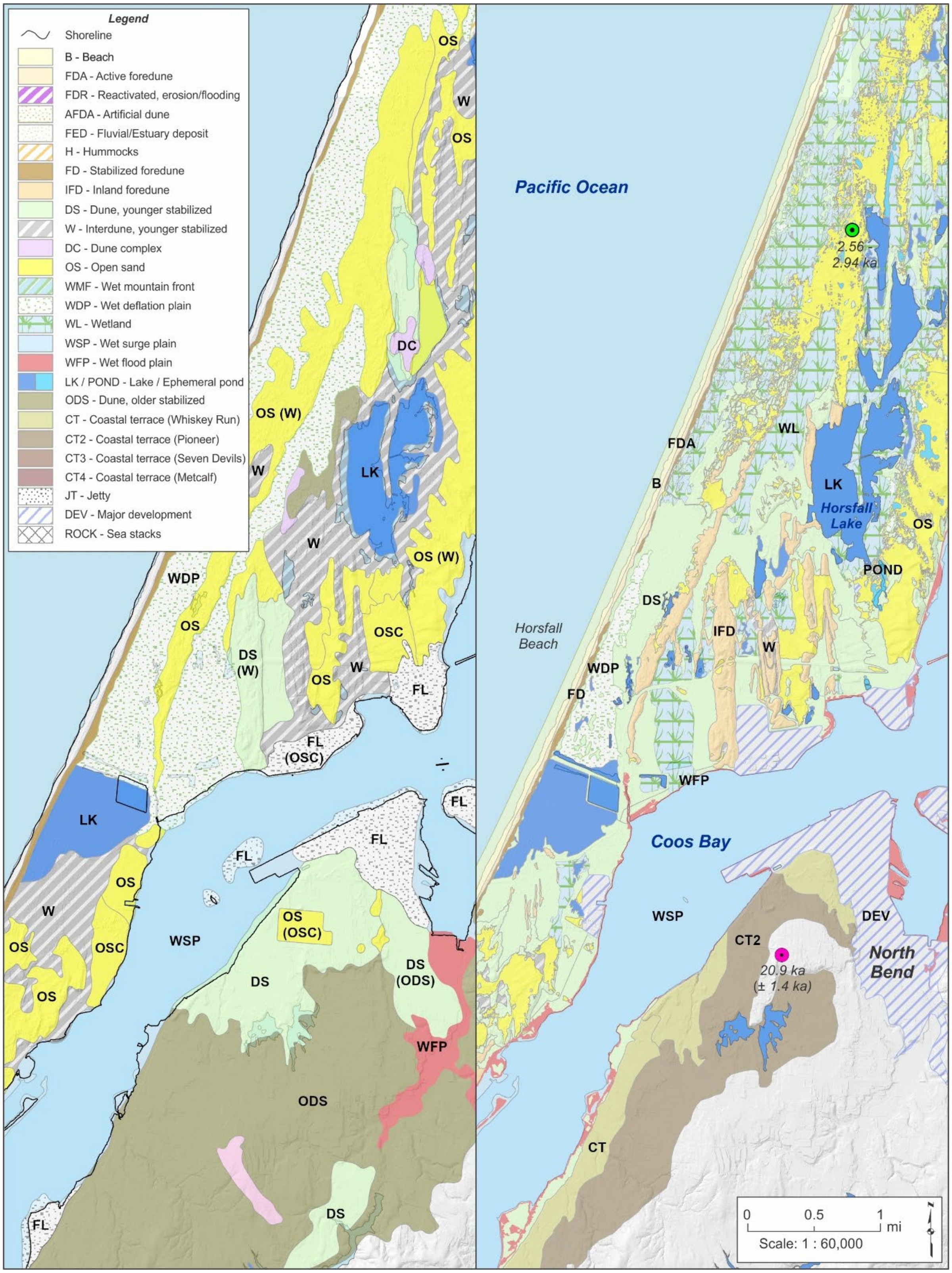
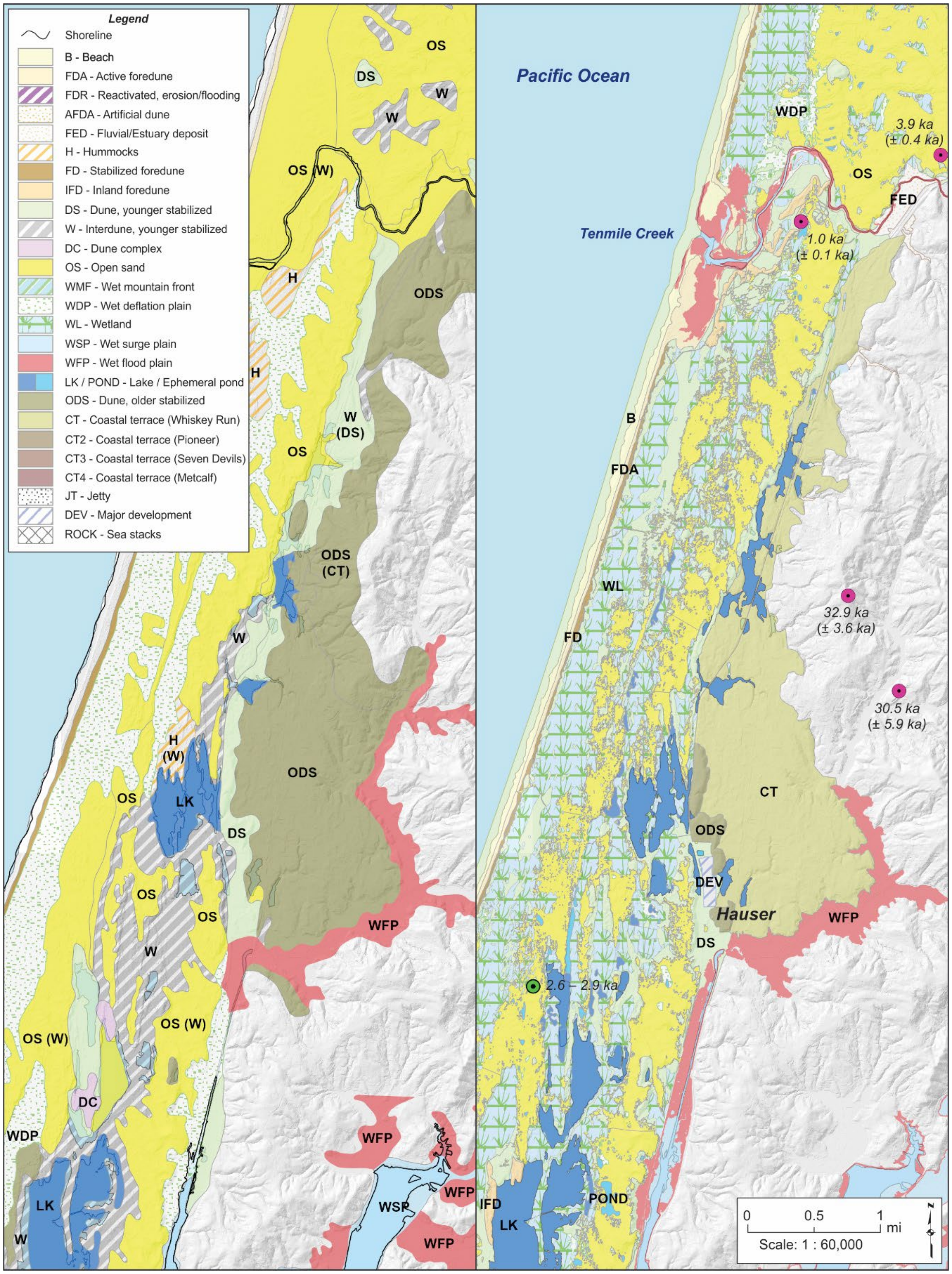


Figure 4.8. Beach and dune geomorphic mapping classifications for Hauser in northern Coos County. (*left*) original USDA (1975), (*right*) updated version. Green and pink circles respectively denote ^{14}C and thermoluminescence (TL) dates determined by Peterson and others (2007).



5.0 CONCLUSION

The objective of this beach and dune mapping study was to produce updated information on the spatial extent of the beach and foredune system in Coos County that may be subject to existing and future storm-induced wave erosion, runup, overtopping, and coastal flooding. These data are of importance to DLCD and the coastal counties of Oregon to improve implementation of Statewide Planning Goal 18. Specifically, Goal 18 requires that local jurisdictions adopt a beach and dune overlay zone in their comprehensive plan, which may be used to manage development on or near such features. Regional mapping of the original beaches and dunes overlay zone of the Oregon Coast was undertaken between 1972 and 1975 by the USDA Soil Conservation Service (USDA, 1975). However, much has changed on the Oregon Coast, requiring that the USDA (1975) overlay zone be updated to reflect current conditions. As noted throughout this report, some of the largest changes to have taken place along the coast include:

- The rapid expansion of European beach grass (*Ammophila arenaria*), which has helped to stabilize many dune systems.
- Dune management activities such as foredune grading and planting.
- Changes in beach and dune morphology due to either coastal erosion or accretion.
- Shoreline changes at the mouths of estuaries controlled by jetties.

The overall study approach follows the original core classification structure developed by the USDA (1975), and Allan (2020), while adding several new classes that address changes in the coastal geomorphology of the Coos County coastline. Of particular importance, our GIS mapping includes a suite of geospatial attributes that broadly characterize the susceptibility of the coastal strip to existing coastal hazards, while also noting the likely future effects of climate change along the coastal strip. Finally, the GIS mapping also include numerous comments and notes made by the authors.

Analyses presented here clearly demonstrate the transformation of the coast over the past 50 years. Of note has been the overall reduction in areas defined as open sand (OS), which has decreased by ~52% since the 1970s. Most of this change can be directly attributed to anthropogenic effects, particularly the introduction of European beach grass (*Ammophila arenaria*) and its expansion on coastal foredunes as well as stabilization from shore pine (*Pinus contorta*) and other native plant species. Although the bulk of this transformation can be attributed to a shift toward younger stabilized dunes (DS), the expansion of areas defined as active foredune (FDA) and stabilized foredunes (FD) is a testament to the role humans have played in driving these changes.

6.0 ACKNOWLEDGMENTS

This project was funded under award #21102 by the Oregon Coastal Management Program of the Department of Land Conservation and Development agency, via a National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management Special Merit Grant. We thank Rhiannon Bizore for her assistance throughout this project, discussion on approach, and constructive comments on the technical report. We also thank Meg Reed for her perseverance in finding the needed funding to complete this important update. Finally, we thank Christina Appleby from DOGAMI for her constructive comments on the report and GIS.

7.0 REFERENCES

Allan, J. C., 2004, An evaluation of the risks from storm erosion and overwash of the Elk River Spit, Oregon, associated with restoring Western Snowy Plover breeding habitat: Open-file-report O-04-17, Oregon Department of Geology and Mineral Industries, Portland, 46 p.

Allan, J.C., 2020, Temporal and spatial changes in coastal morphology, Tillamook County, Oregon: Open-File Report O-20-04, Oregon Department of Geology and Mineral Industries, Portland, Oregon, 27 p.

Allan, J. C., Ruggiero, P., and Roberts, J. T., 2012, Coastal Flood Insurance Study, Coos County, Oregon: Oregon Department of Geology and Mineral Industries, Special Paper 44.

Allan, J. C., Witter, R. C., Ruggiero, P. and Hawkes, A. D., 2009, Coastal geomorphology, hazards, and management issues along the Pacific Northwest coast of Oregon and Washington. In: J.E. O'Connor, R.J. Dorsey and I.P. Madin (Editors), *Volcanoes to vineyards: Geologic field trips through the dynamic landscape of the Pacific Northwest*: Geological Society of America Field Guide 15. The Geological Society of America, p. 495-519.

Bauer, B. O., Sherman, D. J., Nordstrom, K. F., and Gares, P. A., 1990, Aeolian transport measurement and prediction across a beach and dune at Castroville, California, in Nordstrom, K. F., Psuty, N., and Carter, B. (eds.), *Coastal dunes: form and process*: Chicester, Wiley, p. 39-55.

Baldwin, E.M., Beaulieu, J.D., Ramp, L., Gray, J.J., Newton, V.C. and Mason, R.S., 1973, Geology and mineral resources of Coos County, Oregon: Bulletin 80, Oregon Department of Geology and Mineral Industries, Portland, Oregon, 89 p.

Beaulieu, J., and Hughes, P. W., 1975, Environmental geology of western Coos and Douglas counties, Oregon: Bulletin 87, Oregon Department of Geology and Mineral Industries, Portland, 148 p.

Bowles, C.J. and Cowgill, E., 2012. Discovering marine terraces using airborne LiDAR along the Mendocino-Sonoma coast, northern California: *Geosphere*, 8(2): 386–402.

Bureau of Land Management [BLM], 1995, New River ACEC Management Plan: Department of the Interior, Bureau of Land Management.

Burgette, R.J., Guerrero, E.F., Allan, J.C., O'Brien, F.E., McClaughry, J.D., Anthony, L.H., Hairston-Porter, R.W. and Franczyk, J., 2023, Geologic assessment of potential cable landing sites along the Oregon coast: Special Paper 54, Oregon Department of Geology and Mineral Industries, Portland, Oregon, 107 p.

Clemens, K. E., and Komar, P. D., 1988, Oregon beach-sand compositions produced by the mixing of sediments under a transgressing sea: *Journal of Sedimentary Petrology*, v. 58, no. 3, p. 519–529. https://doi.org/10.1306/212F8DDC-2B24-11D7-8648000102C1865D

Cooper, W. S., 1958, *Coastal sand dunes of Oregon and Washington*: Geological Society of America Memoir 72, p. 169. https://doi.org/10.1130/MEM72

Department of Land Conservation and Development [DLCD], (2024), Oregon's Statewide Land Use Planning Goals: Access data: January 2024. https://www.oregon.gov/lcd/OP/Pages/Goals.aspx

Franczyk, J. J., Madin, I. P., Duda, C. J. M., and McClaughry, J. D., 2020, Oregon geologic data compilation [OGDC], release 7 (statewide): Oregon Department of Geology and Mineral Industries. https://pubs.oregon.gov/dogami/dds/p-OGDC-7.htm.

Greenwood, S., Owens, J., Faust, S. and Duncan, S., 2011. Mouth of the Columbia River Regional Sediment Management Plan: Lower Columbia Solutions Group, 40 p.

Hart, R. and Peterson, C.D., 2007, Late-Holocene buried forests on the Oregon coast: *Earth Surface Processes and Landforms*, 32: 210-229.

Kelsey, H.M., Ticknor, R.L., Bockheim, J.G. and Mitchell, C.E., 1996, Quaternary upper plate deformation in coastal Oregon: *GSA Bulletin*, 108(7): 843-860.

Komar, P. D., 1997, *The Pacific Northwest coast: Living with the shores of Oregon and Washington*: Durham and London, Duke University Press, 195 p.

Komar, P.D., 1998, *Beach processes and sedimentation*: Prentice Hall, Inc. Englewood Cliffs, New Jersey, 544 p.

Komar, P.D., Diaz-Mendez, G.M. and Marra, J.J., 2001, Stability of the New River Spit, and the position of Oregon's beach-zone line: *Journal of Coastal Research*, 17(3): 625-635.

Komar, P. D., Torstenson, R. W., and Shih, S.-M., 1991, Bandon, Oregon: Coastal development and the potential for extreme ocean hazards: *Shore & Beach*, v. 59, no. 4, p. 14-22.

Lizarraga-Arciniega, J. R., and Komar, P. D., 1975, Shoreline changes due to jetty construction on the Oregon coast: Oregon State University Publication No. ORESU-T-75-004, 90 p.

Marra, J., 2002, Background report, chronic coastal natural hazards: Unpublished report to the Oregon Department of Conservation and Development.

McClaughry, J.D., Darin, M.H., Azzopardi, C.J.M, Anthony, L.H., Allan, J.C., Burgette, R.J., Guerrero, E.F., and Wiley, T.J., *in press*, Geology of the southern Oregon Coast between Coos Bay and the California Border, Coos and Curry counties, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 109.

McKenzie, K.A., Kelsey, H.M., Kirby, E., Rittenour, T.M. and Furlong, K.P., 2022, Differential coastal uplift quantified by luminescence dating of marine terraces, central Cascadia forearc, Oregon: *Quaternary Science Reviews*, 298: 107853.

Muhs, D. R., Kelsey, H. M., Miller, G. H., Kennedy, G. L., Whelan, J. F., and McInelly, G. W., 1990, Age estimates and uplift rates for late Pleistocene marine terraces: Southern Oregon portion of the Cascadia forearc: Journal of Geophysical Research: *Solid Earth*, v. 95, no. B5, p. 6685-6698.

National Oceanic and Atmospheric Administration [NOAA] National Ocean Service [NOS], 2023, Tidal Datums, Access data: June 2023, https://tidesandcurrents.noaa.gov/datum_options.html.

Newton, V., Kulm, L., Couch, R., Braman, D., Pitts, G., Van Atta, R., and McKeel, D., 1980, Prospects for oil and gas in the Coos Basin, western Coos, Douglas, and Lane counties: Oregon Dept. of Geology and Mineral Ind., OGI-006.

Padgett, J.S., Kelsey, H.M. and Lamphear, D., 2019, Upper-plate deformation of Late Pleistocene marine terraces in the Trinidad, California, coastal area, southern Cascadia subduction zone: *Geosphere*, 15(4): 1323-1341.

Peterson, C.D., Stock, E., Price, D.M., Hart, R., Reckendorf, F., Erlandson, J.M. and Hostetler, S.W., 2007, Ages, distributions, and origins of upland coastal dune sheets in Oregon, USA: *Geomorphology*, 91: 80-102.

Ruggiero, P., Kratzmann, M.G., Himmelstoss, E. A., Reid, D., Allan, J. C., and Kaminsky, G. M., 2013, National assessment of shoreline change: Historical shoreline change along the Pacific Northwest coast (Oregon and Washington): U.S. Geological Survey Open-File Report 2012-1007, https://pubs.usgs.gov/of/2012/1007/.

U.S. Department of Agriculture Soil Conservation Service [USDA], 1975, Beaches and dunes of the Oregon coast: USDA Soil Conservation Service, 158 p.

U.S. Fish and Wildlife Service [USFWS], 2023, USFWS National Wetlands Inventory: U.S. Fish and Wildlife Service, Access data: January 2024, https://www.fws.gov/program/national-wetlands-inventory/wetlands-mapper/.

Wiley, T.J., McClaughry, J.D., Niewendorp, C.A., Ma, L., Herinckx, H.H. and Mickelson, K.A., 2015. Geologic map of the Southern Oregon Coast between Bandon, Coquille, and Sunset Bay, Coos County, Oregon, Oregon Department of Geology and Mineral Industries, Portland, Or., 57 p.

Woodhouse, W. W., 1978, Dune building and stabilization with vegetation: U.S. Army Corps of Engineers, Coastal Engineering Research Centre, Special Report No. 3. https://usace.contentdm.oclc.org/digital/collection/p266001coll1/id/7512/.

Zarnetske, P. L., Hacker, S. D., Seabloom, E. W., Ruggiero, P., Killian, J. R., Maddux, T. B. and Cox, D., 2012, Biophysical feedback mediates effects of invasive grasses on coastal dune shape: *Ecology*, 93(6): 1439-1450.