Open Wide:

Examining the Mouth of the Columbia River

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Geology

The mouth of the Columbia River was not always where it is today. During the last 10,000 years, the local rate of sea-level rise has decreased substantially. From 10,000 to 8,000 years ago, sea level rose from about 55 to 24 m below present mean sea level, averaging 1.6 cm/year. In the last 5,000 years sea level rose to its present stage at an average rate of only .16 cm/year (Gelfenbaum et al., 1999).

Consequently, the mouth of the Columbia River originally extended 11 miles (18 km) further west across the continental shelf, and its waters flowed into what now is Astoria Canyon, a submarine canyon and fan-valley system off the Oregon coast (Niem, 2001). Astoria Canyon, approximately 75 miles (121 km) long, crosses the seaward half of the continental shelf and down the continental slope into Astoria Seachannel, a fan valley. The canyon varies in width from 1.5 to 8.3 miles and is entered by 13 tributaries. The movement of the Columbia River sediment down to the fan valley formed the tributaries (Gelfenbaum et al., 1999).

During autumn and winter, when the river levels are low, the ocean water tides reach up to 140 miles upriver, and the ebb tides take the river water miles out in the ocean. This ebb and flow has not allowed a delta to form, rather, sediment deposited by the river has formed into sand bars and islands that are continually shifting exist at the river's mouth (White, 1995).

The Columbia River discharge is the third largest in the United States, with a mean average flow of about 6000 m^3/s. With the introduction of eleven major and over 200 minor dams in the mid 1900s, flow regulation to prevent flooding in the Columbia River basin has significantly decreased peak flows and the transport capacity of the river. In addition to the

dams, channel maintenance activities have helped decrease sediment supply by a factor of three since historical times (Sherwood et al., 1990).

Native American Landscapes

Native Americans along the mouth of the Columbia River all originated from the Chinookan people. The Chinooks proper lived on the north shore of the mouth, from Grays Bay west to Cape Disappointment, up to Willapa Bay. The Wahkiakums lived east of them, upriver to Oak Point. On the south shore, the Clatsops lived from Tongue Point to the mouth. To the east of the Clatsops, the Cathlamets lived upriver to the point across the river from Skamokawa, Washington. The Clatsops and Chinooks are known as the Lower Chinooks, and the Cathlamets and the Wahkiahums are known as the Upper Chinooks (Fig. 1) (Ruby and Brown, 1976).

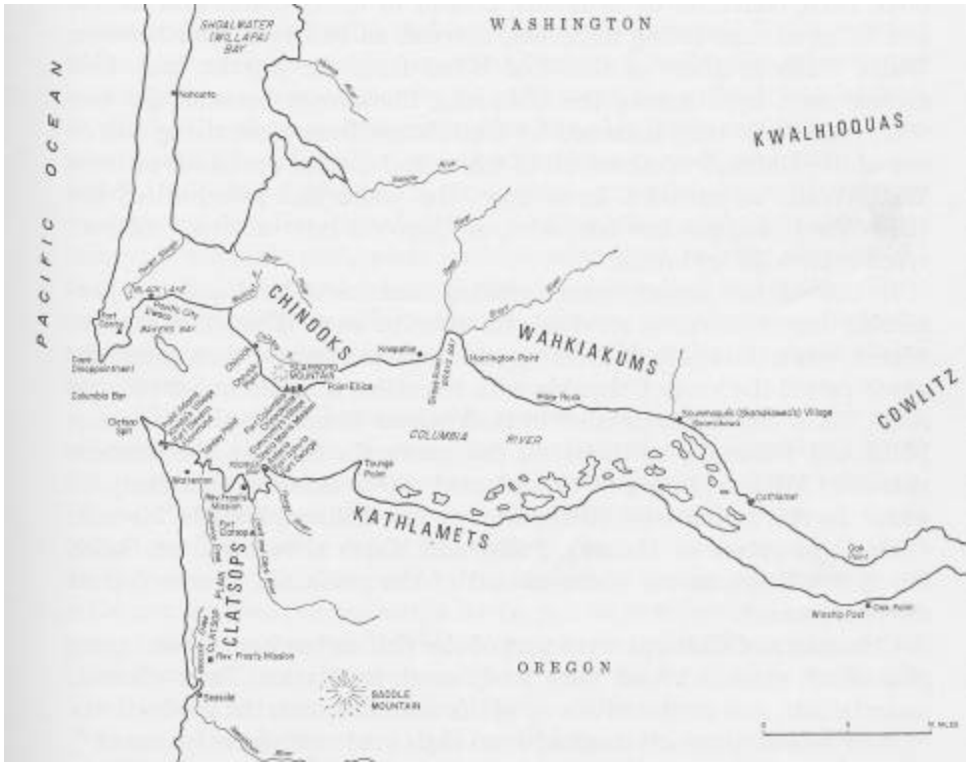

Fig. 1. Lower Chinook Lands, map from Robert H. Ruby and John K. Brown. 1976. The Chinook Indians. University of Oklahoma Press, Norman, 7.

These groups used the river as a means of travel, trade and sustenance. Contrary to popular belief, life was not easy for these people. They had adapted to their land, and the ease with which they interacted with the river and environment had evolved slowly over time. They had access to the best salmon in the river, bright fish not yet scarred and starved from their journey to spawn in streams. Although they fished for smelt, sturgeon, steelhead trout and humpback, sockeye, chum and coho salmon, Chinook salmon was their diet staple (Oregon Historical Society, 1980).

To travel on water, the Lower Chinooks used canoes acquired from trading slaves with the Nootka Indians of Vancouver Island. Made from a single white cedar log, each canoe was about 35 feet long and carried up to twelve people. Although these large canoes were ideal oceangoing vessels, often the natives traveled trade route coastal rivers such as the Chinook, Bear and Chehalis (Ruby and Brown, 1976).

European Discovery

By 1775, the Columbia River mouth had gone virtually unnoticed by explorers until Spanish explorer Bruno de Heceta, on his return trip to Mexico from southeast Alaska, observed a strong current against the port side of his ship the *Santiago*. He wanted to explore the current's source, but since his crew was sick with scurvy, he just made note of the phenomena and continued on his way home (Schwantes, 2000).

In 1788, English merchant John Meares sailed along the Washington coast, looking for the river Heceta had alluded to. After sailing up and down the coast, he could not find the alleged river's mouth, and concluded Heceta had mistaken a sound for a river. Before Meares left the area, he named the "sound" Deception Bay and the high point on its north

shore Cape Disappointment, names which succinctly conveyed his frustration (Ruby and Brown, 1976).

The credit of discovering the Columbia River goes to an American, Captain Robert Gray of the ship *Columbia Rediviva*. Gray was a merchant seaman and traded for mostly sea otter pelts to take to the Chinese market. In May of 1792, he and his crew were looking for Oregon coast inlets to use as new trade routes, and they were very surprised to find the mouth of a large river. After making their way across the bars to the river, the ship became grounded. Gray sent scouts out on boats to find a channel for the ship, and soon the *Columbia Rediviva* was sailing the estuary (Oregon Historical Society, 1980). Word of the ship spread quickly among the Chinooks, and many canoes went to the ship to offer otter pelts for trade (Ruby and Brown, 1976).

Gray left the river at the end of May, but not before naming the river after his ship and the north and south point of the entrance Cape Hancock and Point Adams, respectively. The name Point Adams is used to this day, while Cape Hancock is not. After a few days, Gray encountered British Captain George Vancouver and his ship the *Discovery*. Gray told Vancouver of his discovery, and to his chagrin, Vancouver realized he had passed the same river in April. In October, Vancouver sailed to the mouth of the river and not wanting to risk grounding the *Discovery* on the bars, he sent his lieutenant, William Broughton, to enter the river on the smaller ship *Chatham* (Oregon Historical Society, 1980).

Broughton successfully entered the river and surveyed about 120 miles upriver, near what is now Vancouver, Washington. From the surveying, he drew a detailed chart (Fig. 2) that was published in 1798. Even though Gray's name "Columbia" was used in his charts and publications, the fact that Broughton sailed much farther upriver than Gray was sufficient ground for British to lay claim to the river, according to the British (Schwantes,

2000). Also, Broughton encountered another ship on the Columbia. It was the British ship *Jenny*, under Captain James Baker. Baker said he had been on the river earlier that year, which questions Gray as the discoverer of the river, but not much is known about Baker's purported first trip (Dunbabin, 1954). Broughton named Baker Bay, on the north shore of the Columbia, in honor of Baker.

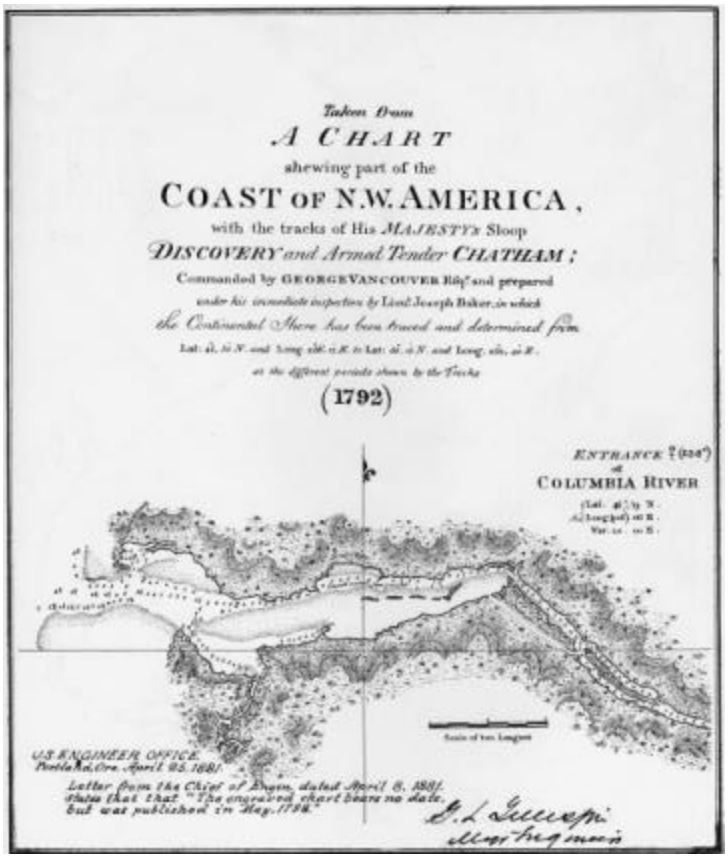

Fig. 2. Broughton's Chart of N.W. America, map from John B. Lockett. 1963. Phenomena Affecting Improvement of the Lower Columbia Estuary and Entrance. Subcommittee on Sedimentation, Jackson, Mississippi, 55.

Captains Meriwether Lewis and William Clark were directed by President Thomas Jefferson to find an inland water route from the Missouri River to the Pacific Ocean to expedite trade operations in the Pacific Northwest. When they reached the Columbia, Lewis

and Clark met the Lower Chinooks on November 7, 1805. Looking out into the Columbia estuary, Clark wrote in his journal of the glorious view:

> *Great joy in camp we are in View of the Ocian, this great Pacific Octean which we been So long anxious to See. and the roreing or noise made by the waves brakeing on the rockey Shore (as I suppose) may be heard distinctly* (Schwantes, 2000).

He was very happy, but his celebration was premature. He was actually about 25 miles from the "Ocian." As mentioned earlier, during autumn and winter the effects of ocean tides are felt strongly throughout the lower Columbia. Clark probably saw the ocean water breaking on the Columbia's bars and mistook them for real ocean waves. Sand bars probably existed farther upriver than they do now, since the construction of jetties. A week later, Lewis and Clark reached the bona fide mouth of the Columbia (Sherwood et al., 1990).

Crossing the Bar

When Gray entered the Columbia River, he encountered two channels across the bar. Broughton, however, just found one. Using that one example, it is evident that navigating the estuary could be treacherous, because of the shifting sand bars and islands. Many unwary ships had found themselves suddenly grounded. The survivors blamed the maps they used as guides, when in fact the maps were quite accurate–at the time they were drawn (Lang and Carriker, 1999).

In 1836, President Andrew Jackson asked William Slacum, who had earlier successfully crossed the bar, to survey the Columbia River and record "authentic

information" about the native people (Lang and Carriker, 1999). Slacum also devised a plan to make the entrance to the Columbia less dangerous. His ingenious scheme involved more than just warning beacons or complex maps. He proposed to blow up Cape Disappointment:

> *I cannot leave this subject without pointing out the great facility and the advantages that would result from a thorough cut of not more than three-quarters of a mile through the lowest point of Cape Disappointment, from Baker's Bay to the ocean. The soil is light, and the height not more than sixty feet at the point proposed; and I have not the slightest doubt that a deep and safe channel would soon be made...*
> (Oregon Historical Quarterly, 1935)

Although his plan never made it past the drawing boards, other similarly large-scale earth-moving projects were implemented by the 20th century.

The bar was a continual hazard for shipping. Several pilot tugboat services tried their luck managing the bar, but couldn't keep above water, literally. By the 1850s the Oregon legislature was compelled to offer a $30,000 subsidy to whoever could operate a tugboat business for five consecutive years (McKinney, 1987).

Changing the Mouth

Even with the pilot service, ships and people were not safe. Since the 1790s, more than 2,000 vessels and 1,500 people have been lost (McKinney, 1987). In 1878 public pressure compelled the government to act again. The government charged the Army Corps of Engineers to survey the mouth of the Columbia River and make permanent improvements. The Corps' recommendations have made the most impact on changing the landscape of the

mouth and estuary (Fig. 3). Surveys showed the river naturally contained two shifting channels, with a sand island (appropriately named Middle Sands) between them that was visible at low tide. Although the north channel was generally deeper, neither channel was suitable for navigation. In the early 1880s Middle Sands broke in two, one half forming Sand Island in Baker Bay and the other half becoming a sand bar (US Army Corps of Engineers, 1938).

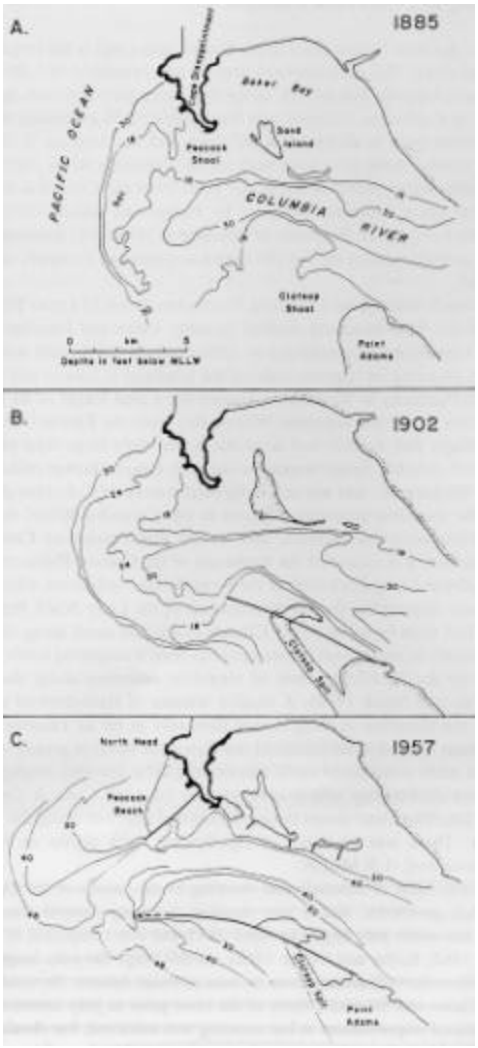

Fig. 3. Changes at the mouth of the Columbia River associated with jetty construction, determined from Coast & Geodetic Survey charts, from Paul D. Komar and Michael Zhenlin Li, 1991. Beach Placers at the Mouth of the Columbia River, Oregon and Washington. Marine Mining. 10:174.

The Corps proposed a plan to construct a 20-foot wide, 8,000-foot jetty that would extend seaward from the south cape. The jetty would partially close the mouth to concentrate the river flow and create a deeper channel for ships. Work began in 1884, and when it was completed ten years later, the improved channel had a minimum depth of 30 feet over the bar (Willingham, 1983).

After a few years it was evident the channel was shoaling and shifting, and by 1902, the channel had all but disappeared, with a minimum depth of 20-22 feet. Congress, in the River and Harbor Act of March 3, 1905, authorized the 2.5-mile extension of the south jetty, the construction of a 2.5-mile north jetty and dredging. The goal of these changes was a channel width of a half-mile that had a 40-foot controlling channel depth on the bar (US Army Corps of Engineers, 1938).

After construction ended, the channel depth grew to 44 feet over an 8,000-foot distance. Measurements taken again in 1937 showed a 40-foot deep channel over a mile wide, plus a 46-foot depth at the river's mouth (Fig. 4, 5). At completion time, these jetties were the largest jetties in the world (Lockett, 1963; McKinney, 1987).

Fig. 4. North Jetty with Baker Bay and Sand Island, photograph from U.S. Army Corps of Engineers Portland District. 1938. Mouth of the Columbia River Oregon and Washington, The District, Portland, Oregon, 36.

Fig. 5. South Jetty with Astoria and Chinook Point, photograph from U.S. Army Corps of Engineers Portland District. 1938. Mouth of the Columbia River Oregon and Washington, The District, Portland, Oregon, 35.

Dredging went on during the jetty construction, and generally helped with increasing the controlling depth. The dredged materials were simply piped into another area of the

Columbia estuary (the area where salt water and fresh water mix), which includes the mouth to about 25 miles upriver (Larison, 1982). Nowadays, dredge disposal sites are miles out in the Pacific Ocean.

Conditions Today

In the early 20th century, farmers were attracted to the rich black soil that was present around the lower river. To accommodate farming, they drained two-thirds of the river's estuary. By the 1930s farmers had established themselves on the banks of the river and were prospering. The riparian area's fragile soil, however, could not handle the strains of agriculture, and by the 1950s and 60s the land was much less productive than before. Farming became marginally profitable, and soon the whole industry collapsed. Today, much of the formerly tilled soil remains unfit for both agriculture and natural estuarine habitat (Larison, 1982).

While agriculture failed, the logging industry has prospered. They have used the lower river as a means of storage, transport of lumber to mills, and a portal to foreign markets. The environmental effects are subtler than those of agriculture. Logs floating in the estuary leach toxins into the water, and erosion from logging washes soil and refuse into the estuary, also polluting it. Logs makes up 91% of the weight exported from the Port of Astoria (Larison, 1982).

The mouth of the Columbia River has become an essential gateway for international trade between Asia and Portland, and large container ships the size of multiple football fields are beginning to make their way up the river. Portland shippers stand to gain millions of dollars doing business with these container ships' companies. Since 1956, periodic dredging began again to maintain a 40-foot depth, and currently, a proposal to dredge the channel to 43

feet is waiting for "biological opinion" from the National Marine Fisheries Service (McKinney, 1987; Pyati, 2001). The US Army Corps of Engineers also hired Sustainable Ecosystems Initiative, an independent consultant, to research the environmental effects dredging has on the river, such as releasing toxins and destroying aquatic habitat (Pyati, 2001).

As the mouth of the Columbia River is a way for ships to enter the inland West, it is also a way for civilization's byproducts to exit. The Columbia River, like all rivers, is a waste removal system with the Pacific Ocean as its septic tank. The Coast Guard uses helicopters to monitor the large, easily seen effluents in the river, but cannot check the relatively minuscule amounts of potent runoff chemicals from pesticides, herbicides, oil spills and sewage. Not until recently has research alluded to the permanent effects these synthetic organic chemicals have on biological life.

Salmon have been impacted by the dams and overfishing, but altering the river's flow, pollution and habitat loss have also contributed to their (and other estuary life's) decline. Much of the economy around the mouth is entwined with shipping and the timber industry. Environmentalists and the public have voiced their concern over the sustainability of the region's economy, because it relies heavily on the limited natural resources of the lower Columbia. Industry and development is needed to support the communities, but maintaining the health of the mouth will be the challenge for generations to come.

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