Humboldt Bay
Maritime Industrial Use Market Study
FINAL REPORT

PREPARED FOR

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May 31, 2018

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BST Associates was retained by Humboldt County to prepare an assessment of the long-term demand for land zoned for Coastal-Dependent Industry (CDI) on Humboldt Bay, and to compare this demand with the existing supply.

Supply

- Humboldt Bay currently has 1,380 acres of property zoned for Coastal-Dependent Industrial use. Of this total, 1,100 acres are on land and 278 acres are in the water. More than two-thirds of the property, or 948 acres, is located on the Samoa Peninsula.
- Projected sea level rise may impact a significant portion of the CDI land. As much as 113 acres may be vulnerable by 2030, and as much as 400 acres by 2100.

Economic Background

- Demand for CDI land has been falling for decades.
- The decline in demand is due mainly to the decline of the forest products industry.
- Demand from the forest products industry is unlikely to recover.
- The number of jobs in coastal-dependent industries (primarily forest products and commercial fishing) has fallen substantially. While this decline may have stopped, employment in these industries is not projected to grow substantially.
- The population of Humboldt County is projected to grow at a low rate, i.e. 0.2% per year.
- Marine terminals on Humboldt Bay are farther from inland markets than most other ports on the West Coast. Combined with a lack of rail infrastructure, this makes it unlikely that Humboldt Bay can attract high-volume marine cargo.

Growth and new uses

- Industries most likely to show growth in demand for CDI property are local marine cargo, commercial fishing, mariculture, marine research, and recreational boating.
- A multi-use marine cargo terminal could handle most of the projected growth in local bulk and breakbulk cargo, and possibly a limited volume of local container traffic.
- A system of “marine highways” to shift freight traffic from roads to water has been discussed and studied. This traffic could likely be handled at the multi-purpose terminal.
- Humboldt Bay may see an increase in cruise ship visits, to as many as 10 per season. This traffic can likely be handled at existing facilities.
- Humboldt County quarries may be able to compete for aggregate business in the San Francisco Bay Area and Southern California.
- Humboldt Bay has a potential future in exporting shellfish seed and larvae cultivated in subtidal areas.
- A National Marine Research and Innovation Park (NMRIP) has been proposed for repurposing of the Samoa pulp mill into a multi-use facility housing both research and commercial opportunities in aquaculture, biomass conversion, and renewable energy.

<u>Projected Demand</u>

- Current demand for CDI land is 121 acres.
- Future demand is projected to range from 120 to 492 acres.
- The wide range in projected demand is due to uncertainty of the potential offshore energy sector.
- Without offshore wind energy development, demand is projected to range from 120 acres to 192 acres.

<u>Comparison of Supply and Demand</u>

- The supply of land zoned Coastal-Dependent Industrial exceeds projected long-term demand by 600 to 980 acres.
- Under the high estimate of demand for CDI land and the high estimate of loss of CDI land due to sea level rise, the surplus of CDI land exceeds 200 acres; under lower levels of demand and/or land loss, the surplus of CDI land is higher.

<u>Infrastructure needs</u>

- A single multi-purpose marine terminal of approximately 41 acres could support most of the projected growth in marine cargo.
- The Samoa Peninsula is the only location with CDI properties larger than 25 acres and which are located on the 38-foot deep navigation channel.

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1 INTRODUCTION

1.1 PURPOSE

BST Associates was retained by Humboldt County to prepare an assessment of the long-term demand for land zoned for Coastal-Dependent Industry (CDI) on Humboldt Bay, and to compare this demand with the existing supply.

The results of this analysis will be used by the County to determine which properties should remain zoned for CDI and which might be rezoned for other industrial uses, if it is determined that the supply exceeds projected long-term demand.

In addition, throughout the report we address the types of infrastructure that are needed in order to meet the projected demand.

1.2 METHODOLOGY

This report uses existing reports and analyses, where possible, and combines this material with original research and interviews. A list of sources is included at the end of the report.

1.3 DESCRIPTION OF THE STUDY AREA

Humboldt Bay is the largest harbor of commercial importance between San Francisco and Coos Bay, Oregon. The Bay is 14 miles long and 4.5 miles wide at its broadest point, and is divided from the ocean by two sand spits. The Bay is generally divided into the North Bay, Middle Bay, and South Bay.

Most Coastal-Dependent Industrial uses are concentrated in the Middle Bay, with some in the South Bay. The North Bay is relatively shallow, with more than half exposed as mudflats during low tide. The North Bay is separated from the Middle Bay by a fixed-span highway bridge that prevents large vessels from entering the North Bay. No CDI lands are located in the North Bay.

The Middle Bay runs north from the Bay entrance channel to the highway bridge, with the north spit to the west and the city of Eureka to the east. A 38-foot deep navigation channel serves numerous current and former marine terminals and industrial sites on the east and west banks of the Middle Bay. Most of the CDI lands are located on the Middle Bay.

The South Bay is located south of the entrance channel and is fairly similar in character to the North Bay, with more than half exposed as mudflats at low tide. A 26-foot deep navigation channel provides access to several unused or underutilized CDI properties along east bank.

Historically, two of the largest industries in the region were forest products and commercial fishing. Both of these have seen significant long-term declines and are not projected to recover to their former levels. This significantly impacts the future demand for Coastal-Dependent Industrial lands, since a large share of the vacant CDI lands were once used for manufacturing and shipping forest products.

1.4 Summary of Supply and Demand

The current use and future demand for CDI land was analyzed for a number of different uses, including marine cargo, commercial fishing, recreational boating, mariculture, marine research, and offshore energy. Current estimated use of CDI lands is 121 acres, of which nearly half is related to marine cargo and half to fishing and recreational boating. A smaller share is also used for mariculture.

Projected future demand spans a wide range, due to the uncertainty of the potential offshore energy sector. Without offshore energy, future demand is estimated to range from 120 acres under the low case to 192 acres under the high case. The high case includes growth in demand from marine cargo, fishing and recreational boating, mariculture, and marine research.

Estimates of demand for CDI land from offshore energy are extremely uncertain at this time. Initial planning is underway by parties interested in the concept, but the future scale of the sector is unknown. Estimated demand for CDI ranges from 0 acres under the low forecast to 300 acres under the high forecast, but could end up anywhere in that range.

Table 1-1: Summary of Current CDI Use, Future Demand, and Supply

	Current	Future Acres		Change in Acres		
Use Category	**Acres**	**Low**	**High**	**Low**	**High**	**Comments**
Marine Cargo	54	46	95	-8	41	A single multi-use terminal may accommodate other general cargo, marine highway, and containers
Fishing & Recreational Boating	60	64	67	4	7	
Other Uses						
Mariculture	7	10	20	3	13	
Marine Research	0	0	10	0	10	
Offshore Energy	0	0	300	0	300	Large range of uncertainty
Sub-Total	7	10	330	3	323	
Total	121	120	492	-1	371	
Existing Supply	1,100	1,100	1,100			
Surplus	979	980	608			

Source: BST Associates

2 SUPPLY ANALYSIS

2.1 EXISTING SUPPLY

Humboldt Bay currently has 1,380 acres of property zoned for Coastal-Dependent Industrial use. Of this total, 1,100 acres are on land and 281 acres are in the water.

More than two thirds of the CDI property, or 948 acres, is located on the Samoa Peninsula. Approximately half of the remainder is located in Eureka (i.e. 225 acres), and the rest is split between Fields Landing (i.e. 139 acres), and King Salmon (i.e. 69 acres).

Projected sea level rise may impact a significant portion of the CDI land. According to the high estimate of sea level rise, by the year 2030 as much as 113 acres of CDI land may be vulnerable to inundation. By 2050 this may increase to 278 acres, and by 2100 as much as 400 acres of CDI land may be vulnerable.

Table 2-1: Supply of CDI Land

Location	Land	Water	Total
Eureka	133.9	90.8	224.7
Samoa Peninsula	802.5	145.6	948.1
Fields Landing	99.6	38.9	138.5
King Salmon	63.9	5.2	69.1
Total	1,099.9	280.5	1,380.4

Source: Humboldt County Planning Department

2.2 DESCRIPTION OF LAND USE AND ZONING

The Humboldt Bay Area Plan (HBAP), a component of the County's Local Coastal Program, states that the purpose of the land use designation Industrial/Coastal-Dependent (MC) is to protect and reserve parcels on or near the sea for industrial uses dependent on, or related to, the harbor.[1] Under the HBAP, principal uses allowed on MC lands include any coastal-dependent industrial use that requires access to a maintained navigable channel in order to function, including, but not limited to:

- public docks,
- waterborne carrier import and export operations,
- ship building and boat repair,
- commercial fishing facilities, including berthing and fish receiving, and fish processing when product is for human consumption,
- marine oil terminals,
- offshore oil service or supply bases,
- ocean intake, outfall or discharge pipelines, and
- pipelines serving offshore facilities, aquaculture and aquaculture support facilities.

[1] Humboldt County, *Humboldt County General Plan for the Areas Outside the Coastal Zone*, adopted October 23, 2017

Lands with a land use designation of MC are generally zoned Industrial/Coastal-Dependent (MC), as well. Principally permitted uses in the MC zone district are: Minor Utilities; Coastal-Dependent (subject to Coastal-Dependent Industrial Development Regulations); and Aquaculture (subject to Coastal-Dependent Industrial Regulations).

2.3 DESCRIPTION OF HUMBOLDT BAY

This following description of Humboldt Bay is taken from the Humboldt Bay Area Plan.

> Humboldt Bay is by far the largest and most important estuary on the Northern California coast. It is also the only harbor of commercial importance for major shipping between San Francisco and Coos Bay, Oregon. The Humboldt Bay Planning Area extends from the Mad River to Table Bluff/Hookton Road, excluding the cities of Eureka and Arcata. The coastal zone runs inland to include flood prone bottomlands south of the Mad River, important drainages at Freshwater Creek and Elk River, and Hookton Slough which drains into South Bay.
>
> Humboldt Bay: The Bay itself is 14 miles long and 4.5 miles wide at its broadest point. The Bay system is protected from the ocean by two sand spits, separated by the Bay entrance which is maintained by two rubblemound jetties. Dredged channels extend two miles into South Bay and four miles north from the Bay entrance. Numerous natural tidal channels are also present.
>
> Excluding its tributary sloughs, the Bay is about 16,000 acres in area. Historically the Bay was much larger, perhaps 27,000 acres, but land reclamation of salt marshes and mud flats has reduced it to its present size.
>
> The North (Arcata) Bay covers an area of approximately 8,000 acres. Most of this area, excluding a number of channels formed by tributaries and tidal erosion, is relatively shallow. At low tide 4,500 acres of mud flats are exposed. The areas immediately north and east of North Bay were once marshlands, much of which now serve as pasture.
>
> To the west the North Bay is separated from the Pacific Ocean by a vegetated expanse of forest and dunes that extends north to the Mad River. This dune forest habitat is one of the few stands of its type between Crescent City and Fort Bragg.
>
> The Middle Bay forms a channel which connects the North and South Bays. This channel is nearly six miles long and ranges between ½ and one mile in width. Woodley and Indian Islands are located at the north end of the Middle Bay.
>
> The South Bay is fairly similar in character to the North Bay with a total area of about 4,670 acres, 57% of which are exposed mudflats at low tide. The Hookton Channel, with an average depth of 26 feet, provides deepwater access to King Salmon and Fields Landing. Most of the agricultural area east and south of South Bay is comprised of diked former tidelands.
>
> The Spit separating the South Bay from the ocean is typically more narrow and sparsely vegetated than the North Spit. It is also subject to inundation from the ocean during periods of high tides and seas.[2]

[2] Humboldt County, *Humboldt Bay Area Plan of the Humboldt County Local Coastal Program*, December 2014

2.4 ACREAGE BY LOCATION

2.4.1 Samoa Peninsula

2.4.1.1 History

The Vance and Garwood Lumber Company was established in Eureka in 1856, and moved to a new mill and company town on the Samoa Peninsula in the 1890's. In 1900, the Vance Redwood Lumber Company was sold to A.B. Hammond, and became part of the Hammond Lumber Company. In 1956 the company was sold the Georgia Pacific Corporation (G-P), and in 1972 a portion of G-P was spun off into a newly created company, the Louisiana Pacific Corporation.

The Samoa Pulp Mill was built on the site of the lumber mill in 1965 by Georgia Pacific, and then became a part of Louisiana Pacific when that company was created. In subsequent years the mill operated as Samoa Pacific Cellulose and Stockton Pacific. The mill and town were sold in 1998 to a new company called Simpson-Samoa. At that time, the town of Samoa was one of only two intact lumber company towns in northwestern California.[3]

In 2000, Simpson-Samoa reopened the pulp mill, which had closed in 1993, and sold the remainder of the site to the Samoa Pacific Group LLC. By this time most of the buildings on the mill site had been demolished. The Simpson-Samoa pulp mill was later sold to Evergreen Pulp and finally to Freshwater Tissue Company, before closing for good in 2008. The Humboldt Bay Harbor, Recreation and Conservation District (Harbor District) purchased the site in 2013, and much of the facility has since been demolished.

South of the town of Samoa, Simpson purchased U.S. Plywood's Mutual Plywood Mill at Fairhaven, California for $1 million and an option to buy about 40 million bd. ft. of stumpage. Simpson modified the Mutual Plywood mill to produce redwood siding, changed its name to Fairhaven Plywood, and closed the obsolete Eureka Plywood Mill. With its Mad River and Fairhaven mills, Simpson became the largest plywood producer in California – annual production of 235 million sq. ft. (3/8" basis) of Douglas fir, redwood and overlaid panels.[4]

Crown Zellerbach and Simpson created a new company in 1966 (Crown Simpson), which built a second pulp mill on the Samoa peninsula in 1966, at Fairhaven. Simpson later purchased entire control of the plant from Zellerbach, and operated the mill until it closed in 1992.

2.4.1.2 Existing CDI Property

A large share of the MC-zoned property on the Samoa Peninsula is at the Eureka Municipal Airport. The airport is located near the south end of the peninsula, west/southwest of the old Fairhaven mill site. The airport is located on a single parcel encompassing 311.0 acres, including 272.4 acres that are zoned MC. Included in this MC acreage are 259.1 acres of land and 13.3. acres of water.

Most of the airport property is located along the Pacific Ocean shoreline, and to the west of New Navy Base Road. A small portion of the parcel is located east of the road, along Humboldt Bay. The portion

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[3] Humboldt State University Special Collections website, http://library.humboldt.edu/humco/holdings/LPHammondAid.htm#publicinfooffice (accessed 2-16-2018).

[4] Simpson Timber Company, *Five Generations of Family Management, Number 22*, September 1999.

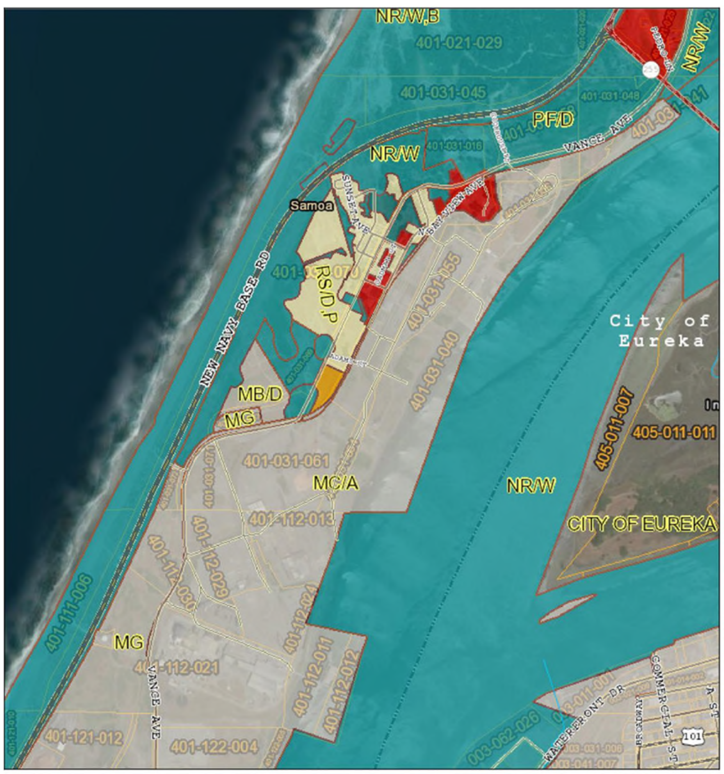
east of the road is vacant and contains no dock or other structures. The airport has not been used for coastal-dependent industries since before World War II. The U.S. Navy operated coastal patrol blimps from the property during World War II, after which it was developed into Eureka Municipal Airport. The site also contains the Samoa Drag Strip, which was built in 1952 and runs parallel to the runway.

Immediately north of the small portion of airport property on Humboldt Bay is a 27.1 acre parcel that is zoned MC, with 23.4 acres of land and 3.7 acres of water. The property is currently in residential use; it has a single residence, and no dock. It does not appear to have had coastal-dependent industrial uses in the past. It is owned by O'Connor and Cirincione.

North of the O'Connor/Cirincione property is a 31.9 acre parcel owned by the City of Eureka. This parcel is vacant. The parcel is located on Humboldt Bay, but does not have a dock, and does not appear to have had coastal-dependent industrial uses in the past.

Finntown is a small enclave of approximately nine residences and a few small industrial businesses. It is located on the bay front approximately midway along the peninsula.

Figure 2-1: Map of Samoa Peninsula



Source: Humboldt County GIS

Table 2-2: MC Property on Samoa Peninsula

Owner	Land	Water	Total
City of Eureka	330.8	13.3	344.1
Harbor District	118.2	35.6	153.8
California Redwood Co.	77.3	0.6	77.9
Sequoia Investments	96.4	13.9	110.3
Other	179.8	82.2	262.0
Total	802.5	145.6	948.1

Source: Humboldt County Planning Department

Existing facilities on the Samoa Peninsula include:

Fairhaven Terminal is located at the former site of Crown-Simpson Pulp Mill and is now owned by Sequoia Investments X LLC. The dock was used for shipping and receiving conventional general cargo, wood pulp, and lumber. The property has a variety of uses, but most of these are not coastal-dependent. The Fairhaven property also contains a number of buildings formerly associated with the mill, as well as a large amount of vacant land.

Redwood Marine Terminal 2 is the site of the majority of the former Freshwater Tissue property. Commonly known as the Samoa pulp mill site, it is now the Harbor District's Redwood Marine Terminal 2 (RMT 2). The District purchased 72-acres of the industrial site in August of 2013 for $1. An adjacent 17 acres is also being purchased, making the entire District-owned complex 89 acres. As an abandoned site, the remaining pulp liquors and other contaminants represented an enormous hazard to Bay health. The District immediately engaged EPA in cleanup. With phases 1 and 2 done, new tenants have begun to move in. One of these tenants is Taylor Mariculture, which makes use of the existing industrial infrastructure to grow clam and oyster seeds. Humboldt County, in cooperation with the Harbor District, has received a Community Development Block Grant (CDBG) to engineer the reuse of the water and wastewater facilities in order to plan for upgrades.

California Redwood Chip Export Dock. The California Redwood Chip Dock was originally constructed to serve the Samoa pulp mill. In 2010, Samoa Properties Inc. acquired the export facility when the Samoa pulp mill was sold to Evergreen Pulp. Prior to this acquisition, the dock had been idle for approximately a decade. The California Redwood Company uses the wood chip export facility to export sawmill byproducts to overseas customers.[5]

Redwood Marine Terminal 1. The Redwood Marine Terminal 1 (RMT 1) is owned by the Harbor District, and was formerly the Town of Samoa Wharf and Dock. Redwood logs were shipped to the site by rail where they were milled into lumber, and then the lumber was shipped out by water. The property now houses a variety of operations; RMT 1 functions primarily as a working dock for commercial fishermen, but also houses an aquaponics research facility and a hagfish processing/shipping operation. Adjacent to RMT 1 are the Samoa Shops and railroad roundhouse, which are being renovated into a museum. The adjacent historic Town of Samoa is also undergoing renovation.

2.4.2 Woodley Island

The Woodley Island Marina is located across Eureka Channel from downtown Eureka and is at the end of the navigation channel. The marina is owned and operated by the Humboldt Bay Harbor Recreation and Conservation District, and is used for mooring commercial fishing boats, and recreational and other small craft. The marina is located in land zoned as "Public Facilities – Marina", as opposed to "Coastal-Dependent Industry".

2.4.3 Eureka

Within the City of Eureka there 79 parcels containing a total of 225 acres of CDI zoned property, of which 134 acres are land and 91 acres are water. These properties currently host a mix of CDI and non-

[5] Driscoll, John, "California Redwood looks to restart chip export facility; ships would move sawmill byproduct to Asian markets", *The Times-Standard*, October 15, 2010. http://www.times-standard.com/article/zz/20101015/NEWS/101019432 (accessed March 8, 2018).

CDI uses. The 79 parcels of CDI property in Eureka are combined into 25 properties; some of these properties contain only one parcel and some contain multiple parcels.

The CDI properties in Eureka are relatively small when compared to those on the Samoa Peninsula or at Fields Landing. As shown in Table 2-3, 12 of the 25 properties are less than 3 acres in size, including both land and water acreage. Three of the properties are between 3 and 10 acres, six properties are 10 to 20 acres, and four properties are larger than 20 acres. None of the properties is larger than 24 acres.

All but one of the properties are currently zoned MC. The one exception is a 2.9-acre water parcel south of the Chevron Terminal.

While these properties (with the one exception) are zoned for coastal-dependent industry (i.e. MC zoning), many were not historically used for coastal-dependent purposes, and even fewer are currently in CDI use. Of the 25 properties, 14 were historically in CDI use and 11 were not. The 14 properties encompass approximately 110 acres, including 72 acres of land and 38 acres of water. Property not historically in CDI use totals 114 acres, including 62 acres of land and 52 acres of water.

Only nine of the 25 properties are currently in CDI use. These nine properties total 86 acres, including 54 acres of land and 32 acres of water. Property not currently in CDI use totals 138 acres, including 79 acres of land and 59 acres of water.

Table 2-3: CDI Property in Eureka

			Acres (approx.)			CDI Status		
Sub Area	**#**	**Description**	**Land**	**Water**	**Total**	**Current Use**	**Historical Use**	**Zoned MC**
1	1	Fisherman's Terminal	2.3	0.2	2.5	Yes	Yes	Yes
1	2	Coast Seafood / Sanford	1.7	1.2	2.9	Yes	Yes	Yes
1	3	Old Ice House	1.4	0.0	1.4	No	Yes	Yes
1	4	COE Parking Lot East of Bar Fly	1.1	0.4	1.5	No	Yes	Yes
1	5	EDA Fish Plant (Pacific Choice)	2.0	0.1	2.1	Yes	Yes	Yes
1	6	Marina, Public Bathroom, and Parking Lot	1.7	1.1	2.8	No	No	Yes
2	7	City-owned Parcel in center of Marina Way	2.9	-	2.9	Yes	Yes	Yes
2	8	Wharfinger, Dock B, and Schneider Dock	1.3	16.3	17.6	Yes	Yes	Yes
2	9	Schneider Properties	21.4	-	21.4	Yes	Yes	Yes
2	10	Tosco (Former Renner Bulk Plant)	4.3	2.8	7.1	Yes	Yes	Yes
2	11	Eureka Forest Products	15.3	4.2	19.5	Yes	Yes	Yes
2	12	Isolated Parcel within Eureka Forest Products	1.4	-	1.4	No	No	Yes
2	13	Preston Properties	12.1	9.4	21.5	No	No	Yes
3	14	Peninsula Directly South of Del Norte St	5.7	14.6	20.3	No	No	Yes
3	15	Waterfront West of Poleshed	3.4	20.6	24.0	No	No	Yes
3	16	Mall Back Lot	6.3	-	6.3	No	No	Yes
3	17	Parcel 4 and North	14.8	3.0	17.8	No	Yes	Yes
4	18	Chevron	3.4	7.0	10.4	Yes	Yes	Yes
5	19	Waterfront South of Chevron	0.0	0.3	0.3	No	Yes	Yes
5	20	Offices South of Chevron	0.8	-	0.8	No	No	Yes
5	21	Water South of Chevron	0.0	2.9	2.9	No	Yes	No
5	22	Hikshari Trail North	3.8	3.4	7.2	No	No	Yes
5	23	Truesdale South Trailer Park Area	14.7	-	14.7	No	No	Yes
5	24	Residential N. of HBF Training Grounds	0.5	-	0.5	No	No	Yes
5	25	HBF Training Grounds	11.6	3.3	14.9	No	No	Yes
		Total	133.9	90.8	224.7			

Source: City of Eureka

The City of Eureka grouped the 25 properties into five sub-areas for their 2017 analysis of CDI property. (See Figure 2-2). These sub-areas are numbered one through five, arranged from north to south.

Sub-Area 1 includes six properties:

- Fishermen's Terminal is a 2.5-acre property that is currently in CDI use, including 2.3 acres of land and 0.2 acres of water. This processing facility is used by several fish processors, as well as a seafood restaurant.
- The Coast Seafood / Sanford property is 2.9 acres, most of which is in CDI use. The property includes approximately 2.2 acres that are occupied by the Coast Seafood processing plant and the adjacent 0.7-acre vacant property. Total land area of the property is 1.7 acres and water area is 1.2 acres.
- The Old Ice House property has been vacant since Eureka Ice and Cold Storage closed in 2008. This property is 1.4 acres, all of which is land.
- The City of Eureka owns a 1.5-acre property to the west of the old ice house that is used as a parking lot (i.e. non-CDI use). This property includes 1.1 acres of land and 0.4 acres of water.
- The EDA Fish Plant is located on a 2.1 acre property owned by the City of Eureka. This property is in CDI use, with a fish processing plant currently operated by Pacific Choice. The property includes 2.0 acres of land and 0.1 acre of water.
- The remainder of sub-area one is used by the City of Eureka marina, along with the associated parking lot and restroom facility. This property is 2.8 acres, including 1.7 acres of land and 1.1 acres of water.

Sub-Area 2 is located to the southeast of Sub-Area One. It is the largest of the five sub-areas, accounting for 91 of the 225 acres. More than a third of this sub-area is water acreage; water accounts for nearly 33 acres and land 59 acres. Most of the waterborne cargo activities in Eureka occur in this sub-area.

- The northernmost property is a city-owned parcel that is currently vacant. This parcel is 2.9 acres, all of which is land. The parcel is adjacent to Dock B.
- To the west and south of the City parcel is large water parcel that has several docks. The property is 17.6 acres, of which 16.3 acres is water and 1.3 acres is land. The property contains Humboldt Dock B, which is unused and in poor condition. The dock is approximately 200 feet long, and the navigation channel adjacent to the dock has an authorized depth of 26 feet. This property also contains the Schneider dock currently used for exporting logs.
- Adjacent to the city-owned parcel is the 21-4-acre Schneider property. This property is currently in CDI use, and is where logs are handled for export via the Schneider dock.
- South of the Schneider is the 7.1-acre former Tosco Refining property. This property was historically used for receiving and storing petroleum products, but the oil receiving equipment and tanks have been removed, and contamination has been remediated.
- Eureka Forest Products owns a 19.5-acre property that is currently used for shipping woodchips by water. The property includes 15.3 acres of land and 4.2 acres of water, and has a dock in active use.
- Surrounded by the Eureka Forest Products property is a vacant 1.4-acre property that is zoned MC but has not historically been used for CDI purposes.
- At the south end of Sub-Area 2 is Preston Properties, a 12.08 acre former plywood mill site. The property contains several large buildings, with some current non-CDI use. Most of the property (i.e. 9.37 acres) consists of tidelands that historically served as a log pond.

Sub-Area 3 is the second-largest of the sub-areas, containing a total of 68.5 acres. The majority of this property is water acreage; water accounts for 38.3 acres and land accounts for 30.2 acres. None of the property is currently in CDI use, and most is natural area.

- The first property is a 20.3-acre parcel located adjacent to and south of the Del Norte Street Fishing Pier. This property consists mainly of a natural area, but also contains a parking lot for the fishing pier. It is not in CDI use, and was not historically in CDI use. Most of the property (i.e. 14.6 acres) is water, and the remaining 5.7 acres is land.
- The next property to the south is also primarily natural area that has not historically been used for CDI purposes. Total area is 24.0 acres, of which 20.6 acres is water and 3.4 acres is land. This property and the one adjacent are located between the tide line and the new Humboldt Bay Trail. This trail is located along the right of way of the North Coast Railroad Authority.
- Located east of the Humboldt Bay Trail is a 6.3-acre parcel that contains a parking lot for the Bayshore Mall. This property is not in CDI use, and was not used historically for CDI purposes.
- West of the mall and south of the two natural area properties is a 17.8-acre property that is also now primarily natural area. The property historically had CDI uses but has been vacant for decades.

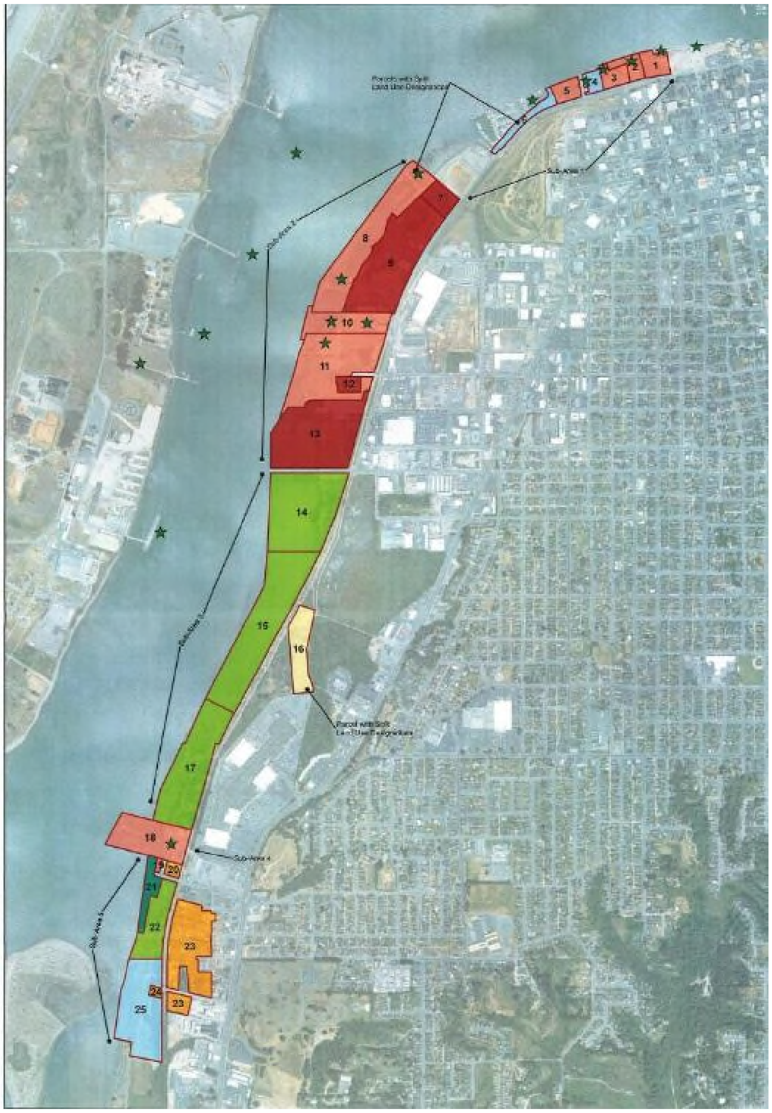
Sub-Area 4 has one property, which is the location of the Chevron Terminal.

- The Chevron Eureka Terminal is a 10.4-acre property that contains the dock and bulk fuel storage facility. Seven acres of the property are water and 3.4 acres are land. The facility receives petroleum products by barge and ships them out by truck. Approximately 80% of the fuel used by the greater Eureka area is delivered via barge to the Chevron Terminal.

Sub-Area 5 has 41.2 acres of property, including 31.4 acres of land and 9.9 acres of water. None of the properties currently has CDI uses, and only one of the seven properties historically had CDI use.

- The northernmost property consists of three parcels that are primarily water, and that contain a total of 0.3 acre. This property is not currently in CDI use, and was not historically in CDI use.
- Across Christie Street to the west is a 0.8-acre property. This property has several non-CDI office buildings on it, and the property was not historically in CDI use.
- Five water parcels form a 2.9 acre property to the south of the 0.3 acre property. This property is not currently in CDI use, and but a portion of it was used for CDI purposes.
- A number of parcels are combined into one 7.2-acre property that contains the City's Hikshari Trail, a recreational trail that runs along the waterfront. Although zoned MC, this was not historically in CDI use.
- The largest property in Sub-Area Five is the 14.7-acre Truesdale South Trailer Park Area. This property is in residential use, and was not historically in CDI use.
- The southernmost property in Sub-Area 5 is 14.9 acres used by Humboldt Bay Fire as training grounds. The property contains 11.6 acres of land and 3.3 acres of water. The current use is non-CDI, and the property was not historically in CDI use.

Figure 2-2: Map of Eureka



Source: City of Eureka

2.4.4 Fields Landing and King Salmon

The Fields Landing - King Salmon area is located on the east side of Humboldt Bay, south of the entrance channel and along the 26-foot Fields Landing Channel. The North Coast Railroad right of way runs parallel to the shoreline through this area, and the MC land is located between the shoreline and the railroad right of way.

Total MC area is 207.6 acres, including 163.5 acres of land and 44.1 acres of water.

King Salmon is located north of Fields Landing and several miles south of Eureka. Four parcels in the area are wholly or partially zoned as MC. Total MC area is 69.1 acres, of which 63.9 acres are land and 5.2 acres are water.

There are no docks associated with MC land at King Salmon.

All of the MC land in King Salmon is associated with the Humboldt Bay Generating Station, operated by Pacific Gas & Electric Company (PG&E). Originally this site contained a nuclear power plant, Humboldt Bay Power Plant, which began operations in 1963. The nuclear plant operated until 1976, when it was shut down for refueling. Due to changes in safety regulations, upgrades to the plant were uneconomical and the plant was not restarted, and the plant was subsequently used only to store spent fuel. Decommissioning of the plant was approved in 2009 and is currently in process, as is restoration of the site. This process is projected to continue for several decades. The Humboldt Bay Generating Station is a natural gas-powered facility that began operations on the site in 2010.

A key feature of the power plant site is a man-made channel that runs from Humboldt Bay to the property. The channel was previously used to provide cooling water to the nuclear power plant, but the gas-fired plant that replaced the nuclear plant does not use the same cooling process. PG&E transferred ownership of Fisherman's Channel to the Humboldt Bay Harbor, Recreation and Conservation District, and the Harbor District assumed to the responsibility for dredging the channel. This channel is crossed by several fixed low-level bridges which prevent navigation in the channel to the MC property.

Figure 2-3: Map of King Salmon

Source: Humboldt County GIS

Table 2-4: MC Property at Fields Landing and King Salmon

Location	Land	Water	Total
King Salmon			
Humboldt Bay Generating Station	63.9	5.2	69.1
Sub-total	63.9	5.2	69.1
Fields Landing			
Humboldt Bay Forest Products	52.5	23.5	76.0
Fields Landing Terminal	30.6	13.3	43.9
Small parcel marine related uses	3.9	1.1	5.0
Other	12.6	1.0	13.6
Sub-total	99.6	38.9	138.5
Total	163.5	44.1	207.6

Source: Humboldt County Planning Department

Fields Landing at one time had three cargo docks, but now there are just two. These facilities historically handled logs, woodchips, and other forest products, as well as fuel and fish. Fields Landing was also home to one of the last remaining whaling stations in the United States, which operated until 1951.

The Humboldt Bay Forest Products dock is located at the north end of Fields Landing. Humboldt Bay Forest Products controls most of the MC property at Fields Landing, including 52.5 acres of land and 13.3 acres of water, or a total of 76.0 acres. The site includes adjacent parcels from several ownerships, and contains potential wetlands, flood areas, mud flats and old pilings.[6]

The other dock is located at the mid-point of the Fields Landing shoreline, between the Humboldt Bay Forest Products dock and Fields Landing Terminal. This site consists of several small parcels owned by several different parties. MC property includes 4.1 acres of land, 1.3 acres of water, and 5.2 acres in total. Uses on the site have included fish processing and fishing related operations, as well as others.[7]

The former Kramer Dock at the south end of Fields Landing was purchased by the Harbor District and renamed Fields Landing Terminal. The terminal formerly had a dock approximately 900 feet long, but it was not in usable condition and was removed in 2010[8]. The primary use of the site is now the Fields Landing Boat Yard, operated by the Harbor District. This is self-serve facility, with the haul-out services provided by the Harbor District.[9] There is also one commercial boat repair operation at the site. The terminal encompasses a total of 43.9 acres of MC property, of which 30.6 acres is land and 13.3 acres is water.

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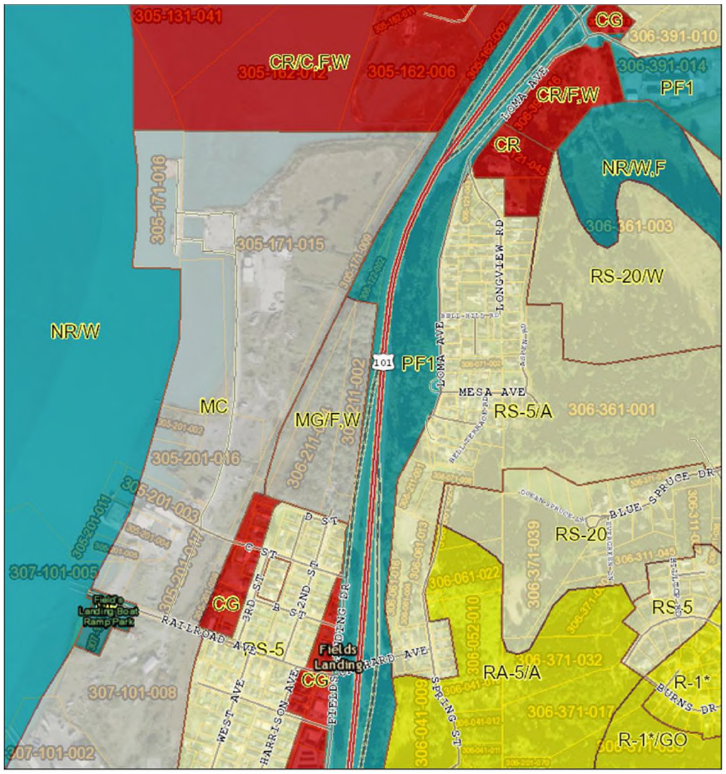
[6] PB Ports & Marine, *Port of Humboldt Bay Harbor Revitalization Plan Final Report*, February 2003.

[7] *ibid*

[8] LACO, *Technical Memorandum, Coastal-Dependent Industrial Site Inventory Review, Assessor's Parcel Numbers 401-301-05, 401-301-09, 401-311-01*, March 26, 2015.

[9] PB Ports & Marine, *Port of Humboldt Bay Harbor Revitalization Plan.*

Figure 2-4: Map of Fields Landing



Source: Humboldt County GIS

2.5 IMPACTS OF SEA LEVEL RISE

Rising sea levels create at the risk of inundation for many of the coastal-dependent industrial properties on Humboldt Bay.

According to a recent report prepared by Trinity Associates, there are approximately 52 miles of shoreline on Humboldt Bay that form a barrier protecting nearly 10,000 acres of low-lying areas from tidal inundation. A New Year's Eve 2005 king tide and storm surge caused sea levels to rise 1.8 feet, the highest water level ever recorded on Humboldt Bay. By 2050 sea level rise may cause king tides to rise as much as three feet, and roughly 35 miles of barrier shoreline (58% of the artificial shoreline) could be overtopped, flooding the areas protected by the barriers. This includes the communities of King Salmon, Fields Landing, and Fairhaven.[10]

The *Sea Level Rise Vulnerability Assessment*, prepared as part of the update of the Humboldt Bay Area Plan, projected the level and timing of the risk from sea level rise. This projections for sea level rise were prepared by Northern Hydrology and Engineering (NHE), based on sea level at the North Spit tide gauge. The projected high sea level rise and the planning horizon is presented in Table 2-5.

[10] Laird, Alderon, *Humboldt Bay Area Plan Sea Level Rise Vulnerability Assessment*, January 2018.

Table 2-5: Potential Tidal Inundation Due to Sea Level Rise

Year	Rise above MMMW	Rise above MAMW
2030	0.9 ft.	1.1 ft.
2050	1.9 ft.	1.6 ft.
2070	3.2 ft.	3.3 ft.
2100	5.4 ft.	4.9 ft.

Note2: MMMW is mean monthly maximum water
MAMW is mean annual maximum water
Source: Northern Hydrology and Engineering

Trinity Associates notes that "All development located in vulnerable areas is at risk of becoming inundated by saltwater, or flooded by rising groundwater. Vulnerable assets include land uses and developments, public coastal access/recreation, natural and cultural resources, transportation facilities, and utility infrastructure."

The Trinity report estimated the potential inundation of all land use types in the coastal zone. Under the high scenario, the amount of Coastal-Dependent Industrial land at risk of inundation rises from 79 acres (8% of total) in 2030 to 400 acres (41% of total) in 2100. (See Table 2-6).

Table 2-6: Potential Tidal Inundation of CDI Land Due to Sea Level Rise

Year	Current Acres	2030	2050	2070	2100
Sea level rise		0.9 Ft.	1.6 Ft.	3.3 Ft.	4.9 Ft.
Acres inundated	968	79	113	278	400
% inundated		8%	12%	29%	41%

Source: Trinity Associates

3 DEMAND – MARINE CARGO

3.1 INTRODUCTION

The purpose of this study is to identify growth trends for maritime industrial uses, refine the inventory of available maritime industrial land on Humboldt Bay, and to determine the current demand for maritime industrial uses and Industrial/Coastal-Dependent land ("MC" zoned land). The study will also determine what maritime industrial support infrastructure is needed to best match this demand, with a special focus on the Redwood Marine Terminal II site on the Samoa Peninsula. The findings of this study may be used to further protect critical lands zoned MC, as well as to rezone other MC zoned land not critical to regional maritime industrial operations.

This document builds on previous analyses, supplementing existing data with additional information gathered through stakeholder interviews, data analysis, and other relevant sources. This section also includes a brief review and forecast of the Humboldt Bay economy.

3.2 HUMBOLDT COUNTY POPULATION AND ECONOMY

Trends and forecasts for Humboldt county are presented in this section. This analysis draws heavily from the county-wide forecasts prepared by the Transportation Economics Branch, Office of State Planning, California Department of Transportation as well as the most recently completed comprehensive economic development report by Humboldt County.[11] As shown in Table 3-1, key findings include:

- Population growth has been relatively slow:
    - Humboldt County's population was 136,100 in 2016, growing at an average annual rate of 0.4% between 2000 and 2016.
    - Future population growth is projected to grow at an average rate of 0.2% per year between 2017 and 2050, with the total population projected to reach 146,500 in 2050.
    - Humboldt County accounts for 0.4% of the population in California.
- Employment has declined slightly during the past 16 years:
    - The employment base stood 51,400 in 2016, which was down approximately 1,000 employees from 2000.
    - Employment is projected to grow at an average rate of 0.3% per year between 2017 and 2050, reaching 58,000 employees in 2050.
    - Humboldt County accounts for 0.3% of California employment.

The sectors of the economy that typically use Coastal-Dependent Industrial land include resource and industrial sectors, such as natural resources and mining, manufacturing, and transportation, as well as farming, construction, warehousing, utilities, and wholesale trade. In Humboldt County these sectors accounted for 12,300 jobs in 2000, but only 8,900 jobs in 2016. Most of the decline was due to falling employment in the forest products industry, which accounts for about half of the manufacturing base.

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[11] Caltrans, Office of State Planning, Transportation Economics Branch, *California County-Level Economic Forecast 2017-2050*. September 2017.

Future employment in these sectors in Humboldt County is projected at grow at an average rate of 0.3% per year, with projected employment reaching 10,000 jobs in 2050.

- The share of jobs from resource and industrial sectors declined from 23% of all employment in 2000 to 17% in 2016, and is expected to remain at this level in 2050.
- There were 5,100 manufacturing jobs in 2000, accounting for 42% of the resource/industrial jobs. The share of manufacturing jobs declined to 23% in 2016 and is projected to remain at this level in 2050.

Table 3-1: Humboldt Bay Economic Forecast

Year	Population (thousands)	Total Employment (thousands)	Resource & Industrial Employment (thousands)	Share of Total Employment
2000	126.7	52.4	12.3	23%
2016	136.1	51.4	8.9	17%
2050	146.5	58.0	10.0	17%
Compound annual growth rate				
2000-16	0.4%	-0.1%	-2.0%	-1.9%
2017-50	0.2%	0.4%	0.3%	0.0%

Source: Caltrans

The Caltrans forecast can be used to rank employment sectors by the number of jobs projected to be created in Humboldt County between 2016 and 2050.

1. Leisure and hospitality
2. Education and healthcare
3. State and local government
4. Retail trade
5. Professional services
6. Natural resources and mining
7. Manufacturing
8. Transportation, warehousing, and utilities
9. Farm
10. Other
11. Information
12. Wholesale trade
13. Financial activities
14. Federal government
15. Construction

Humboldt County's unemployment rate was 3.9% in April 2017, which is considered near full employment.

Humboldt County's most recent Comprehensive Economic Development Study (CEDS)[12] was completed in 2012, with a planning period running from 2012 through 2018. The CEDS identified target sectors for growth based on four criteria:

[12] Humboldt County, *Prosperity, Comprehensive Economic Development Strategy 2013-2018*. 2012

- Expanding opportunity in job and/or firm growth,
- Growing quality in higher than average or increasing wages,
- Improving competitiveness in California, and
- Career potential.

Six industries were identified as targets of opportunity:

- Diversified Health Care,
- Building and Systems Construction,
- Specialty Food, Flowers & Beverages,
- Investment Support Services,
- Management & Innovation Services, and
- Niche Manufacturing (defined to include light high-value products that can easily be shipped on trucks).

The Prosperity report described the relative disadvantage for high-volume commodity markets that Humboldt County producers face due to the relatively greater distance from markets and resulting higher transport costs than competitors in other parts of California and other U.S. cities and regions.

3.3 Forest Products Industry

The history of the Humboldt Bay region is tied to the forest products industry, and most of the land zoned for coastal-dependent industry was at one time used by forest products.

The California timber industry is much smaller than it was four decades ago. Over the past four decades the state's highest timber harvest was in 1988, with nearly 4.7 billion board feet harvested. This dropped to just 0.8 billion board feet in 2009[13], with the decline most pronounced from 1988 through 1994, a period in which harvest volumes fell by half. After 1994 there were several periods when the decline slowed or stopped for several years (i.e. from 1994 through 1997, and from 2001 through 2007), but there were also periods of decline (i.e. from 1997 through 2001, and from 2007 through 2009. (See Figure 3-1).

The housing market crash and economic recession caused the most recent drop in volume (i.e., from 2007 through 2009). As the market recovered so did harvest volumes; harvest volumes grew from 0.8 billion board feet in 2009 to more than 1.6 billion board feet in 2013, and averaged approximately 1.5 billion board feet per year from 2014 through 2016.

In California, one of the major changes that has occurred is a shift of timber harvest away from public lands. During most of the 1980's more than 40% of the state timber harvest, or as much as 2.0 billion board feet, occurred on public lands. Harvest from public lands began to drop sharply after 1988, and by 1994 less than 0.4 billion board feet of timber came from public lands, or less than 15% of the state total. Between 1994 and 2016 public lands accounted for an average of approximately 12% of total harvest, although from 2012 through 2016 public land averaged closer to 14% of the state timber harvest.

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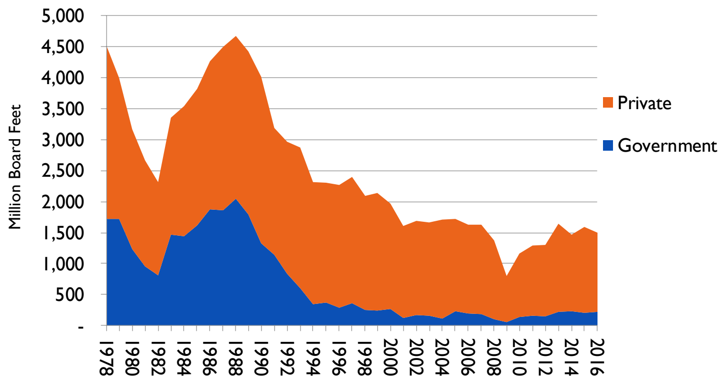
[13] California State Board of Equalization, *California Timber Harvest Statistics*. http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf (accessed January 12, 2018).

Figure 3-1: California Timber Harvest Trends



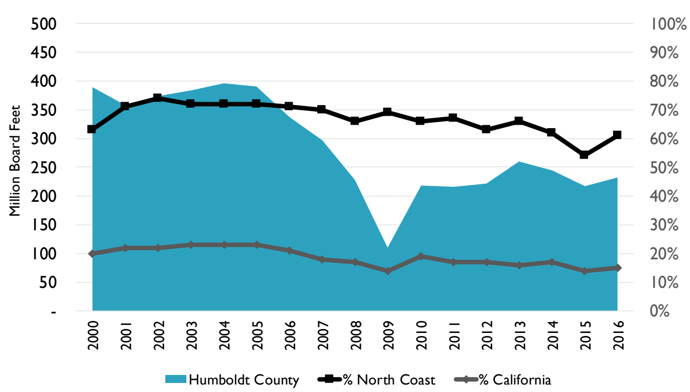
Source: California State Board of Equalization

The timber harvest in Humboldt County grew from approximately 360 million board feet in 2001 to 390 million board feet in 2005, before falling in each of the next four years. Humboldt County's timber industry was hit hard by the housing crash, and by 2009 harvest volumes had dropped to just 110 million board feet. Since the peak of the recession the Humboldt County timber industry has recovered, but harvest volumes remain lower than they were prior to the recession, averaging 230 million board feet per year from 2010 through 2016. (See Figure 3-2)

The California State Board of Equalization groups four counties into the North Coast region (i.e. Del Norte, Humboldt, Mendocino, and Sonoma). Humboldt County is by far the largest producer of timber in the region, accounting for more than 60% of the harvest in 2016. Humboldt County's share has slowly trended lower since 2002, when it accounted for 74% of the region's harvest.

Humboldt County accounted for 15% of California timber harvest volume in 2016. Humboldt County was also the largest producer of timber in the state that year, as it was in most years from 2000 through 2016.

Figure 3-2: Humboldt County Timber Harvest Trends



Source: California State Board of Equalization

The number of mills in Humboldt County declined between 2000 and 2012, as shown in Table 3-2, from 15 operating mills in 2000 to 12 in 2012. The number of sawmills declined from 12 in 2000 to 8 in 2012, and the one medium-density fiberboard and particleboard mill closed[14]. Sierra Pacific Industries explained the reasons behind the closure of its Arcata mill in 2016 as:

> "A fall-off in the amount of suitable timber for sale in this area, coupled with flat home construction in the U.S., and increased lumber imports from Canada have all played a role in our decision to close the mill. But, make no mistake, the largest factor was that the type and size of logs that this mill cuts are simply not available in ample supply to continue to run the mill. When combined, these factors leave us no choice but to close the plant. In an effort to keep the Arcata mill running, SPI has been transporting logs from the interior of California, and has barged logs from British Columbia and Washington. However, those efforts proved to be uneconomical."[15]

The number of biomass operations grew from one operation in 2000 to three operations in 2012, but these plants are also experiencing economic challenges. Utilities are obligated to use renewable energy (including biomass energy), but the amount purchased from various sources depends on the cost of the energy. Biomass power plants are not necessarily the lowest cost renewable energy source, due to the cost of transporting fuel from the source to the plant, the labor costs associated with extraction and production of the fuel material, and other costs.[16] There is also competition for wood chips from export markets, described in more detail later in this report in the section on woodchips.

Table 3-2: Humboldt Bay Forest Product Mills (2000 to 2012)

Year	Sawmills	MDF and particle-board	Bioenergy	Other	Total
2000	12	1	1	1	15
2006	7	1	1	1	10
2012	8	-	3	1	12

Source: USDA[17]

Lumber production in the California Redwood Region (which is dominated by Humboldt County) declined from around 2.2 million board feet (mmbf) in the late 1980s to between 400 mmbf and 550 mmbf from 2008 through 2016, representing a decline of approximately 25%. The California Redwood Region also lost market share during this time period, declining from 9% of West Coast production in the late 1980s to 4% at present. (See Figure 3-3).

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[14] U.S. Department of Agriculture, *California's Forest Products Industry: A Descriptive Analysis, for years 2000, 2006 and 2012*

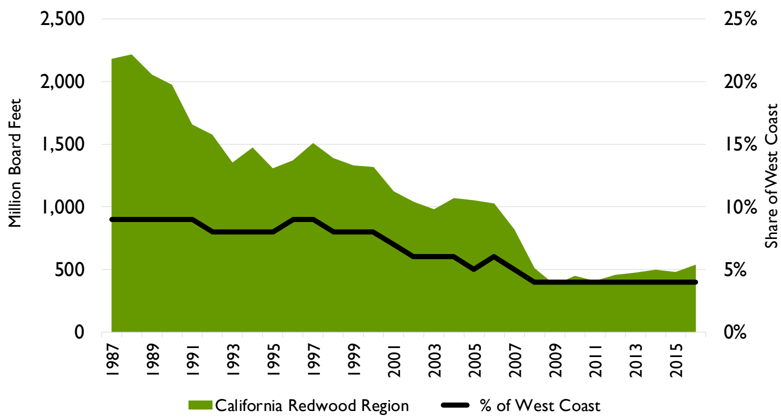
, 2012.

[15] Sierra Pacific Industries, "Sierra Pacific Industries Announces Permanent Closure of Arcata, CA Sawmill", press release, January 25, 2016.

[16] Joyce, Michael, "Does Biomass Still Have A Place In Humboldt County's Energy Future?", *Eureka Times Standard,* May 2, 2016.

[17] U.S. Department of Agriculture, *California's Forest Products Industry*.

Figure 3-3: Lumber Production in California Redwood Region

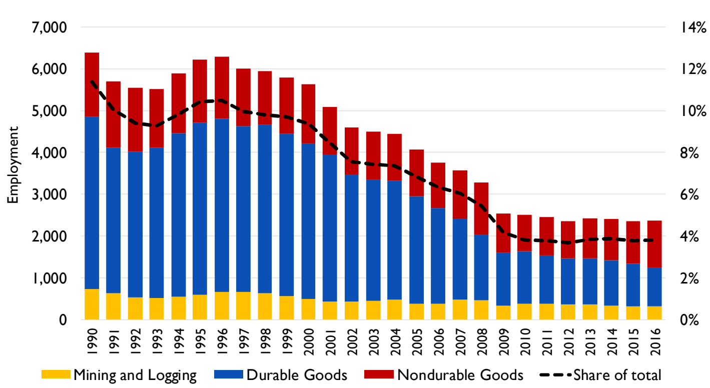


Source: Western Wood Products Association

Employment in forestry-related sectors in Humboldt County has stabilized in recent years, following a long and sustained decline. Three of the main economic sectors related to forest products include mining and logging, manufacturing of durable goods (such as lumber) and manufacturing of non-durable goods (such as paper and pulp). Combined employment in these three sectors dropped from a high of nearly 6,400 jobs in 1990 to approximately 2,500 jobs in 2009, and then averaged approximately 2,400 jobs from 2012 through 2016.

Durable goods manufacturing saw the largest decline in employment; the number of jobs in this category fell from more than 4,100 in 1990 to 930 in 2016, a decline of nearly 78%. Jobs in mining and logging fell from 720 in 1990 to 310 in 2016, a drop of nearly 57%. Non-durable goods manufacturing includes a number of sectors that are not forestry related (such as fish processing); the 26% decline in employment in this category was less than in the others but the number of jobs still fell from more than 1,500 in 1990 to 1,140 in 2016.

Figure 3-4: Forestry-Related Employment in Humboldt County



Source: Bureau of Economic Analysis

Discussions with industry experts suggest that the forest product industry has reached stability at present levels and that little additional growth is expected.[18] Log exports from Humboldt Bay have stabilized in recent years but future volumes are unlikely to grow substantially.

3.4 Transportation Links

For most Coastal-Dependent Industrial uses, links to transportation infrastructure are a critical factor in determining the utility of any property. These links include navigation channels, rail lines, and highways. This section describes the transportation infrastructure for each of these modes in the Humboldt Bay region.

3.4.1 Waterborne Navigation

3.4.1.1 Description of Humboldt Bay

The following description of Humboldt Bay is excerpted from the *Harbor Safety Plan of the Humboldt Bay Area*.

> Humboldt Bay is a landlocked harbor on the coast of Northern California, about 225 nautical miles north of San Francisco and about 156 nautical miles south of Coos Bay, Oregon.
>
> The greater Humboldt Bay actually consists of two large bays connected by a long, narrow channel and separated from the ocean by two long, narrow spits. From the entrance, Humboldt Bay extends north and south a distance of approximately 14 miles, varying in width from 0.5 to 4 miles, and covering an area of over 17,000 acres. Humboldt Bay is surrounded by rolling terraces, steep mountains and narrow valleys typical of the coast ranges of the region. Dense forests of redwood and Douglas fir cover much of the area. Humboldt Bay is the only harbor between San Francisco and Coos Bay with channels deep enough to permit passage of large, commercial ocean-going vessels.
>
> The entrance to Humboldt Bay is bordered by two rubble mound jetties approximately one-half mile apart and extending perpendicularly from the ends of two long, narrow sand spits that separate the shallow bay from the ocean. The water surface of Humboldt Bay covers over 26 square miles at high tide and about 8 square miles at low tide.
>
> Humboldt Bay is usually divided into three distinct areas: North or Arcata Bay, Middle or Entrance Bay, and South Bay. The southwest ends of Woodley and Indian Islands may be considered the south end of North Bay. South Bay extends south of the South Spit Jetty and King Salmon. (See Figure 3-5).
>
> North Bay covers about 13 square miles and is 5.8 miles at its longest and 4.3 miles at its widest points. It is bounded by North Spit to the west, Arcata Bottoms to the north, Bayside Bottoms and Fickle Hill to the east and Eureka to the south. Indian (formerly Gunther), Woodley, and Daby Islands are all located in the southern portion of North Bay. North Bay is extremely shallow, with over one-half the area (approximately 7 square miles) exposed at low tide. These tidal flats are dissected by several deep channels and numerous shallow channels. Samoa Channel and Eureka Channel are the principal commercial waterways of North Bay. The Arcata Channel located in the extreme North Bay (18 feet deep and 150 feet wide) is no longer used for commercial navigation and has not been maintained since 1931.

---

[18] Kelly, Erin, interview with the authors, April 4, 2018. Dr. Kelly is Associate Professor, Forest Policy, Economics and Administration, Humboldt State University.

Entrance Bay is approximately 5 miles long and a maximum of one mile wide. It is bounded by North Spit to the west, and Eureka and the Elk River floodplain to the east. Unlike North and South Bay, it consists of a single deep channel, with generally steep sides.

South Bay covers approximately 7 square miles, with a maximum length of 4 miles and maximum width of about 2.5 miles. It is bounded by South Spit to the west, Humboldt Hill and Beatrice Flats to the east and Table Bluff to the south.

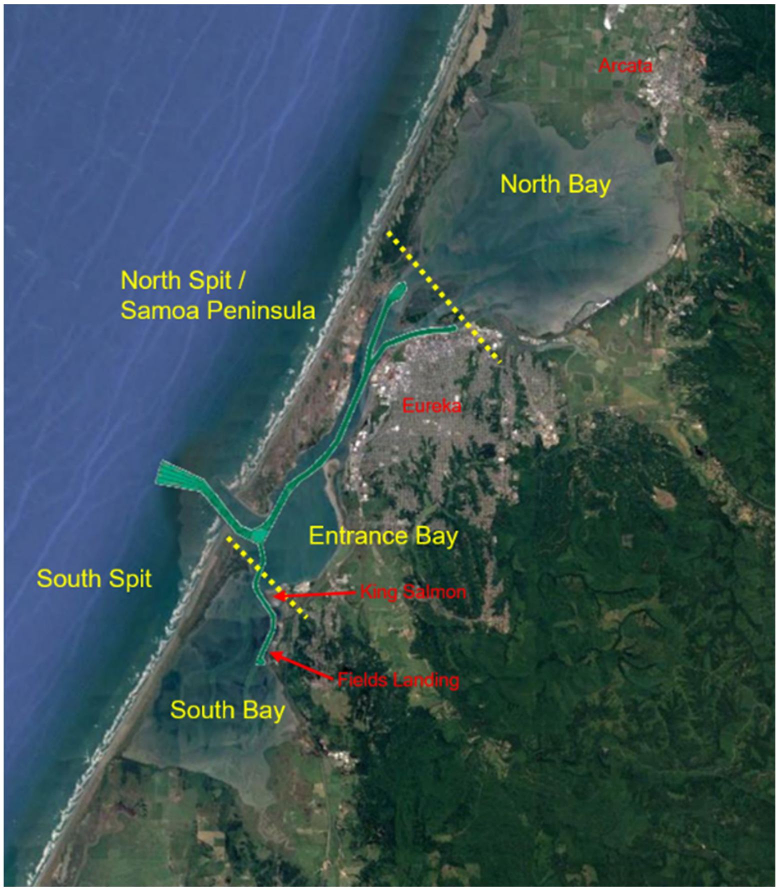
South Bay is similar to North Bay with respect to the broad expanses of tidal flats. These flats are also incised by tidal channels. Only one, the Fields Landing Channel, is used commercially and is maintained by the United States Army Corps of Engineers (USACE).

Separating the Bay from the ocean are two long sand spits with a narrow inlet between them. North Spit is about 10 miles long and 0.5 to 0.9 miles wide. Much of this spit consists of large dunes, up to 50 feet high and heavily forested in places. South Spit is about 4 miles long and varies from 0.1 to 0.7 miles in width; it consists of sparsely vegetated dunes much smaller than those on North Spit.

The commercial/industrial portion of Humboldt Bay is generally located in mid-Humboldt Bay between the southern end of the Fields Landing Channel and the Samoa Bridge to the north. Within this area, coastal-dependent industrial uses exist on the east side of the Samoa Spit, along a one-mile stretch of Eureka's shoreline and along a similar length of the Fields Landing Channel in the community of Fields Landing.[19]

[19] Humboldt Bay Area Harbor Safety Committee., *Harbor Safety Plan of the Humboldt Bay Area*, revised July 2009.

Figure 3-5: Humboldt Bay



Source: BST Associates, Google Earth image

3.4.1.2 Navigation Channels

The approved navigation project for Humboldt Bay includes: 1) the bar and entrance channel, 2) North Bay Channel, 3) Eureka Channel, 4) Samoa Channel, 5) Samoa Turning Basin, and 6) Fields Landing Channel.

- The bar and entrance channel is approved to a depth of 48 feet below mean lower low water (i.e. -48 MLLW[20]), and tapers from a width 2,100 feet at the ocean end to 750 feet at the bay end of the channel.
- The North Bay Channel, Samoa Channel, and Samoa Turning Basin are authorized to -38 feet MLLW.
- The first 0.4 miles of the Eureka Channel is authorized to -38 feet MLLW, while the final 1.1 mile is authorized to -26 feet MLLW.
- The Fields Landing channel is authorized to -26 feet MLLW.

Details for each of these channels are presented in Figure 3-6 below.

[20] "MLLW" is the average of the lower low water height of each tidal day.

Figure 3-6: Navigation Channel Authorized and Current Dimensions

HUMBOLDT BAY AND HARBOR CHANNEL DEPTHS

TABULATED FROM SURVEYS BY THE CORPS OF ENGINEERS - SURVEYS TO AUG 2017

CONTROLLING DEPTHS FROM SEAWARD IN FEET AT MEAN LOWER LOW WATER (MLLW)						PROJECT DIMENSIONS		
NAME OF CHANNEL	LEFT OUTSIDE QUARTER	LEFT INSIDE QUARTER	RIGHT INSIDE QUARTER	RIGHT OUTSIDE QUARTER	DATE OF SURVEY	WIDTH (FEET)	LENGTH (NAUT. MILES)	DEPTH MLLW (FEET)
BAR CHANNEL	39	43	44	39	8-17	2100-750	1.0	48
ENTRANCE CHANNEL	31	43	42	39	8-17	750	0.8	48
NORTH BAY CHANNEL	34	36	35	24	8-17	400-500	3.0	38
EUREKA CHANNEL								
OUTER REACH	30	29	27	15	3-17	400	0.4	38
INNER REACH	A 13	B 13	C 15	D 10	3-17	400	1.1	26
SAMOA CHANNEL	35	37	36	34	3-17	400	1.3	38
TURNING BASIN	34	35	34	22	3-17	400-1000	0.3	38
FIELDS LANDING CHANNEL	20	26	25	20	3-17	300	1.9	26
TURNING BASIN	16	19	23	23	3-17	300-800	0.1	26

A. SHOALING TO 4 FEET FOR LAST 3,000 FEET OF THE REACH.
B. SHOALING TO 4 FEET FOR LAST 3,000 FEET OF THE REACH.
C. SHOALING TO 7 FEET FOR LAST 2,900 FEET OF THE REACH.
D. SHOALING TO 7 FEET FOR LAST 3,400 FEET OF THE REACH.
NOTE - CONSULT THE CORPS OF ENGINEERS FOR CHANGES SUBSEQUENT TO THE ABOVE INFORMATION

Source: NOAA

The authorized channel depth of 38 feet is similar to the authorized depth at other coastal ports, such as Grays Harbor (36 feet) and Coos Bay (37 feet). In the San Francisco Bay area many ports have similar or less draft, including terminals inside Carquinez Strait (35 feet), Stockton (35 feet), Sacramento (30 feet) Richmond (38 feet), and Redwood City (30 feet). Major container ports are substantially deeper, with depths of 50 feet or more at West Coast ports.

One recurring issue for navigation channels in Humboldt Bay is heavy shoaling that tends to occur following maintenance dredging, and which results in operating restrictions for deep-draft-vessels that adversely affect commerce and limit the Bay's use as a harbor of refuge. Sand accumulates outside of the Bay entrance, and then strong waves and currents eventually transport the sand into the federally-maintained Humboldt Bar and Entrance Channel and into interior channels. The Corps of Engineers has proposed a study that would evaluate long-term solutions to shoaling of the Federal navigation channels, but funding for this study has not been secured.

3.4.2 Rail Transportation

Humboldt Bay is one of the only significant harbors on the U.S. West Coast that does not currently have rail access to inland markets. The rail line that once connected Humboldt Bay to the North American rail system has been out of service since 1998, when it was severely damaged by flooding.

The lack of rail service limits the types and volumes of cargo that might move through marine terminals on Humboldt Bay, and impacts the demand for Coastal-Dependent Industrial land. Most of the dry bulk commodities exported through West Coast ports are transported by rail from inland origins, more than half of container traffic moves by rail, and a significant portion of automobile imports and exports move by rail. Without a rail connection, Humboldt Bay marine traffic will likely be limited to products moving to and from the local region by truck.

The *Humboldt Bay Alternative Rail Corridor Concept Level Construction Cost and Revenue Analysis Final Report*[21], completed for the Harbor District in 2013, analyzed the cost to construct a new east-west rail corridor as well as the cost to reconstruct the existing line, and estimated the volume of cargo that would be needed for the rail line to be financially feasible. This analysis noted that, for most of the commodities and origins studied, the proposed rail routes to Humboldt County did not offer a rail distance advantage over other West Coast ports. In several instances the proposed new Humboldt routes did have a rail distance advantage, but this advantage was small. More importantly, all of these other West Coast ports have rail lines that are already in place and are capable of handling large volumes of heavy rail traffic, without the significant investment needed to construct rail access to Humboldt County (estimated at approximately $1.1 to $1.2 billion for a new east-west route and $0.6 billion for rebuilding the existing route).

3.4.2.1 History of Rail Service

The following description of the out-of-service rail line is taken from the Harbor District's Alternative Rail Corridor analysis.

> Beginning in 1902, the Humboldt Bay Region was served by the former Northwest Pacific (NWP) line of the Southern Pacific (SP). The NWP was an amalgam of over 43 different rail companies, including the Eureka & Oregon, which the SP pieced together with the Santa Fe Railway until that company's ownership was bought out by SP in 1929. The NWP connected the communities of Trinidad, Arcata, Samoa, Korbel, Blue Lake and Eureka with communities in Mendocino, Sonoma and Napa counties as well as the national rail network.
>
> The railroad's alignment generally paralleled the northwest/southeast trending topography that resulted from ancient and on-going geologic processes associated with terrane and marine sediment accretion related to the Gorda Plate Subduction Zone. These processes create a series of ridges and valleys that run parallel to the Pacific Coast. The northern portion of the NWP rail line generally followed the Eel River through one of the valleys then crossed over a divide near Willits eventually dropping in the Russian River drainage until reaching Santa Rosa. US Highway 101 roughly follows this same path.
>
> While owned by Southern Pacific, the primary traffic transported by the railroad was lumber and other forest products generated by the numerous sawmills located in Humboldt County and along the rail corridor. This business was routed south along the NWP to the SP main line near Vallejo, and then routed to the SP yard in Roseville (near Sacramento) for eventual transport to the product's final destination.
>
> Throughout its history, the NWP was difficult to maintain and keep in service. In fact, the rail corridor has been out of service since the portion of the rail line most difficult to maintain (Eel River canyon near Dos Rios) washed out in 1998 and has not yet been placed back in service. Even before that washout, however, the number of carloads moving on the line had decreased, and in the 1980's SP sold portions of the line at various times to a shortline operator.
>
> Even though the NWP continued to generate traffic into the 1990's, SP decided to sell the line due in part to its high maintenance costs. These costs were two to three times higher than on other branch lines owned and operated by SP. Limited shipments continued under the new ownership until the line washed out in the Eel River Canyon. The Federal Railroad

[21] BST Associates, *Humboldt Bay Alternative Rail Corridor Concept Level Construction Cost and Revenue Analysis Final Report*, August 22, 2013.

Administration (FRA) embargoed the railroad in 1999, with only the southern portion south of Windsor reopened in 2011.[22]

3.4.2.2 Potential for Resumption of Rail Service

The most recent regional transportation plan from the Humboldt County Association of Governments includes the following discussion of the potential to re-open the rail line.

> The Northwestern Pacific (NWP) Railroad was acquired by the North Coast Railroad Authority (NCRA) through State and federal funds. The NWP's Eel River Division of rail lines north of Willits was purchased with State funds in 1992. The Russian River Division line south of Willits was purchased with federal funds in 1996. The NWP Railroad line, which formerly served Humboldt Bay, has been out of service since 1998, and service is not expected to resume within the RTP's 20-year planning horizon.[23]
>
> A market and financial analysis completed for the Harbor District in 2003 concluded that reopening of the rail line along the existing corridor would only cover operating costs under the most optimistic scenarios. However, the report further stated that this projection did not address the capital costs of bringing the railroad up to a state of good repair that would allow the operations to begin, and in no way reflected the current outstanding financial commitments of the NCRA or previous operators. These two major cost issues would have to be considered in the final evaluation of the financial feasibility of this railroad.[24]

The 2013 *Alternative Rail Corridor* analysis concluded that a reconstructed north-south rail line or a new east-west rail line would need to move very large volumes of cargo in order to be financially feasible, and that this cargo would primarily be commodities shipped by water to or from Humboldt Bay. A rail line to Humboldt County would face strong competition from existing ports, primarily those on the U.S. and Canadian West Coast, as well as ports on the U.S. East and Gulf Coast and in Mexico, depending on the origin and destination of the cargo. Humboldt County would face several competitive disadvantages relative to these other ports, including the lack of a rail distance advantage to inland markets, and the need to cover the cost of construction. In addition to the lack of rail infrastructure, waterborne exports of large volumes of bulk commodities would likely require substantial investments in new cargo terminals, and substantial investment in navigation channel deepening. The report concluded that development of rail service to Humboldt County is likely to be both high cost and high risk.[25]

A more economically feasible alternative to direct rail service to Humboldt Bay may be the use of rail-barge service. Under this concept, railcars would be loaded onto a rail-barge at a terminal connected with the mainline rail system, and then transported to Humboldt Bay to be unloaded at a rail barge terminal connected to the local rail system. This option would enable rail service to/from points

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[22] BST Associates, *Humboldt Bay Alternative Rail Corridor.*

[23] Humboldt County Association of Governments, *HCAOG 20-Year RTP–2017 Update/Public Draft,* September 2017.

[24] PB Ports & Marine, *The Long Term Financial and Economic Feasibility of the Northwestern Pacific Railroad,* January 2003.

[25] BST Associates. *Humboldt Bay Alternative Rail Corridor.*

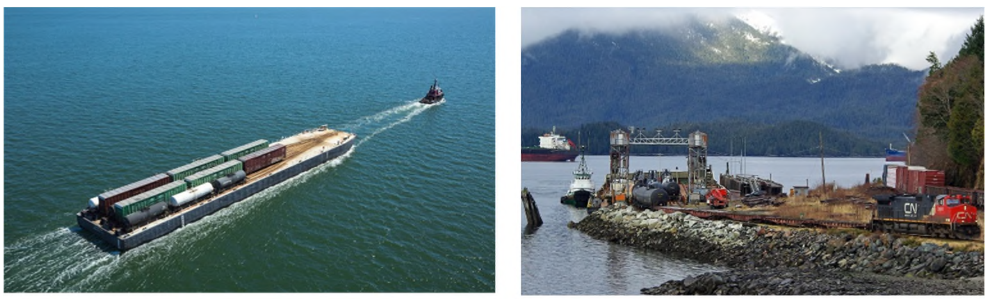
throughout the U.S. and would also eliminate the need to transport railcars through the Cities of Eureka and Arcata.

Rail-barge operations are used in difficult water conditions in both Alaska and Western Canada:

- Canadian National Railway has had rail-barge service connecting Whittier, Alaska with the British Columbia mainline rail system in Prince Rupert since 1962. Rail-barges have a capacity of 45 railcars.
- Seaspan Marine service provides service between Vancouver Island (Nanaimo and Swartz Bay) with mainland British Columbia (Fraser River). Rail-barges have a capacity of 22 to 30 railcars.

Figure 3-7 shows a typical rail barge (Seaspan) and a rail-barge terminal (CN rail-barge terminal at Prince Rupert). Canadian National Railroad's Aqua Train provides service to Alaska, while Seaspan Marine provides service to Vancouver Island.

Figure 3-7: Rail-Barge and Terminal



Source: Seaspan, Canadian National

3.4.3 Highway

One issue that Humboldt Bay shippers have historically faced is limits on the size of trucks using the main highways that link the region to the east and south. As noted in the *2003 Port of Humboldt Bay Harbor Revitalization Plan*[26], the competitiveness of trucks moving freight to/from Humboldt Bay was limited by truck length restrictions that did not apply at competing ports. At that time, no portion of Humboldt County was served by truck routes meeting Federal STAA (Surface Transportation Assistance Act) interstate truck length guidelines, which provide for semi-trailer lengths of up to 53 feet.

According to the Goods Movement Element of the *HCAOG 20-Year RTP*[27], the highway system in Humboldt County includes routes designated Terminal Access, California Legal Network, and California Legal Advisory Routes. Terminal Access Truck Routes are portions of State routes or local roads that allow STAA trucks, which are commercial trucks that conform to the weight, width, and length standards allowed by the federal Surface Transportation Assistance Act.

The length restrictions for trucks serving Humboldt County are now being reduced. In 2017, SR 299 was upgraded to Terminal Access status when reconstruction was completed on Buckhorn Grade in Shasta

[26] PB Ports & Marine, *Port of Humboldt Bay Harbor Revitalization Plan*.

[27] Humboldt County Association of Governments, *Variety in Rural Options of Mobility Semi-Final Draft*, 2017.

County. The route is now free of STAA restrictions between Interstate 5 and U.S. Highway 101. State Route 299 is currently the only STAA route serving the Port of Humboldt Bay.

California Legal Trucks have access to the entire state highway system, unlike STAA trucks, which may be longer than "California Legal" trucks. The California Legal Network highways in Humboldt are:

- SR 299 (Arcata to Trinity County)
- SR 255 (Eureka to Arcata)
- SR 211 (Fernbridge to Ocean Avenue in Ferndale)
- SR 200 (McKinleyville to Blue Lake)
- SR 96 east of Junction Route 169 (Willow Creek to Yreka)
- SR 36 in Humboldt at its eastern end (near Alton) and western end (Van Duzen River Bridge near Dinsmore).

On trucking routes designated as California Legal Advisory Routes, the California DOT (Caltrans) advises that trucks should have semi-trailers shorter than the 40-foot kingpin-to-rear-axle (KPRA) distance that is allowed on the rest of the California Legal Network. KPRA advisories range from 30 to 38 feet. Routes are restricted primarily because they have narrow lanes or tight radius curves. The tight curves make it difficult for longer trucks to stay within their lane while going around tight curves.

U.S. Highway 101 is a Terminal Access Route in Humboldt County, except for a five-mile stretch of California Legal Advisory Route from the Humboldt/Mendocino County line to Richardson Grove State Park. This stretch has a KPRA Advisory maximum of 32 feet long (livestock trucks are exempt from this restriction), which effectively prohibits STAA trucks. To move freight through this five-mile stretch, haulers driving STAA-conforming trucks must unload the cargo and transfer it to shorter trucks that are allowed on this section of highway. This raises the cost for trucking between Humboldt County and the San Francisco Bay Area.

Caltrans has designed upgrades for the section of U.S. 101 through Richardson Grove State Park to allow STAA trucks through the stretch, and the project is in the permitting stage. When this southern segment of U.S. 101 is redesignated as a Terminal Access route, STAA trucks will have uninterrupted access on U.S. 101 from the Oregon border to San Francisco.

3.5 West Coast Marine Cargo Trends

Between 1982 and 2007, West Coast port traffic grew by 350 percent (as seen in Figure 3-8), but after 2007 total tonnage saw little growth. Most of the growth was due to containers, which increased by more than 700 percent between 1982 and 2007. Container volumes dropped substantially during the recession that started in 2008 and remained relatively low for nearly a decade, but finally surpassed the record 2007 volume in 2017.[28]

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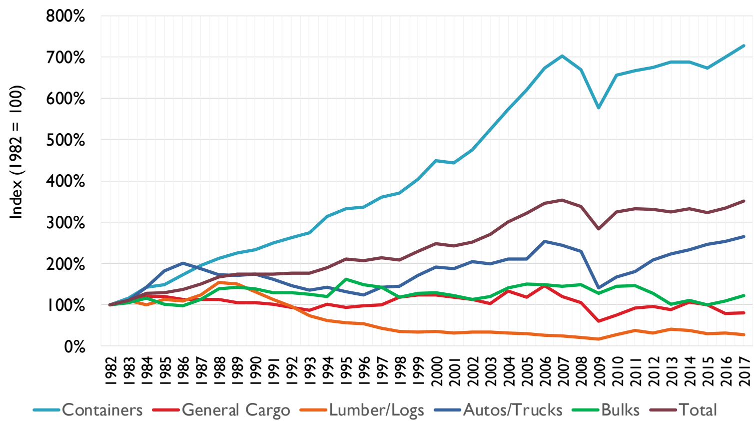
[28] The Pacific Maritime Association (PMA) measures cargo on the basis of revenue tons: container cargo is assessed on the basis of a revenue unit or a TEU (twenty-foot equivalent unit), and Non-Containerized Cargo is reported in revenue tons on the basis of measurement (e.g., on a volume basis where 40 cubic feet equals one revenue ton; on a weight basis where 2,000 pounds equals one revenue ton; or on the basis of board feet where 1,000 board feet equals one revenue ton.

Figure 3-8: Comparison of West Coast Cargo Trends



Source: BST Associates, using data from Pacific Maritime Association

Automobile traffic also grew substantially, but at a much slower rate than containers. Like containers, automobile traffic growth peaked immediately prior to the recession but dropped sharply during the recession; it took until 2015 to fully recover.

Bulk cargo volumes have generally grown over the past 35 years, but this growth has been uneven. In certain years the volume has been up as much as 62 percent above the base year of 1982, but in other years the volume was the same as in 1982. From 2013 through 2016 the volume of bulk cargo was never more than 10 percent higher than in 1982, but in 2017 it was 23 percent higher than in 1982.

General cargo volumes also fluctuated between 1982 and 2017, but have generally trended downward. For the most part, general cargo volumes have not been more than 20 percent higher than in 1982, although in 2004 they were 32 percent higher and at their peak in 2006 they were 46 percent higher. General cargo volumes dropped sharply in 2009 and were 40 percent lower that year than they were in 1982. In both 2016 and 2017 they were still 20 percent lower than in 1982.

Lumber and logs volumes dropped more than other cargo types over the past 35 years and were 70 percent lower in 2017 than they were in 1982. There was a period during the 1980's when the volume of logs and lumber increased to as much as 50% higher than in 1982; by 1992, however, the volume of logs and lumber fell below that of 1982 and continued to fall. Since 2000, the volume of logs and lumber has averaged approximately one-third of the 1982 volume.

Table 3-3 shows cargo volumes and growth rates, by commodity type, for 1982, 2000, and 2017.

Table 3-3: Cargo Growth Trends by Commodity Group

				Average Annual Growth Rate		
Year	**1982**	**2000**	**2017**	**1982-2017**	**1982-2000**	**2000-2017**
Autos	10.31	19.72	27.29	2.8%	3.7%	1.9%
Bulk	41.57	53.81	51.08	0.6%	1.4%	-0.3%
Containers	38.72	174.01	281.27	5.8%	8.7%	2.9%
General	8.08	9.95	6.54	-0.6%	1.2%	-2.4%
Logs & Lumber	5.59	2.11	1.69	-3.4%	-5.3%	-1.3%
Total	104.28	259.60	367.88	3.7%	5.2%	2.1%

Source: Pacific Maritime Association

3.5.1 Humboldt Bay Marine Cargo Trends

According to data from the U.S. Army Corps of Engineers, marine cargo volumes moving into and out of Humboldt Bay fell from approximately 1.5 million metric tons in 1990 to 424,000 metric tons in 2016. This decline was especially strong between 1990 and 2010, a period in which volumes dropped by nearly 75%. (See Table 3-4).

Historically, most of the cargo tonnage was comprised of foreign exports and domestic receipts.

- Between 1990 and 2010 foreign exports dropped sharply and then stopped completely. From 2010 through 2016 foreign exports restarted, but at much-reduced volumes.
- Domestic receipts grew between 1990 and 2000, but dropped between 2000 and 2010, and then fell slightly between 2010 and 2016.
- For the most part foreign imports have not been a major source of marine cargo in Humboldt Bay. As noted later in this section, however, for part of the period from approximately 2000 through 2008 there was a bump in foreign imports.
- Domestic shipments grew slowly over the long run, increasing from 28,000 metric tons in 1990 to 109,000 metric tons in 2016. However, as shown later in this section, there was also a surge of domestic shipments for several years in the mid-1990's.

Table 3-4: Humboldt Bay Cargo Trends

	Metric Tons (1,000's)				Average Annual Growth Rate			
Year	1990	2000	2010	2016	1990-2000	2000-2010	2010-2016	1990-2016
Foreign Imports	11	37	-	-	12.9%	100.0%	nm	10.0%
Foreign Exports	978	366	-	30	-9.4%	100.0%	Nm	-12.5%
Domestic Receipts	462	546	308	286	1.7%	-5.6%	-1.2%	-1.8%
Domestic Shipments	28	40	70	109	3.6%	5.8%	7.7%	5.4%
Total	1,479	989	377	424	-3.9%	-9.2%	2.0%	-4.7%

Source: U.S. Army Corps of Engineers

3.5.1.1 Foreign Exports

Waterborne foreign exports from Humboldt Bay have historically been dominated by forest products, including woodchips, pulp, lumber and logs. While this remains the case, export volumes declined by more than 95% between 1990 and 2016.

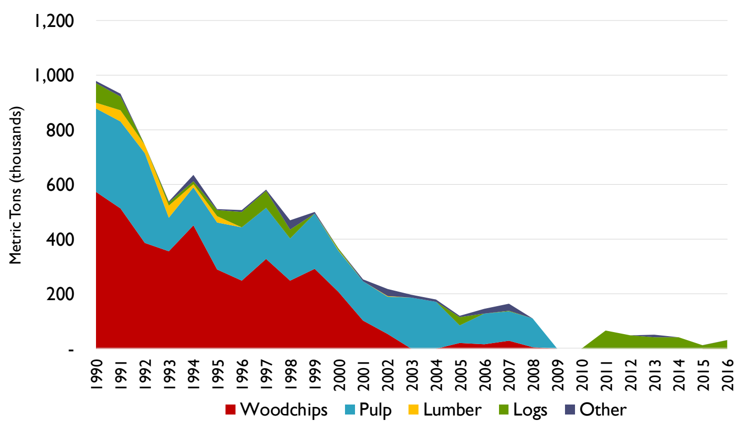
In 1990, marine terminals on Humboldt Bay shipped 573,000 metric tons of woodchips to foreign destinations. From 1990 through 2008 exports of woodchips declined nearly every year (with the exception of three years), before stopping altogether in 2009. Woodchip exports resumed at low levels in 2011 and averaged 42,000 metric tons per year from 2011 through 2016.

Exports of pulp were directly related to the manufacturing operations of the two pulp mills on the Samoa Peninsula, and when pulp manufacturing stopped so did pulp exports. Pulp exports averaged nearly 320,000 metric tons per year from 1990 through 1992. When the Crown Simpson mill closed in 1992 exports fell by nearly two-thirds, to 122,000 metric tons in 1993 and 137,000 metric tons in 1994. Volumes increased in 1995, averaging 170,000 metrics tons per year over the next decade. As production at the remaining pulp mill slowed so did exports of pulp, and exports of pulp finally ceased completely after 2008.

From 1990 through 1998, log exports from Humboldt Bay averaged 36,000 metric tons per year, ranging from a low of zero metric tons to a high of 72,000 metric tons. From 1999 through 2010 log exports were rare, but in 2011 they resumed once more, and averaged 40,000 metric tons per year from 2011 through 2016.

A limited volume of lumber was exported from Humboldt Bay during the early 1990's, but essentially no lumber exports have occurred since 1995. Other commodities are occasionally exported in small quantities, but their volume averaged only 7,000 metric tons per year from 1990 through 2016, and 4,000 metric tons per year from 2007 through 2016. (See Figure 3-9).

Figure 3-9: Humboldt Bay Exports (1,000 Metric Tons)



Source: BST Associates using data from the U.S. Army Corps of Engineers

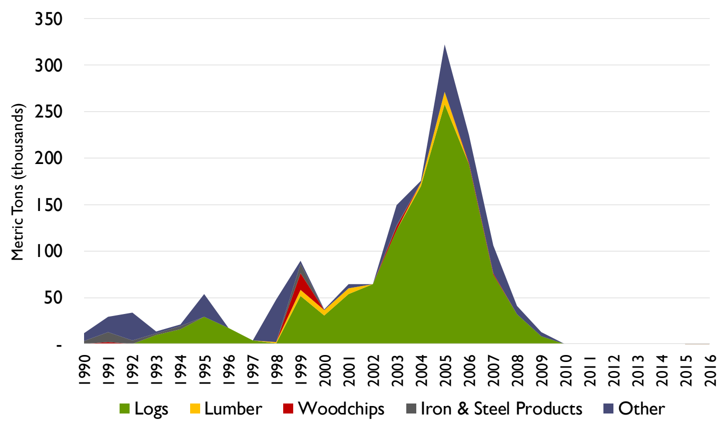
3.5.1.2 Foreign Imports

Waterborne imports to Humboldt Bay exceeded 100,000 metric tons in only five years out of the past 27 years. In most years imports totaled less 50,000 metric tons, and from 2010 through 2016 there were no foreign imports.

Logs accounted for most of the tonnage during high import years. During the mid-1990's imports of logs averaged approximately 18,000 metric tons per year for several years before falling nearly to zero. In 1999 import volumes began to increase, eventually growing from 52,000 metric tons in 1999 to a high of 258,000 metric tons in 2005. From 2006 through 2009 log imports dropped sharply, and since 2010 no logs have been imported into Humboldt Bay from foreign sources.

In addition, Humboldt Bay has received iron/steel and other products from foreign producers to support local construction projects. These imports have been sporadic during the study period and have not occurred since 2009. (See Figure 3-10).

Figure 3-10: Humboldt Bay Imports (1,000 Metric Tons)



Source: BST Associates using data from the U.S. Army Corps of Engineers

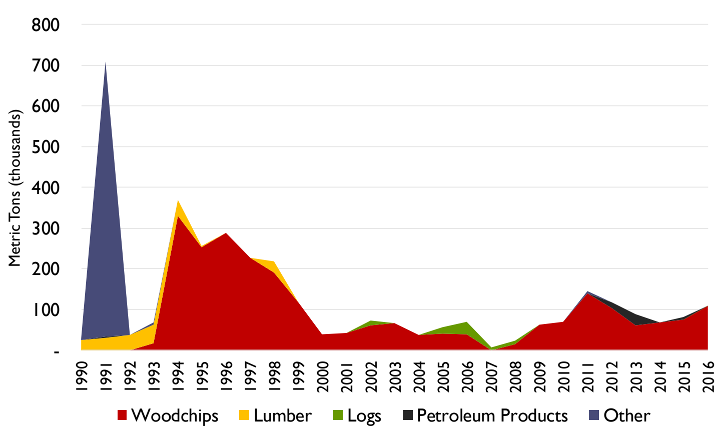
3.5.1.3 Domestic Shipments

The main product shipped by water from Humboldt Bay to domestic locations is woodchips. Since 1994 woodchips have accounted for approximately 90% of domestic shipments, on average, and in many years accounted for 100% of domestic shipments.

One outlier was in 1991, when a high volume of dredge spoils was shipped out of the bay.

Other products that have been shipped in limited volumes to domestic destinations have included lumber, logs and petroleum products. Most domestic lumber shipments occurred from 1990 through 1994, and none have occurred since 1998. (See Figure 3-11).

Figure 3-11: Humboldt Bay Domestic Shipments (1,000 Metric Tons)



Source: BST Associates using data from the U.S. Army Corps of Engineers

3.5.1.4 Domestic Receipts

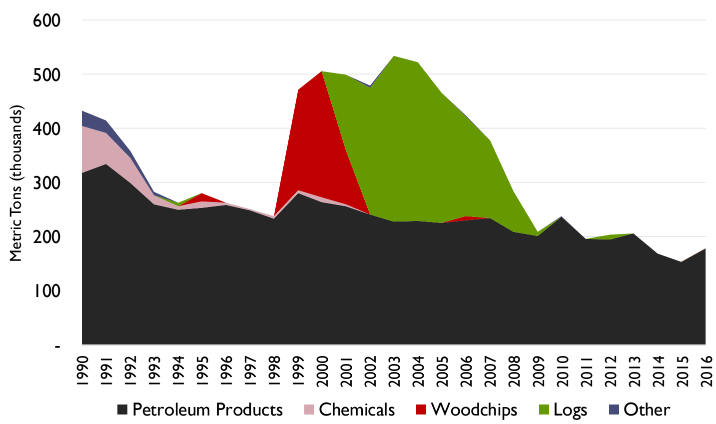
Since 1990, petroleum products have accounted for most of the domestic waterborne receipts. Most of this product is barged in from San Francisco Bay area refineries, for consumption in the local market. Over time the annual volume of receipts has dropped slowly, from more than 300,000 metric tons in the early 1990's to less than 200,000 metric tons in recent years.

In addition to petroleum products there have been occasional receipts of woodchips, logs, and chemicals from domestic sources. Chemical receipts were highest in the early 1990's and ended in

2001, and were related to pulp mill operations. Woodchips for use in pulp production were shipped in by water for several years (primarily 1999 through 2001), but essentially ended when pulp production stopped.

Logs also saw a period of high domestic inbound volumes, especially from 2001 through 2008. Log receipts grew from 140,000 metric tons in 2001 to more than 300,000 metric tons in 2003 and nearly that high in 2004, before tailing off over the next several years. Domestic receipts of logs have been quite limited since 2009. (See Figure 3-12)

Figure 3-12: Humboldt Bay Domestic Receipts (1,000 Metric Tons)



Source: BST Associates using data from the U.S. Army Corps of Engineers

3.5.1.5 Harbor District Records

According to vessel records maintained by the Harbor District, most cargo vessels that call in Humboldt Bay are barges. As shown in Table 3-5, barges accounted for 42 out of 48 cargo vessels in 2017, or approximately 88% of vessel calls. Between 2000 and 2017 barges averaged 86% of yearly vessel calls, with a minimum of 77% and a maximum of 98%.

The total number of vessel calls grew from 135 in 2000 to a peak of 192 in 2003 but dropped to just 54 vessel calls in 2009. From 2010 through 2017 the number of calls averaged 58 per year and ranged between 42 and 78. In 2017 there were 48 calls.

Woodchips, logs, and fuel (petroleum products) account for essentially all cargo vessel calls. Fuel barge calls averaged approximately 31 per year from 2000 through 2017, but from 2014 through 2017 this dropped to approximately 25 calls per year. Woodchip barge calls dropped between 2003 and 2008 but grew again from 2009 through 2016. In addition, from 2014 through 2017 a number of ships carrying woodchips called on Humboldt Bay, and this had not occurred since 2002. Log vessel calls (mainly barges) dropped from a high of 101 in 2003 to just 3 in 2009. From 2010 through 2017 the number of log vessels ranged from one to nine per year.

Different commodities tend to be carried in either barges or ships:

- Woodchips and hog fuel are primarily carried in barges,
- From 2000 through 2009 logs were primarily carried in barges, but since 2010 they have mainly moved in ships, and
- Fuel (petroleum products) is moved by barge.

Table 3-5: Cargo Vessel Calls in Humboldt Bay

Commodity	Vessel Type	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chips	Barge	24	22	23	29	14	21	19	11	4	17	18	34	28	16	17	16	32	10
Chips	Ship	3	5	2												3	2	4	5
Hog Fuel	Barge		1		2		8	7	6	2									
Fuel	Barge	27	36	30	31	33	30	32	35	35	31	37	34	30	31	25	23	25	28
Logs	Barge	47	58	57	100	84	82	78	38	13	3								4
Logs	Ship	2		1	1							1	9	7	7	5	1	2	1
Lumber	Barge	4	2	1															
Lumber	Ship	4	3																
Pulp	Barge	2	2	2		1													
Pulp	Ship	22	29	28	29	32	13	19	15	14									
Other	Ship								1	1	3		1	1		3			
Other	Barge		2																
Total	Barge	104	123	113	162	132	141	136	90	54	51	55	68	58	47	42	39	57	42
Total	Ship	31	37	31	30	32	13	19	16	15	3	1	10	8	7	11	3	6	6
Total	Total	135	160	144	192	164	154	155	106	69	54	56	78	66	54	53	42	63	48

Source: Harbor District

3.5.1.6 Findings

Marine cargo transiting Humboldt Bay terminals consists of local/regional commodities that are:

- Inbound cargoes
  - Consumed by the local population such as petroleum products,
  - Inputs to production comprised mainly of logs, woodchips and chemicals for local mills, as well as steel for local construction products
- Outbound cargoes
  - Outputs of the local forest products industry (logs, woodchips, lumber and pulp) bound for overseas and domestic markets.

As described in the prior chapter, the existing inland transportation infrastructure constrains marine cargo activity to the local/regional market. However, even if the inland transportation infrastructure were to be improved, Humboldt Bay does not offer a distance advantage relative to competing ports.

3.6 Breakbulk & Neobulk Cargo

Breakbulk cargoes include unitized, palletized or packaged general goods, which are not containerized. Neobulk cargoes refer to non-containerized cargoes that require specialized berths and equipment, such as logs, steel, autos, and roll on - roll off (RO-RO) cargoes (mining, agriculture and construction equipment, etc.), among other cargoes.

Prior to containerization, virtually all non-bulk cargoes moved in breakbulk form. Since the 1970s, however, the majority of breakbulk cargo has been converted to containers. As a result of this shift the breakbulk trade has become far more specialized, targeting certain high-volume commodities such as fruit, lumber, woodpulp, paper and some steel products. Based on the high volume and handling uniformity of the commodities involved, ocean carriers have introduced more sophisticated cargo unitization methods and larger vessels with self-contained bridge-type cranes that can handle large, unitized loads of lumber, paper, pulp, etc. quickly and efficiently like containers. In order to maximize use of these ships, ocean carriers prefer to move more cargo through fewer ports.

3.6.1 Logs

3.6.1.1 Historical Trends

United States log exports declined sharply during the 1990's, falling from 16.2 million metric tons in 1990 to just 4.4 million metric tons in 2001. From 2001 through 2009 annual log export volumes were less than 4.7 million metric tons. Log export volumes started to grow in 2010 due to a rapid increase in exports to China and exceeded 9.1 million metric tons in both 2013 and 2014, but were lower again in 2015 and 2016. In 2016 the U.S. exported 7.6 million metric tons of logs, or less than half of what it exported in 1990. (See Figure 3-13).

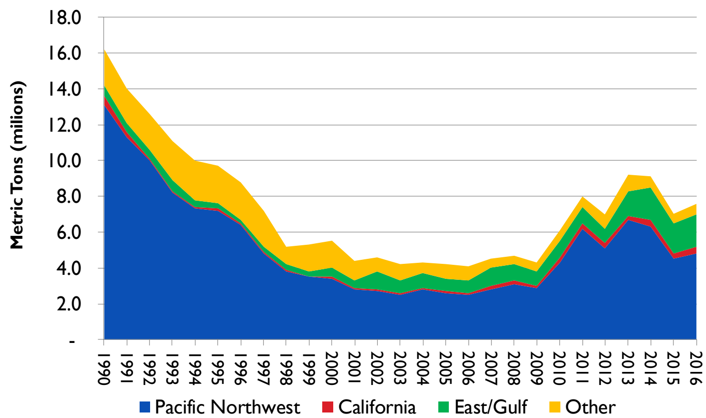
Most U.S. logs are exported from the Pacific Northwest. From 1990 through 2016 the Northwest accounted for at least 70% of exports and as much as 86%; in 2016 the Northwest accounted for 74% of U.S. log exports. Nearly all of the decline in U.S. exports occurred in the Northwest, where exports fell from 13.7 million metric tons in 1990 to less than 4.0 million metric tons during the 2000's. Northwest exports recovered to more than 6.3 million metric tons in both 2013 and 2014 but fell below 5 million metric tons in 2015 and 2016.

California has long been a minor center of log exports. Between 1990 and 2016 the state's share of U.S. exports ranged between 1% and 7%. From 1992 through 2006 California exports never exceeded 150,000 metric tons, but from 2014 through 2016 they were higher than 400,000 metric tons.

East and Gulf Coast states were only minor exporters from 1990 through 2012, never reaching 1.0 million metric tons. This region has seen growth in recent years, however, exporting nearly 1.5 million metric tons in 2014 and more than 1.7 million metric tons per year from 2014 through 2016.

The remaining U.S. log exports were from "Other" regions, essentially all of which is Alaska. Alaska accounted for as much as 29% of U.S. log exports during the late 1990's and early 2000's but accounted for less than 10% from 2014 through 2016. Total volume from Alaska dropped from a high of more than 2.2 million metric tons in 1993 to less than 0.6 million metric tons per year from 2014 through 2016.

Figure 3-13: U.S. Log Export Trends



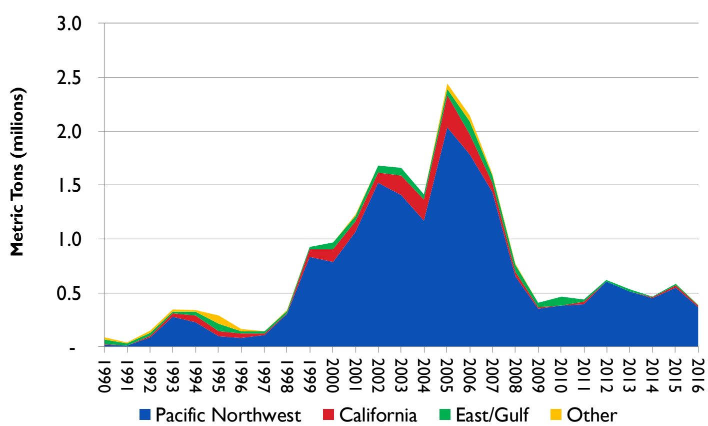
Source: U.S. Census Bureau Foreign Trade Division

The United States imports logs as well as exports, but at a much lower level. For much of the decade of the 2000's, import volumes averaged more than 1.0 million metric tons per year and exceeded 2.1 million metric tons in both 2005 and 2006. In contrast, for most of the 1990's log imports were less than 0.4 million metric tons, and from 2009 through 2016 they exceeded 0.6 million metric tons only once. (See Figure 3-14).

As with exports, most of the log imports moved through ports in the Pacific Northwest. The Northwest saw import volume range from essentially nothing to as much as 2.0 million metric tons, while all other regions combined never saw log import volumes of 0.5 million metric tons.

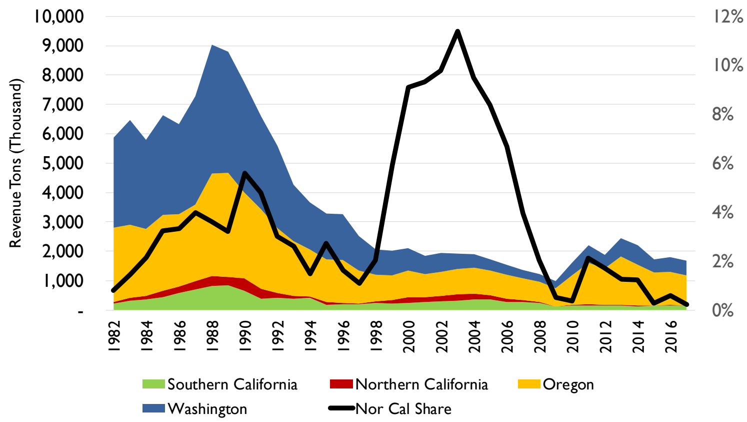
California ports handled small volumes of log imports during the 2000's but saw very few during most of the 1990's, and essentially none after 2009. These imports were driven by local mills trying to maintain production levels as local timber resources declined. However, importing logs proved to be cost prohibitive, and was listed as a key reason for the closure of the Sierra Pacific Industries mill in Arcata.

Figure 3-14: U.S. Log Import Trends



Source: U.S. Census Bureau Foreign Trade Division

Figure 3-15: West Coast Logs & Lumber Trends (1,000 revenue tons)



Source: BST Associates using data from the Pacific Maritime Association

3.6.1.2 Forecast

For the most part, log exports from Humboldt Bay have stabilized in recent years. Future volumes are unlikely to grow substantially.[29]

Future market conditions are clouded by log prices, which are driven by increased U.S. log consumption for the domestic market coupled with the strength of the U.S. dollar. Other unknowns include growth rates in Asian economies and additional competition from other sources such as New Zealand and Canada. Exports of logs from British Columbia increased 14% in 2016 and are now nearly as large as the log exports from U.S. West Coast.

In the longer-term, log exports face many uncertainties. Japan has historically been the largest market for West Coast log exports, but is expected to decline due to an increase in domestic timber harvests in Japan. The Chinese market is expected to grow but at a slower pace than in the past and with significant volatility due to international competition.

3.6.1.3 Potential demand at Humboldt

Logs are currently exported from the Schneider Dock in Eureka. This log export operation uses approximately 11 acres, including acreage on the site as well as log storage on an adjacent property. Future demand is projected to range between 11 acres and 15 acres (See Table 3-6).

Table 3-6: Current CDI Use and Future Demand- Logs

	Current	Future Acres		Change in Acres	
Land Use	**Acres**	**Low**	**High**	**Low**	**High**
Logs	11	11	15	11	15

Source: BST Associates

[29] Kelly, Erin, interview with the authors.

3.6.2 Other General Cargo

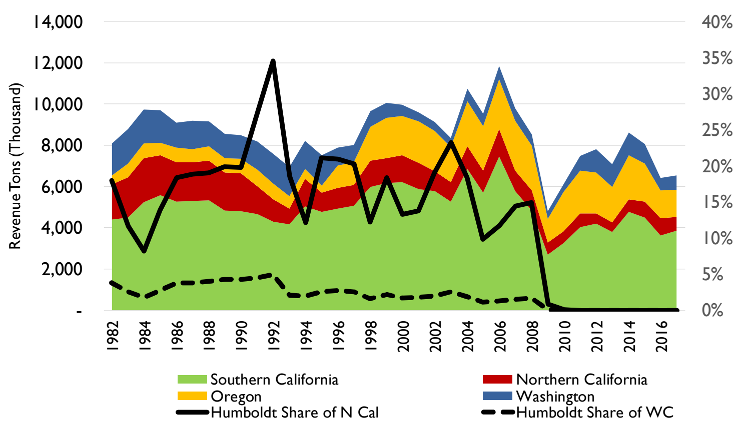
Breakbulk cargoes include unitized, palletized or packaged general goods, which are not containerized.

3.6.2.1 Historical Trends

Data from the Pacific Maritime Association separates breakbulk/neobulk cargoes into two categories, lumber/logs and other general cargo.

Southern California dominates U.S. West Coast ports in other general cargo traffic. This region saw volumes of other general cargo grow from 4.4 million revenue tons in 1982 to 7.5 million revenue tons in 2006. Volumes began to drop sharply in 2007 and reached a low of just 2.7 million revenue tons in 2009. They have since recovered somewhat, but volumes in 2017 were approximately half of what they were at the peak. Much of the general cargo handled in Southern California consists of fruit imports and exports, steel slabs, and other manufactured goods. (See Figure 3-16).

Figure 3-16: West Coast Trends in Other General Cargo Imports



Source: Pacific Maritime Association

Northern California was the second largest load center on the U.S. West Coast for other general cargo during most of the 1980's and 1990's. Volumes from Oregon surpassed those of Northern California in 1996, however, and have been higher since then. (Note that the PMA data groups all ports on the Lower Columbia River as Oregon ports, including Vancouver, Kalama, and Longview, Washington). The volume of other general cargo moving through Northern California ports dropped sharply in 1991, falling from 1.8 million revenue tons in 1990 to 1.3 million revenue tons in 1991. From 1991 through 2008 volumes ranged between 0.8 million and 1.3 million revenue tons, but from 2009 through 2017 these volumes ranged from less than 0.5 million revenue tons to 0.8 million revenue tons.

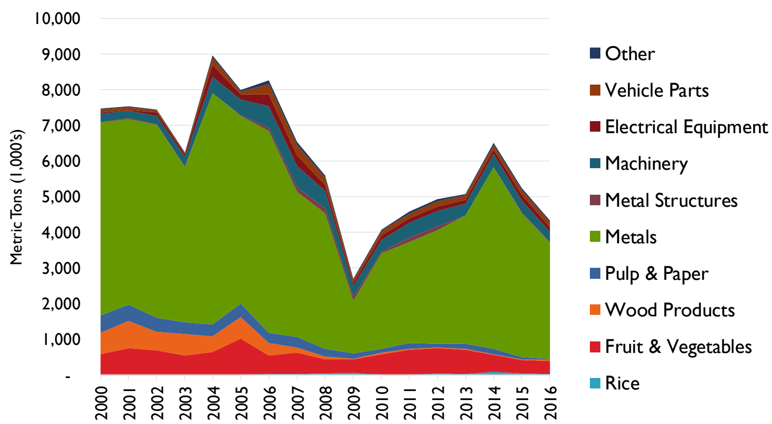
Humboldt Bay marine terminals accounted for a substantial share of Northern California general cargo trade until 2009 (i.e. primarily lumber and pulp), but from 2010 on the Humboldt Bay terminals handled essentially no breakbulk/neobulk cargo other than logs. From 1982 through 1992 Humboldt Bay general cargo volumes averaged 320,000 revenue tons per year. From 1992 through 2002 the average dropped to 200,000 revenue tons, from 2002 through 2008 it averaged 165,000 revenue tons, and from 2009 through 2017 was essentially zero.

West Coast foreign imports of breakbulk/neobulk cargo volumes dropped by more than half between the peak year of 2004 and 2016. Imports dropped from 9.0 million metric tons in 2004 to less than 2.7 million metric tons, at the height of the recession. Following the recession volumes increased until 2014, but dropped again in both 2015 and 2016.

West Coast imports of breakbulk/neobulk cargoes are dominated by metals, especially steel; from 2000 through 2016 metals accounted for an average of 68.7% of breakbulk/neobulks. Much of this steel is used in the construction industry, and the decline in construction during the recession is reflected in the dropping imports of metals. Imported steel is generally used in the market adjacent to the inbound port but a portion also moves on to more distant production centers for use in manufacturing. Non-containerized fruits and vegetables were the second-largest category, accounting for an average of 10.2% of imports, followed by machinery (6.6%) and wood products (3.5%). No other commodity type accounted for an average of more than 3.0% over that time period. (See Figure 3-17)

Humboldt Bay marine terminals handled only occasional imports of other breakbulk/neobulk cargo from 2000 through 2016. Most of this was metals, and essentially all of the imports occurred from 2000 through 2005.

Figure 3-17: West Coast Breakbulk/Neobulk Imports



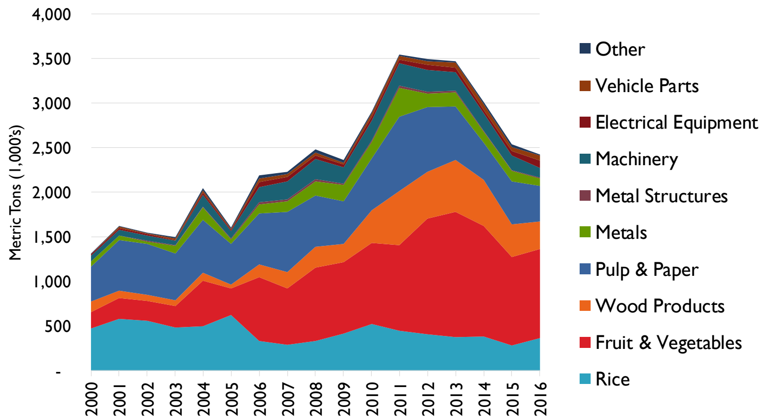
Source: WISERTrade

West Coast exports of breakbulks/neobulks grew substantially between 2000 and 2016; however, volumes peaked from 2011 through 2013 and then dropped in subsequent years. Export volumes grew from 1.3 million metric tons in 2000 to approximately 3.5 million in 2011, 2012, and 2013. Over the next two years export volumes dropped nearly 1.0 million metric tons, and in 2016 the export volume was 2.4 million metric tons. (See Figure 3-18).

Exports of breakbulks/neobulks are led by fruits & vegetables, pulp & paper, wood products, and rice. The volume of non-containerized fruits and vegetables grew from less than 190,000 metric tons in 2000 to more than 1.4 million metric tons in 2013, before dropping to less than 1.0 million metric tons in 2016. Exports of non-containerized wood products grew from less than 120,0000 metric tons in 2000 to 610,000 metric tons in 2011. After averaging more than 500,000 metric tons from 2012 through 2014 volumes dropped to approximately 310,000 metric tons in 2016.

Exports of pulp and paper were essentially the same in 2016 as they were in 2000 (i.e. 390,000 metric tons), but in 2016 were less than half of what they were during the peak year of 2011. The volume of non-containerized rice (i.e. bagged rice) dropped slowly from 2000 through 2016.

Figure 3-18: West Coast Breakbulk/Neobulk Exports



Source: WISERTrade

In Humboldt Bay, woodpulp accounted for nearly all foreign exports of breakbulk/neobulk cargo from 2000 through 2016. With the exception of 2010 these exports essentially ceased in 2006, due to the closure of the last pulp mill in Samoa.

3.6.2.2 Potential demand at Humboldt

Existing facilities are adequate to accommodate existing volumes of breakbulk/neobulk cargoes. The Humboldt Bay region may generate sufficient levels of waterborne cargo to support a general cargo dock if a new industry were to be developed in Humboldt Bay. Offshore wind systems, which are described in greater detail in the next chapter, could generate sufficient volumes to require a more extensive terminal.

The estimated range of CDI land required to meet future general cargo volumes ranges between zero (i.e. the activity does not occur on Humboldt Bay) and 25 acres. (See Table 3-7).

Table 3-7: Current CDI Use and Future Demand, General Cargo

Land Use	Current Acres	Future Acres Low	Future Acres High	Change in Acres Low	Change in Acres High
General Cargo	0	0	25	0	25

Source: BST Associates

3.6.3 Automobiles and Ro-Ro

3.6.3.1 Historical Trends

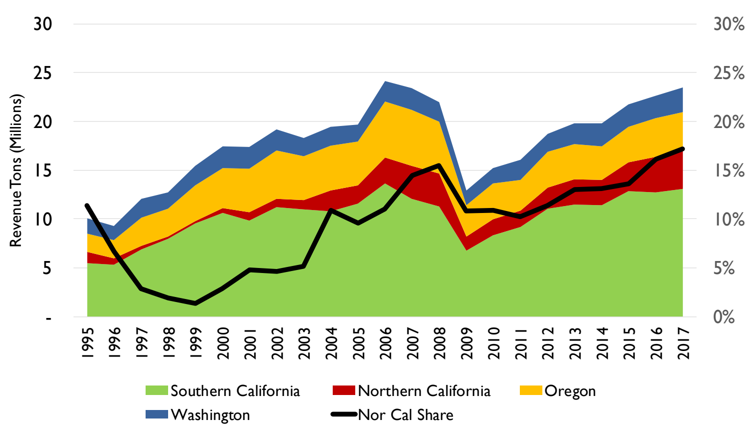
Sales of autos in the U.S. averaged 16 to 17 million units from 2000 to 2007, until the Great Recession drove sales to a low of 10.4 million units in 2009 (a drop of nearly 40%). Restructuring of the auto industry and gradual recovery of the economy led to a rebound in sales. Auto sales reached 16.5 million units in 2014, and exceeded 17 million units in both 2015 and 2016.

In the U.S., the market share of foreign vehicles grew from approximately 17% in 2000 to a peak of 26% in 2009. A growing share of these vehicles is manufactured in Mexico, which has now surpassed Japan as the second largest exporter to the U.S. Canada remains the largest exporter to the U.S., with export volumes that have remained relatively stable.[30]

Exports of autos from the U.S. across all ports and border crossings increased rapidly between 2000 and 2015, growing at an annual rate of 11.4%. Emerging markets in China, India, Brazil, Eastern Europe and South Africa drove much of this growth.[31]

Inbound receipts of automobiles on the U.S. West Coast move primarily through California ports. More than half of West Coast waterborne automobile receipts move through Southern California, but the share moving through Northern California ports grew steadily from 2011 through 2017; Northern California share of West Coast auto receipts climbed from 10.2% in 2011 to 17.2% in 2017. This was Northern California's largest share of automobile receipts since at least 1995, and the 4.0 million revenue tons of automobiles was the highest since at least 1995. (Note that PMA data includes rolling equipment in the autos category, and also includes vehicles bound to and from Hawaii).

Figure 3-19: West Coast Inbound Automobile Trends (1,000 revenue tons)



Source: BST Associates using data from the Pacific Maritime Association

Outbound shipments of automobiles from the U.S. West Coast are much more limited than receipts, but have grown substantially over the past decade. Total shipments more than doubled between 2009 and

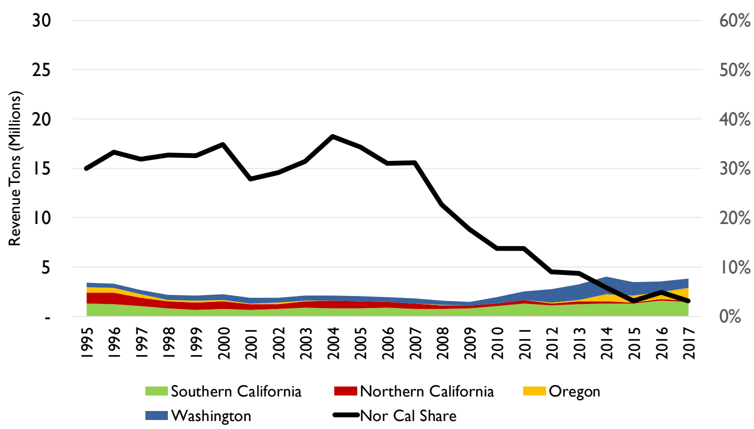
[30] BST Associates, *2017 Marine Cargo Forecast and Rail Capacity Analysis*, August 2017.

[31] ibid

2017, growing from less than 1.5 million revenue tons to more than 3.8 million revenue tons. Outbound shipments were nearly that high in 1995 but fell steadily through 2009.

Northern California ports handled approximately one-third of automobile shipments from 1995 through 2007. Since 2008 that share has fallen, however, and in 2017 Northern California ports accounted for only 3.2% of shipments.

Figure 3-20: West Coast Outbound Automobile Trends (1,000 revenue tons)



Source: BST Associates using data from the Pacific Maritime Association

3.6.3.2 Forecast

According to Mercator[32], vehicles are the only high-volume commodity currently moving through RO-RO terminals on San Pedro Bay. Imports are projected to grow from approximately 600,000 metric tons in 2015 to 1.4 million metric tons in 2040, or at a rate of growth of 3.5% per year[33]. Vehicles are typically distributed to local markets by truck, and to more distant markets by rail or by truck.

Vehicles are also exported to foreign destinations or shipped to domestic markets (mainly Hawaii) from San Pedro Bay ports, but in much smaller volumes than imports. Vehicle exports are projected to grow from 50,000 metric tons in 2015 to 19,000 metric tons in 2040.

Ports in the region that handle vehicle imports and exports include Port of Hueneme in Oxnard (north of Los Angeles), Los Angeles, Long Beach, and San Diego. All of the terminals have direct rail access.

Northern California auto terminals are all in the San Francisco Bay area. Richmond and Benicia have handled vehicles for many years, while San Francisco recently began receiving auto imports again.

Auto imports moving through Pacific Northwest ports fell from 743,000 metric tons in 2000 to 643,000 metric tons in 2010 as a result of the Great Recession. By 2015 import volumes had climbed back to 736,000 metric tons, and through 2035 are projected to grow to between 890,000 metric tons and 1.17 million metric tons.[34]

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[32] Mercator International and Oxford Economics, *Executive Summary for San Pedro Bay Long-term Unconstrained Cargo Forecast*, January 2016.

[33] ibid

[34] BST Associates, *2017 Marine Cargo Forecast.*

Auto exports moving via Pacific Northwest ports were minimal at the beginning of the century but have grown sharply. Exports totaled 16,000 metric tons in 2000 and fell to only 4,000 metric tons in 2005, but grew to 252,000 metric tons in 2015. By 2035, exports of automobiles from the Pacific Northwest are projected to reach from 670,000 metric tons to as much as 876,000 metric tons.

Four ports in the Pacific Northwest handle automobile imports or exports: Portland, Vancouver (Washington), Tacoma, and Grays Harbor. All of these terminals are served by both the Union Pacific and the BNSF railroads.

3.6.3.3 Potential demand at Humboldt Bay

For the most part, automobile port terminals: 1) are located in or near major population centers, and 2) require access to railroads. Vehicles destined for local markets are distributed by truck, while inland markets are generally served by rail.

Figure 3-21: Automobiles and Rail Auto Racks at Grays Harbor

Source: Port of Grays Harbor

Because of the limited population in the Humboldt Bay region, and because of the lack of rail access, Humboldt Bay is not likely to become a vehicle import or export center. Therefore, the future acreage required for this use is zero. (See Table 3-8).

Table 3-8: Current CDI Use and Future Demand, Vehicles

Land Use	Current Acres	Future Acres Low	Future Acres High	Change in Acres Low	Change in Acres High
Vehicles	0	0	0	0	0

Source: BST Associates

3.6.4 Containers

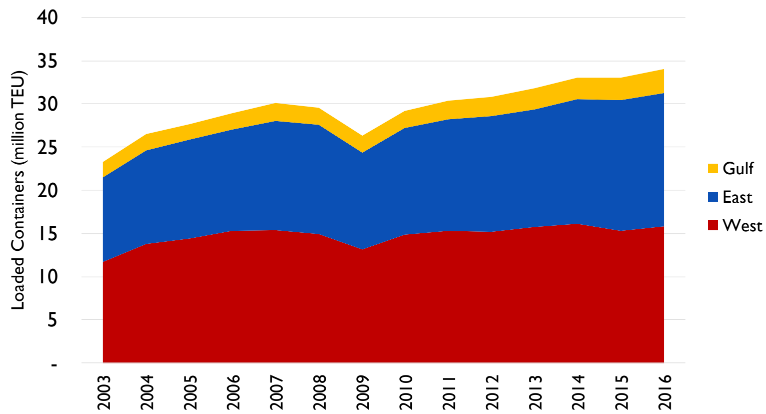
3.6.4.1 Historical Trends

Loaded containers (including both international and domestic) moving through mainland U.S. ports grew from 23.2 million TEU[35] in 2003 to 34.0 million TEU in 2016. This long-term growth trend was interrupted by the recession, which caused container volumes to drop from a peak of 30.0 million TEU in

[35] TEU is twenty-foot equivalent unit

2007 to 26.3 million TEU in 2009. Container volumes began to recover in 2010, and by 2011 they had surpassed the 2007 record. From 2011 through 2016 volumes grew by another 3.6 million TEU. (See Figure 3-22).

Figure 3-22: U.S. West Coast Loaded Container Trends (,1000 TEU)



Source: US Army Corps of Engineers

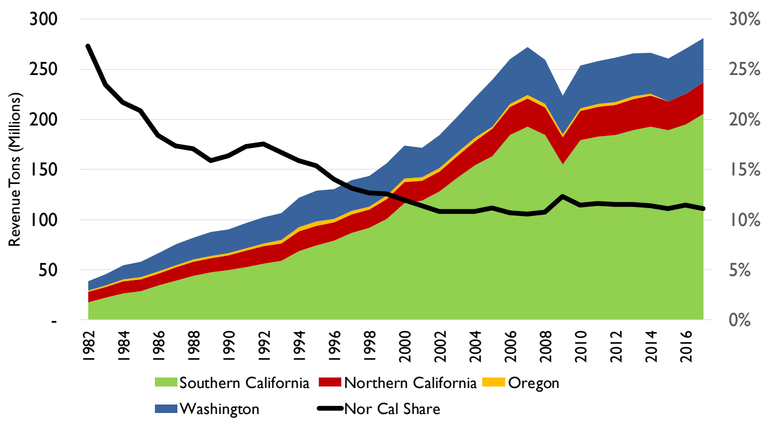
The West Coast handles more containers than either the East Coast or Gulf Coast, but the margin has been dropping. In 2003 the West Coast handled nearly 2.0 million more TEU than the East Coast, but by 2016 that margin had fallen to less than 0.4 million TEU. (See Figure 3-23).

From 2003 through 2016 container volume growth averaged nearly 3.0% per year, even with the drop that occurred in 2009. Growth was much faster before the recession, however, averaging 6.6% per year from 2003 through 2007. After the recession growth averaged 2.6% per year, from 2010 through 2016.

Prior to the recession West Coast container volumes were growing faster than volumes at East Coast and Gulf Coast ports. West Coast growth averaged 7.1% per from 2003 through 2007, compared with 6.6% on the East Coast and 3.7% on the Gulf Coast. This changed after the recession, with West Coast growth averaging just 1.1% per year from 2010 through 2016, compared to 3.8% on the East Coast and 5.1% on the Gulf Coast. Over the entire period (i.e. 2003 through 2016) West Coast growth averaged 2.3% per year, compared to 3.8% on the East Coast and 5.1% on the Gulf Coast.

The West Coast was also more deeply impacted by the recession. On the West Coast container volumes dropped by nearly 2.3 million TEU (excluding empty containers), a decline of 14.6%. East Coast volumes dropped by 1.4 million TEU (i.e. 11.0%) and Gulf Coast volumes dropped by less than 0.2 million TEU (or 6.5%).

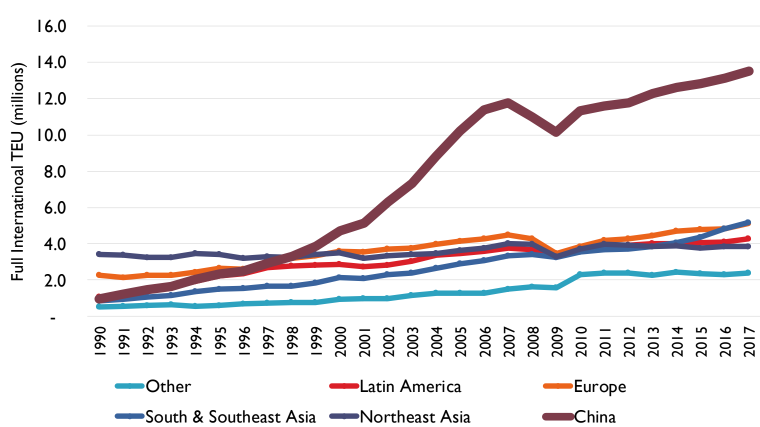
Figure 3-23: West Coast Container Trends (Million revenue tons)



Source: BST Associates using data from the Pacific Maritime Association

Most growth in international container volumes at U.S. ports since 1990 has been due to increasing trade with China. China accounted for less than 11% of the trade in 1990, but accounted for 39% in 2017, and U.S.-China container volume grew from 1.0 million TEU to 13.5 million TEU. Northeast Asia (excluding China) volume grew from 3.4 million TEUs to 3.8 million TEUs, but the region's share of U.S. container trade dropped from 37.3% in 1990 to 11.2% in 2017. The volume from South and Southeast Asia increased faster than the volume from Northeast Asia, growing from 0.9 million TEUs in 1990 to 5.2 million TEUs in 2017, and market share grew from 9.5% to 15.0%. Other trading regions include Europe, which accounted for 15.0% of total volume in 2017, and Latin America/Caribbean, which accounted for 12.5% of volume in 2017. (See Figure 3-24).

Figure 3-24: U.S. International Container Tons (Million Full TEU)



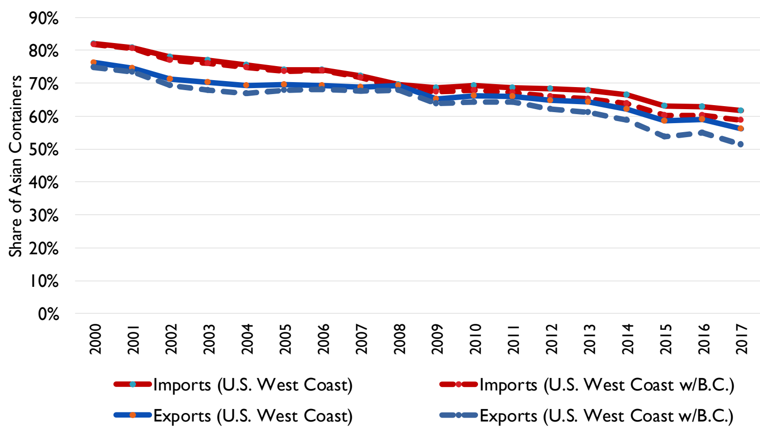
Source: BST Associates using data from PIERS

Since the development of mini-landbridge service (i.e., ocean containers carried by rail), shippers on the East and Gulf Coasts have had some ability to choose between the relatively higher speed and higher cost of shipping via rail through West Coast ports, and the relatively lower speed and lower cost of all-water routings. West Coast ports handle the majority of containerized cargo that moves from Asia to the United States, but the U.S. West Coast market share has declined steadily since 2000 as ports on the East Coast, Gulf Coast, and British Columbia have attracted cargo from Asia.

Between 2000 and 2017, the share of U.S.-Asia containerized imports that moved through U.S. West Coast ports declined from 82.1% to 61.7%, and the share of exports fell from 76.2% to 56.1%, as shown on Figure 3-25. When U.S. cargo moving through British Columbia ports is included, the U.S. West Coast share of Asian imports fell from 81.7% to 58.8%, while U.S. West Coast share of exports fell from 74.8% to 51.4%.

U.S. East Coast market share of the U.S.-Asia import container trade grew from 17.3% in 2000 to 32.3% in 2017, U.S. Gulf Coast market share grew from 0.2% to 3.8%, and Western Canada market share grew from 0.5% to 4.8%. For containerized exports, the U.S. East Coast market share grew from 22.3% to 34.5%, U.S. Gulf Coast market share grew from 0.4% to 4.9%, and Western Canada market share grew from 1.9% to 8.5%.

Figure 3-25: West Coast Share of Asia-North America Container Market



Source: Source: PIERS, IANA

Container traffic on the U.S. West Coast is concentrated in three port regions: San Pedro Bay (i.e. Los Angeles and Long Beach), San Francisco Bay (i.e. Oakland), and Puget Sound (i.e. Seattle and Tacoma). Other ports in California and in the Pacific Northwest also handle limited volumes of containers, but these are generally for small, niche markets. For shippers and carriers, the size of the local/regional market historically has been the most important factor used in deciding which ports to use. In terms of population and consumption, the largest local markets are the Los Angeles region and the San Francisco Bay Area, with the Puget Sound port market area being much smaller.

Approximately 65% of the containers imported via Los Angeles and Long Beach moves by rail to inland destinations such as the Midwest, while at the Port of Oakland only 20% to 30% of import containers move out of that region by rail. In the Puget Sound region less than half of the inbound cargo is distributed within the local market area, and approximately 60% of imports from Asia are shipped by rail to inland destinations.

In Western Canada, Vancouver, B.C. serves as the primary gateway for Asian cargo destined for all of Canada and also competes with U.S. West Coast ports for imported Asian container traffic destined for the U.S. Midwest. This is reflected in the relatively high level of intermodal traffic at Vancouver, where approximately 70% of total imports is shipped inland. At Prince Rupert, located in northern British Columbia approximately 565 miles north of Seattle, nearly 100% of containers move by intermodal rail service to inland points in Canada and the United States.

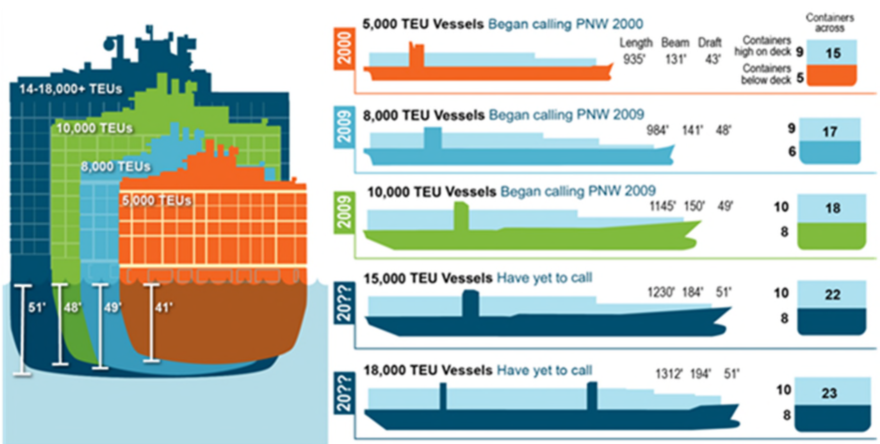
The main impediment to growth in the Asia to East/Gulf Coast container trade has been the size and capacity of the Panama Canal. With the existing Canal reaching capacity in the number of ships that can pass through daily, and new ships being built that are too big for the original locks, Panama made the decision to construct third, larger set of locks. The new locks, which opened in 2016, allow ships up to 150 feet wide and 1,200 feet long, compared with the original maximum width 106 feet and length of 965 feet.

One of the most significant changes affecting selection of container ports is the deployment of ultra large container ships ("ULCS"). This trend has been developing for years but has accelerated in the recent past, and this trend is expected to continue into the future. In the 1970s, the largest containerships had a capacity of 1,800 TEUs. In the early 1980s, the largest ships had a capacity of 4,000 TEUs. By the mid-1990s, the largest ships reached 8,200 TEUs. The Maersk Triple E class vessels introduced in the mid-2000s, have a capacity of 18,000+ TEUs. The move toward even larger vessels continues, with orders for vessels with 24,000 TEUs of capacity.

In order to accommodate the new ULCS, the burden is placed on port operators to invest in:

- Linear berth space exceeding 2,600 feet for two ULCS berthed at the same time
- Container cranes capable of accommodating the ULCS (with an outreach of 18 containers or more)
- On-dock rail of sufficient size to accommodate intermodal traffic generated by ULCS (24,000 feet of rail trackage)
- Sufficient water depth in navigation channels and at berth to accommodate a 51 foot draft

Figure 3-26: Evolution of Container Ships



Source: Mercator International[36]

[36] Mercator International, *Seaport Alliance Strategic Business Plan*, May 16, 2015.

3.6.4.2 Potential demand at Humboldt Bay

Humboldt Bay is not likely to play a significant role in West Coast container markets with the possible exception of a potential marine highway operation. The West Coast market is increasingly concentrated at the San Pedro Bay ports, with significant new competition from British Columbia ports.

Significant changes in the container industry also make it more difficult for smaller ports to compete for container traffic. These changes include consolidation of shipping lines, larger ships, and growth in the size of terminals.

Portland is a prime example of the issues facing smaller ports. Portland has a significantly larger population base than Humboldt Bay, and has excellent rail connections from the two major western railroads. Portland is also served by a 43-foot deep navigation channel, compared with the 38-foot channel in Humboldt Bay. At one time three container shipping lines operated from Portland, and annual container volumes were as high as 330,000 TEU in 1995. However, by 2014 this number had dropped to just 165,000, and in 2015 it fell to less than 23,000 TEU as two of the three carriers pulled out of the market. A recent analysis for the Port of Portland[37] concluded that “The trend toward larger ships in the transpacific will continue and there will be limited opportunities for Portland to attract a transpacific service due to vessel size limitations. Alliances control almost 90% of the transpacific freight. This is not a favorable condition for a smaller port like Portland.”

While Humboldt Bay is unlikely to become a regional container port, there is potential for a multi-use terminal to handle some container traffic, as well as breakbulks and other container types.

3.6.4.3 Potential demand at Humboldt

There may be opportunity to handle limited volumes of containers moving in domestic trade. Cargo might include municipal solid waste (i.e. garbage) and forest products. The U.S. Maritime Administration has promoted the concept of “marine highways” to shift freight traffic from roads to water, as discussed in the following section.

It is unlikely that Humboldt Bay will become a container load center due to:

- limits on the size of ship that can transit the navigation channels,
- the lack of railroad connections, and
- the limited local population base.

The projected future demand from CDI land for container shipping is zero acres. (See Table 3-9).

Table 3-9: Demand for CDI Land – Containers

Land Use	Current Acres	Future Acres Low	Future Acres High	Change in Acres Low	Change in Acres High
Containers	0	0	0	0	0

Source: BST Associates

3.6.5 Marine Highway / Domestic

The U.S. Maritime Administration has extensively studied the potential for barges and/or vessels to move cargo along inland and coastal waterways, creating an alternative to conventional freight and

[37] Advisian, *Terminal 6 Business Study*, January 2018.

cargo movement by trucks and rail. Several of the potential routes identified are located on the West Coast.

In 2014, a MARAD-funded study identified three potential West Coast routes with the best chances of supporting a short-sea service, e.g., San-Pedro Bay Ports (Ports of Los Angeles and Long Beach) to the Port of Oakland; San-Pedro Bay Ports to Pacific Northwest Ports (Ports of Seattle and Tacoma); and Port of Oakland to Pacific Northwest Ports. Other options that were not included in the expanded analysis included: San Diego/San Pedro, San Pedro/Port Hueneme, Oakland/ Redwood City, and Humboldt Bay/Crescent City); these were not included because the relatively short-distance between the port pairs was not cost or time competitive with truck transportation. The report identified the best opportunity as "international cargoes that are bulky and heavy, are not time-sensitive, and will load in 20-, 40- or 45-foot container assets." [38]

> There are several potential social and environmental benefits from developing marine highways, including: creating and sustaining jobs in U.S. vessels and in U.S. ports and shipyards; increasing the state of good repair of the U.S. transportation system by reducing maintenance costs from wear and tear on roads and bridges; increasing our nation's economic competitiveness by adding new, cost-effective freight and passenger transportation capacity; increasing the environmental sustainability of the U.S. transportation system by using less energy and reducing air emissions (such as greenhouse gases) per passenger or ton-mile of freight moved.
>
> Further environmental sustainability benefits come from the mandatory use of modern engine technology on designated projects; increasing public safety and security by providing alternatives for the movement of hazardous materials outside heavily populated areas; increasing transportation system resiliency and redundancy by providing transportation alternatives during times of disaster or national emergency; and increasing national security by adding to the nation's strategic sealift resources.[39]

One of the West Coast corridors that was studied is the M-5 Marine Highway Corridor, which runs north-south along the coast. The M-5 corridor is described as:

> The corridor includes the Pacific Ocean coastal waters, connecting commercial navigation channels, ports, and harbors from San Diego, CA to the US-Canada border north of Seattle, WA. It spans Washington, Oregon and California along the West Coast.
>
> Several areas along the corridor have considerable annual truck hours of delay, most notably in the urban areas of California, Portland, OR, and Seattle, WA; as well as rail congestion in that Southern California and the Pacific Northwest are also plagued with freight rail congestion.
>
> Navigable coastal waters that parallel the entire I-5 Corridor, combined with numerous deep and safe rivers, bays, and ports, can help to accommodate some of this expected increase in traffic, reducing landside travel delays and greenhouse gas emissions along this essential freight corridor.

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[38] Cardno TEC Inc., *West Coast Marine Highway Market Analysis Project*, April 2014. Prepared for the West Coast Corridor Coalition through a cooperative agreement with United States Department of Transportation – Maritime Administration.

[39] U.S. Maritime Administration, "America's Marine Highway Program", https://www.marad.dot.gov/ships-and-shipping/dot-maritime-administration-americas-marine-highway-program/ (accessed 3-22-2018).

Sponsors include the California Department of Transportation (Caltrans), the Oregon Department of Transportation (ODOT), the Washington State Department of Transportation (WSDOT)) and supporters (Pacific Northwest Waterways Association, California Marine Affairs and Navigation Conference, Humboldt Bay Harbor, Recreation, and Conservation District / Port of Humboldt Bay, Port of Skagit County, WA, Skagit County Board of Commissioners, Town of La Conner, WA, and Swinomish Tribal Community). [40]

Figure 3-27: M-5 Marine Highway Corridor

In 2010, the California Green Trade Corridor / Marine Highway Project was created to link the Ports of Stockton and Sacramento with the Port of Oakland via the "M-580" route. MARAD awarded a $30 million Transportation Investment Generating Economic Recovery (TIGER 1) to upgrade the port facilities and purchase the equipment needed to transport containers. It was projected that this container-on-barge service could eliminate 180,000 truck trips from I-580, I-80, and I-205 corridors primarily for consumer goods and agricultural products grown in Central California and Northern California. The "M-580" barge service operated between Stockton and Oakland for fourteen months in 2013-2014 as a pilot project. The test was considered to be a qualified success, shifting 7,259 containers to barge over 116 barge trips.[41]

The Port of Stockton announced it would end the weekly container-on-barge service to and from the Port of Oakland in 2014 because it only attracted half of the expected volume. The reasons for the cessation of service included higher cost of operation than for trucking, and difficulty in convincing shippers to terminate contracts with trucking firms. In order for this barge service to be viable there must be sufficient sustainable cargo volume for the service. If the distance from the shipper to the port is minimal, the cost of accessing the terminal may be acceptable but as the distance increases, the

[40] U.S. Maritime Administration, marine highway corridor descriptions, https://www.marad.dot.gov/wp-content/uploads/pdf/Click-here-for-Route-Descriptions.pdf (accessed 3-22-2018).

[41] CalTrans, *Long Term Implementation of the M-580 Marine Highway*, December 2015.

overall costs may exceed the other options for shippers. Trucking is also more flexible in that it minimizes delays waiting for service.

3.6.5.1 Potential demand at Humboldt

Marine highway systems need an anchor user with sufficient volumes to drive an acceptable level of service and to minimize per unit costs. Cargoes in Humboldt Bay that have been considered for such service include municipal solid waste and lumber. Marine highway service could also accommodate breakbulk and container cargoes.

If an offshore wind program were initiated in Humboldt Bay, a marine highway service could link Humboldt Bay with the Port of Oakland or San Francisco. A similar service operated on Puget Sound, to transport airliner components from Seattle to the Boeing assembly plant near Everett. In 2005, Boeing began to outsource certain oversized airplane components to a manufacturer in Japan. These components were carried in oversize containers aboard container ships that offloaded in Seattle, and then loaded onto barges for transport to a Port of Everett dock in Mukilteo, near the assembly plant. Once container volumes reached a sufficient level, however, the ships carrying the oversize containers began calling directly at the Port of Everett.

The potential for success of such a program in Humboldt Bay is uncertain until more is known about the scale and on-shore infrastructure requirements of the offshore wind energy industry.

The projected demand for CDI lands from marine highway service is zero acres. (See Table 3-10). If such a service were to be created, however, it could likely be accommodated at a multi-purpose terminal that handles breakbulk and other cargo types.

Table 3-10: Demand for CDI Land – Marine Highway

	Current	Future Acres		Change in Acres	
Land Use	Acres	Low	High	Low	High
Marine Highway	0	0	0	0	0

Source: BST Associates

3.7 Dry Bulk Cargo

Dry bulk cargoes are those that can be handled with a system of conveyor belts, hoppers and other equipment between trucks, railcars, storage facilities and ships. The bulk cargo market is actually not a single market, but rather a collection of individual commodity markets, each subject to its own set of market dynamics and trade trends based on supply, demand and other variables. They generally include commodities and basic materials with a low unit value moving in very high volume, such as coal, iron ore, various forms of semi-processed iron, minerals, cement, grains, and woodchips.[42]

3.7.1 Overview

Dry bulk commodities are shipped by water to and from foreign ports as well as to and from domestic ports. Dry bulk movements on the U.S. West Coast are dominated by foreign trade, and essentially all of the growth in dry bulk movements since 1990 was due to increasing foreign trade.

Foreign exports are the largest type of movement, accounting for two-thirds of dry bulk movements in 2016. Exports actually trended downward from 1990 through 2002, but since then have risen substantially. Exports averaged approximately 50 million tons per year from 1990 through 1994, increased substantially from 1995 through 1997, and then dropped to an average of 46 million metric tons from 1998 through 2003. After 2003 the volume exports started a long period of growth, reaching nearly 76 million metric tons in 2016 and averaging more than 70 million metric tons per year from 2012 through 2016. (See Figure 3-28)

Foreign imports also grew over the long run (i.e. from 1990 through 2016) but saw higher volumes in the middle of that period than at the end. Overall, imports grew from less than 14 million metric tons in 1990 to more than 18 million metric tons in 2016, an increase of 34%. Imports grew slowly from 1992 through 2000 and then again from 2003 through 2006, reaching a peak of more than 25 million metric tons. Imports dropped sharply during the recession, falling to just 11 million metric tons in 2009. After 2009 import volumes grew each year, exceeding 18 million metric tons in 2016.

Domestic shipments and domestic receipts of dry bulks move in smaller volumes than in foreign trade, with domestic shipments accounting for approximately 6% of dry bulk movements and domestic receipts accounting for 11%. Volumes of both dropped between 1990 and 2016, but much of this decline occurred early in the period.

Domestic receipts have run through several cycles of growth and decline, reaching lows of 13 million metric tons in 1994, 10 million metric tons in 2001, and nine million metric tons in 2009. High volumes included 16 million metric tons in 1993, 15 million metric ton in 1996, and more than 14 million metric tons in 2004 and 2005. From 2013 through 2016 domestic receipts were approximately 12 million metric tons per year, except in 2015.

Domestic shipments essentially followed the same cycles as domestic receipts, while averaging approximately 5 million metric tons less than domestic receipts. Domestic shipments dropped from a high of more than 16 million metric tons in 1990 to a low of less than five million metric tons in 2010. From 2013 through 2016 domestic shipments averaged six million metric tons per year.

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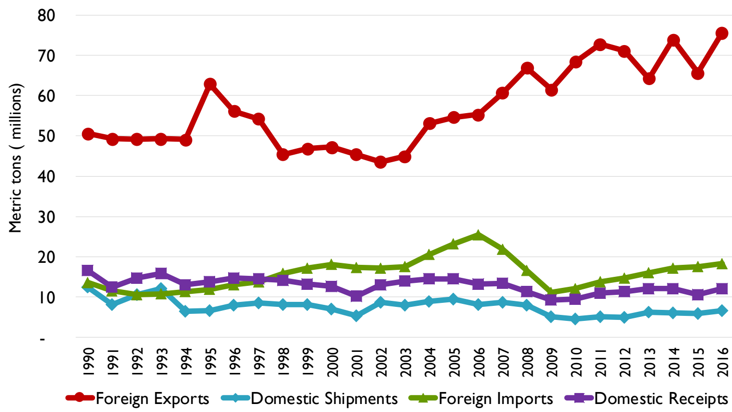
[42] PB Ports & Marine, Inc., *Port of Humboldt Bay Harbor Revitalization Plan*.

Figure 3-28: West Coast Dry Bulk Trends (Million Metric Tons)

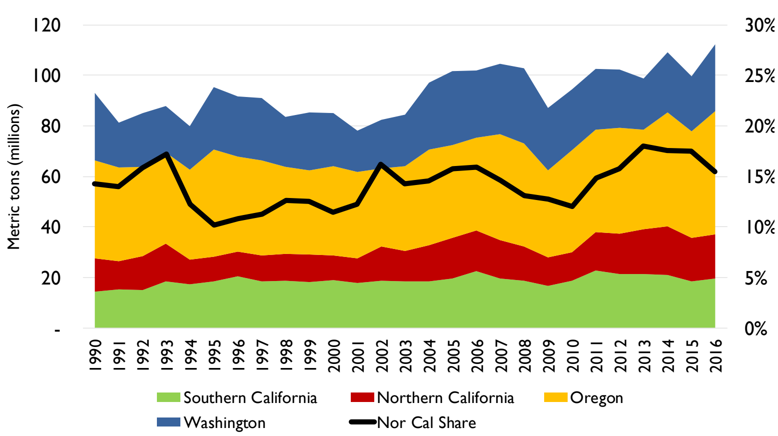


Source: US Army Corps of Engineers

Northern California's share of U.S. West Coast dry bulk movements averaged 14% from 1990 through 2016; in the most recent five years this average was closer to 17%. Northern California's share dropped from 17% in 1993 to less than 11% in 1995 and 1996 but has trended upward since then. (See Figure 3-29).

Total dry bulk tonnage for Northern California grew from approximately 13 million metric tons in 1990 to 15 million metric tons in 1993 and then remained near 10 million metric tons from 1994 through 2001. Since 2002 Northern California dry bulk tonnage has trended upward, never dropping to less than 11 million metric tons and averaging more than 17 million metric tons per year over the most recent five years. In 2014 Northern California ports handled a record 19 million metric tons of dry bulks.

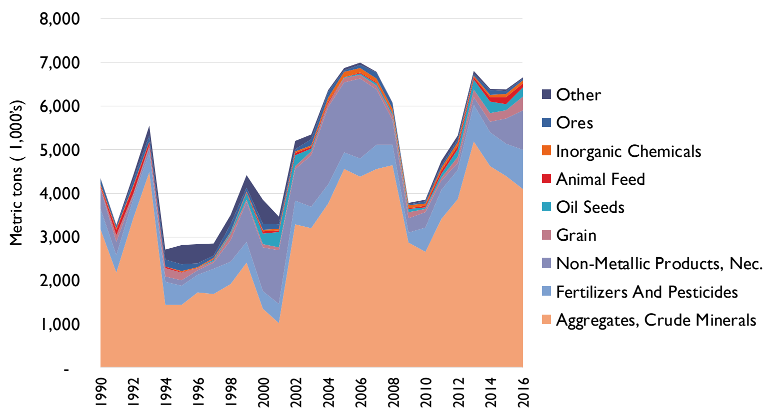
Figure 3-29: West Coast Dry Bulk Trends by Region (Million Metric Tons)



Source: US Army Corps of Engineers

In Northern California, aggregates and crude minerals (primarily gypsum) account for more than half of waterborne dry bulk receipts (both domestic and foreign traffic). Fertilizers and pesticides account for nearly 14% of inbound tonnage, and non-metallic products (primarily cement and concrete) also account for 14%. Other products account for a total of less than 12% of inbound dry bulk tonnage. Humboldt Bay is a minor player in dry bulk receipts and accounted for less than 1% of Northern California tonnage from 1990 through 2016, except during the period of 1998 through 2001, when local pulp mills received woodchips by water. (See Figure 3-30).

Figure 3-30: Northern California Dry Bulk Receipts (1,000 Metric Tons)

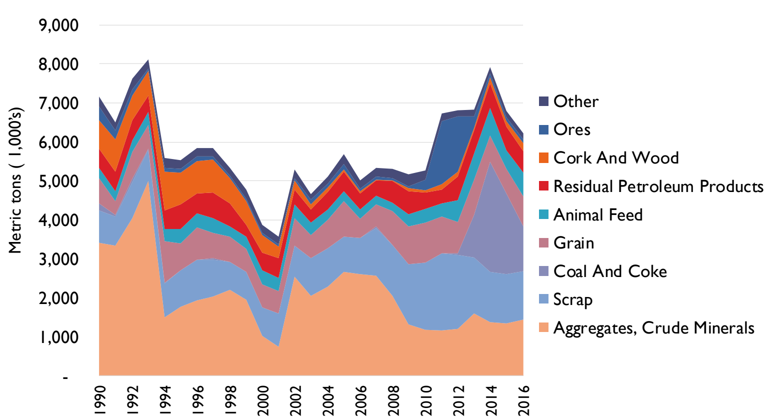


Source: US Army Corps of Engineers

In Northern California, for most of the period from 2000 through 2016 three commodity groups accounted for most dry bulk shipments: aggregates and crude minerals (mainly sand/gravel and sulphur), scrap (i.e. iron and steel), and grain. In 2013, however, the Port of Richmond began exporting coal, and coal has since become one of the top three outbound dry bulks.

During the 1990's one of the major outbound dry bulk commodities was cork and wood (essentially all of which was woodchips), and Humboldt Bay accounted for the majority of this tonnage. Woodchip shipments dropped sharply from 2000 through 2007, and although volumes have increased since then, the volume is still approximately one-quarter of what is was during the 1990's.

Figure 3-31: Northern California Dry Bulk Shipments (1,000 Metric Tons)



Source: US Army Corps of Engineers

3.7.2 Aggregates

Aggregates are a critical input to the construction industry, but in California it has become increasingly difficult to access supplies of this material close to population centers. Aggregates are low-value commodities that move in large volumes, and increasing distance greatly increases the delivered price. Humboldt Bay is a relatively long distance from population centers but it has significant supplies of aggregates. Humboldt Bay may be able to supply markets such as the San Francisco Bay area or the Los Angeles area if the delivered price is competitive with other suppliers.

The California Geological Survey (CGS) describes aggregates as follows:

> Sand, gravel, and crushed stone are 'construction materials.' These commodities, collectively referred to as aggregate, provide the bulk and strength to Portland Cement Concrete (PCC), Asphaltic Concrete (AC, commonly called 'black top'), plaster, and stucco. Aggregate is also used as road base, subbase, railroad ballast, and fill. Aggregate normally provides from 80 to 100 percent of the material volume in the above uses."
>
> The building and paving industries consume large quantities of aggregate and future demand for this commodity is expected to increase throughout California. Aggregate materials are essential to modern society, both to maintain the existing infrastructure and to provide for new construction. Therefore, aggregate materials are a resource of great importance to the economy of any area. Because aggregate is a low unit-value, high bulk weight commodity, it must be obtained from nearby sources to minimize economic and environmental costs associated with transportation. If nearby sources do not exist, then transportation costs can quickly exceed the value of the aggregate. Transporting aggregate from distant sources results in increased construction costs, fuel consumption, greenhouse gas emissions, air pollution, traffic congestion, and road maintenance.[43]

3.7.2.1 Historical Trends

According to the California Geological Survey, from 1981 to 2010 California consumed an average of about 180 million tons of construction aggregates (all grades) per year. In order to meet the demand, aggregates suppliers are increasingly turning to alternative sources, including sources from out of state or out of the country. For example, the San Diego area imports aggregates from sources in Mexico, while the San Francisco Bay area and now the Los Angeles area import aggregates from Canada.

In the Bay Area, Cemex Aggregates operates an 8.2 acre marine terminal at the Port of Redwood City that receives building materials such as sand and aggregates. These materials are transported via ship from British Columbia and are used for construction projects in the South Bay area.

According to a recent Port of Redwood City press release, "over the past three years Cemex has imported nearly four million metric tons of building materials."[44] According to the Port, there is a dwindling local supply of these materials being mined locally, because quarries are unable to expand.

The construction aggregates arrive at the Port on ships that contain self-unloading features, operated by Canadian Steamship Lines. Eagle Rock Aggregates is the supplier to Cemex of these construction

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[43] California Geological Survey Department of Conservation, *Aggregate Sustainability in California*, 2012.

[44] Port of Redwood City, "Port, Cemex Aggregates Reach New 10-Year Deal" port press release, June 26, 2017.

aggregates. Eagle Rock operates the Orca Quarry, located on the northeast coast of Vancouver Island, BC, which is a very first-rate sand and gravel resource with significant long-term capacities.

Southern California also started receiving aggregates from the same quarry in 2016, using the same type of ship. Like the terminal in Redwood City, the Long Beach terminal is approximately eight acres.

The inability to permit expanded or new quarries in Southern California is similar to that in Northern California, and has led construction material firms to look for new sources of sand and gravel. According to a recent article in the Los Angeles Times, "a 2012 report from the California state geologist estimates that quarries in Los Angeles County and the Bay Area have permits to produce less than one-third of the aggregate that will be needed over the next 50 years. San Diego, which already imports aggregate from Mexico, is in even worse shape."[45]

Total transportation cost is what makes shipping aggregates by water make sense. According to the article in the Los Angeles Times, aggregates are moved by conveyor belt from the mine to the ship loader in Canada, then is loaded in ships that can carry about 75,000 tons of material. The total cost to move the material from the quarry in Canada to a construction site in Los Angeles is $16.00 per ton, compared to nearly $23.00 per ton for trucking 65-miles from an inland quarry to Los Angeles.

3.7.2.2 Forecast

The CGS projects that California's 50-year demand for aggregates was more than 12 billion tons, as of January 2011. Statewide, currently permitted reserves are only capable of meeting 34% of that demand, and in some areas the situation is much worse. Many of these areas with permitted reserves that are substantially lower than forecast demand are located on navigable waterways, and may be capable of receiving aggregates by water. (See Table 3-11).

For example, in the San Francisco Bay Area (and connecting waterways) the North San Francisco Bay P-C (production-consumption) region has permitted reserves capable of meeting just 21% of 50-year demand, in the South San Francisco Bay P-C region the supply is equal to 29% of demand, in Sacramento County reserves may only meet 6% of demand, and in Stockton-Lodi reserves may meet 53% of demand.

[45] Koren, James Rufus, "Why builders of big L.A. projects are making concrete with gravel and sand shipped from Canada", *Los Angeles Times*, November 4, 2017.

Table 3-11: Comparison of 50-Year Demand to Permitted Aggregate Reserves

Aggregate Study Area	50-Year Demand (million tons)	Permitted Aggregate Reserves (million tons)	Permitted Reserves Compared to 50-Year Demand	Projected Years Remaining
Bakersfield P-C Region	438	143	33%	21 to 30
Barstow-Victorville P-C Region	159	124	78%	31 to 40
Claremont-Upland P-C Region	203	109	54%	21 to 30
El Dorado County	76	18	24%	11 to 20
Fresno P-C Region	435	46	11%	10 or fewer
Glenn County	59	33	56%	21 to 30
Eastern Merced County	100	50	50%	21 to 30
Western Merced County	28	Proprietary	>50%	31 to 40
Monterey Bay P-C Region	346	323	93%	41 to 50
Nevada County	100	26	26%	11 to 20
Palmdale P-C Region	577	152	26%	11 to 20
Palm Springs P-C Region	295	152	52%	21 to 30
Placer County	151	152	101%	More than 50
North San Francisco Bay P-C Region	521	110	21%	11 to 20
Sacramento County	670	42	6%	10 or fewer
Sacramento-Fairfield P-C Region	196	128	65%	11 to 20
San Bernardino P-C Region	993	241	24%	11 to 20
San Fernando Valley / Saugus-Newhall	476	77	16%	10 or fewer
San Gabriel Valley P-C Region	809	322	40%	11 to 20
San Luis Obispo-Santa Barbara P-C Region	240	75	31%	11 to 20
Shasta County	93	52	56%	21 to 30
South San Francisco Bay P-C Region	1,381	404	29%	11 to 20
Stanislaus County	214	45	21%	11 to 20
Stockton-Lodi P-C Region	436	232	53%	31 to 40
Tehama County	62	32	52%	21 to 30
Temescal Valley-Orange County 3	1,077	297	28%	11 to 20
Northern Tulare County	124	27	22%	11 to 20
Southern Tulare County	73	Proprietary	<50%	21 to 30
Ventura County 3	298	96	32%	11 to 20
Western San Diego County P-C Region	1,014	167	16%	10 or fewer
Yuba City-Marysville P-C Region	403	392	97%	41 to 50
Total	12,047	4,067	34%	

Source: California Geological Survey

3.7.2.3 Potential demand at Humboldt

According to the 2003 *Port of Humboldt Bay Harbor Revitalization Plan* "There appear to be significant opportunities for domestic aggregates and rock from the Humboldt County area to be barged or railed down to the Bay Area (especially North Bay locations) to meet a looming shortage of construction materials. Based on extraction reports, interviews with Humboldt County officials, and interviews with landowners and permit holders, it is evident that significant volumes could be produced from the Eel River and potentially lesser amounts from the Van Duzen River for shipment to the Bay Area by barge or rail."

The Humboldt Bay region is home to a number of aggregates quarries, especially along the Mad River and Eel River drainages. The *Revitalization Plan* notes that "Forty-eight Humboldt County sites are currently permitted for in-stream mining of over 2.5 million cubic yards per year. Volumes of 600,000 to 1 million tons per year appear to be within the range of possibility. In addition, 26 sites are permitted for hard rock mining of over 800,000 cubic yards annually. In addition to aggregates, these hard rock sites could produce larger-dimension rock for San Francisco Bay markets. Success in the bulk aggregate and rock markets will depend on transportation costs and potential environmental constraints on harvest volumes."

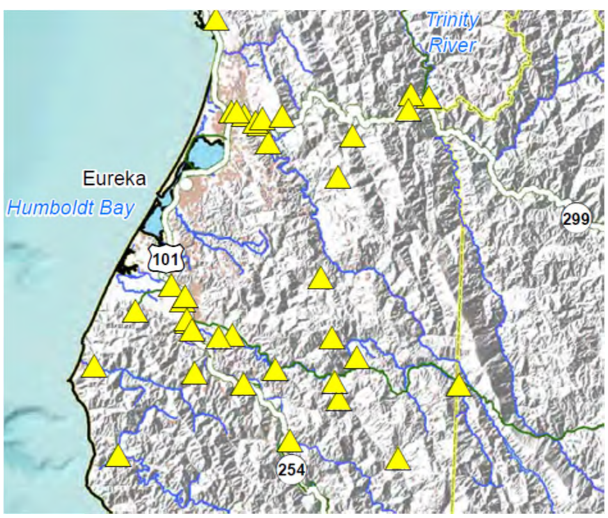
As described above, total transportation cost is a key factor in determining what markets can be economically served from which quarries. Trucking is typically the most expensive option on a ton-mile basis, while shipping by water is the least expensive. In order for quarries in Humboldt County to compete in distant markets, such as Southern California or the San Francisco Bay Area, the inland distance from quarry to shipping terminal and from receiving terminal to final destination must be minimized.

The current operation on Vancouver Island is able to use conveyor belts to move aggregates one mile from the quarry to the ship loading terminal, which minimizes the inland transportation cost on the shipping end. The water distance from the quarry to Redwood City is approximately 1,115 miles, and to Long Beach is 1,450 miles. In a recent article[46], the total cost to transport aggregates from the Vancouver Island quarry to a construction site 25 miles inland from the terminal in Long Beach included:

- Water transportation – 1,465 miles, 75,000 tons per load, \$7.25 per ton, or \$0.005 per ton-mile
- Trucking – 25 miles, 25 tons per load, \$220 per load, or \$0.35 per ton-mile
- Total cost of \$16.05 per ton

A number of quarries on the Mad River are approximately 15 miles by road from terminals in Eureka and on the Samoa Peninsula, while several quarries on the Eel River are less than 15 miles from Fields Landing and less than 20 miles from Eureka. (See Figure 3-32).

Figure 3-32: Aggregate Production Areas in Humboldt Bay Region



Source: California Geological Survey, portion of Map Sheet 52

Humboldt Bay is 721 miles closer to both Redwood City and Long Beach. Using the same cost per ton-mile for water transportation, the waterborne move from Humboldt Bay to either Redwood City or Long Beach would be \$3.57 lower than from the Canadian quarry. Assuming the same trucking cost per ton-mile, this savings on the water transportation would offset approximately 10 miles of the 15 miles for trucking from Humboldt Bay area quarries to a shipping terminal. As a result, Humboldt Bay area

[46] Koren, November 4, 2017.

quarries might be able to compete for this business. Using the same factors as in the Los Angeles example, the total cost to move aggregates from Humboldt Bay quarries through Long Beach to a site 25 miles inland would be $17.75 per ton.

Alternatively, a number of the quarries in the Humboldt Bay area are located adjacent to or near the inactive NCRA rail line, and several quarry owners have expressed interest in transporting aggregates by rail. According to one recent estimate[47], the cost to ship by rail is approximately one-third the cost of transporting by truck, while another[48] estimated that rail transportation was $5.00 per ton less than truck transportation. The potential cost savings from rail may increase the competitiveness of Humboldt Bay aggregates in the distant markets.

The 8.2-acre Redwood City terminal imported four million tons over three years, or an average of 1.33 million tons per year. Based on the estimate of 1 million tons per year from the *Revitalization Plan,* a terminal in Humboldt Bay of eight acres to twelve may be capable of handling the potential demand. (See Table 3-12).

Table 3-12: Demand for CDI Land – Aggregates

Land Use	Current Acres	Future Acres		Change in Acres	
		Low	High	Low	High
Aggregates	0	8	12	8	12

Source: BST Associates

[47] Robinson, Gilpin R. Jr., and Brown, William M, *Sociocultural Dimensions of Supply and Demand for Natural Aggregate— Examples from the Mid-Atlantic Region, United States*, U.S. Geological Survey Open-File Report 02-350, September 2002.

[48] Pincomb, Art, "Mineral Appraisals: What is the Value of a Quarry or Mine?", *The M&TS Journal, Volume 32, Issue 2*, 2nd Quarter 2016.

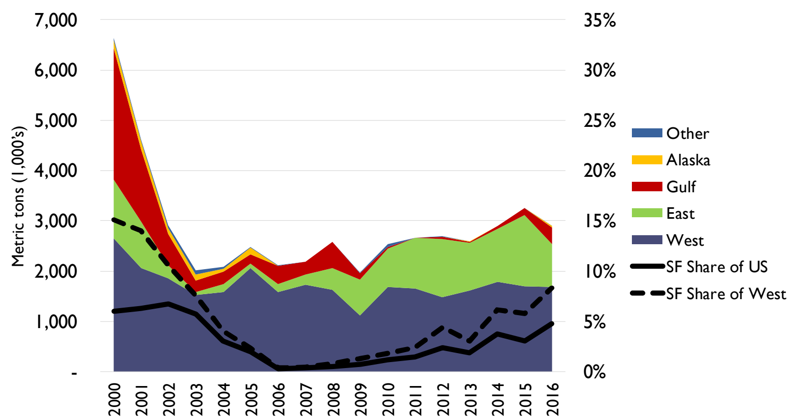
3.7.3 Woodchips

Woodchips are the main inputs to pulp and paper manufacturing. Woodchips are largely a by-product of lumber mills, and the supply of chips is related to output of mills.

3.7.3.1 History

United States exports of woodchips dropped from 6.6 million metric tons in 2000 to just 2.0 million metric tons in 2003, a fall of nearly 70%. Most of drop was due to declining exports from Gulf Coast ports, which saw woodchip tonnage drop by more than 90%. (See Figure 3-33).

Figure 3-33: United State Woodchip Exports



Source: U.S. Census Bureau Foreign Trade Division

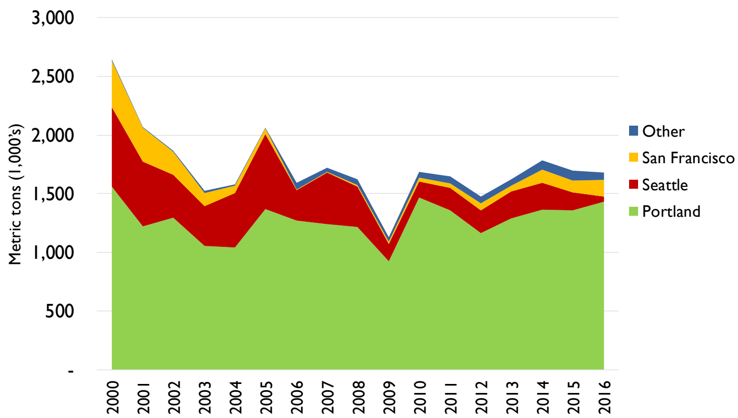
The West Coast has been the largest exporter in the U.S. of woodchips since at least 2000, and in every year since 2002 it has accounted for more than half of all woodchips exports. Gulf Coast exports have remained relatively low, while East Coast exports saw strong growth after 2005.

The San Francisco Customs District, in which Humboldt Bay is located, is a relatively small exporter of woodchips, but market share saw strong growth from 2006 through 2016. In 2006 and 2007 the San Francisco Customs District accounted for less than 1.0% of U.S. exports and also less than 1.0% of West Coast exports. Market share climbed over the next decade, and in 2016 the San Francisco Customs District accounted for 4.8% of U.S. woodchip exports and 8.3% of West Coast exports.

West Coast exports of woodchips generally range between 1.5 million metric tons and 1.7 million metric tons from 2003 and 2016. The primary exceptions were in 2005, when volumes exceed 2.0 million metric tons, and in 2009, when they dropped to 1.1 million metric tons.

The Portland Customs District includes ports on the Columbia River in both Oregon and Washington, as well as ports on the Oregon Coast. The Portland District is by far the largest exporter of woodchips, accounting for 75% or more of West Coast exports from 2008 through 2016. From 2010 through 2016, Portland District woodchips exports averaged 1.6 million metric tons. In contrast, woodchip exports from the San Francisco Customs District averaged less than 170,000 during the same period. (See Figure 3-34).

Figure 3-34: U.S. West Coast Woodchip Exports



Source: U.S. Census Bureau Foreign Trade Division

In addition to exports, for a period in the late 1990's and early 2000's woodchips were received by water. These inbound receipts were used as an input to pulp manufacturing and were imported to make up for a shortage of locally produced woodchips. This was relatively short-lived, however, and woodchips have not moved inbound to Humboldt Bay in more than a decade.

3.7.3.2 Forecast

According to a recent report, there are potential export options resulting from the need to remove trees that were killed by drought, beetles, wildfire, and other damaging agents, which are estimated to include an estimated 102 million standing dead trees. Options to utilize these assets include 350,000 BDT[49] from log exports, up to 250,000 BDT from wood chips, as much as 300,000 BDT from low capital, simple product mix sawmills, and 1.1 million BDT from large scale biomass plants. The dead tree problem is centered in the Southern Sierra Range and the nearest ports are Stockton and West Sacramento. These ports have a maximum draft depth of 35' and 30' respectively. A fully loaded chip vessel requires 38' to 39' of draft. Thus, any vessels originating from either of those ports could only be partially filled. In the past, chip exporters using those ports have dealt with this problem by sending partially loaded vessels to deeper ports in Samoa, California or Coos Bay, Oregon to be fully filled. This practice is costly, but per industry contacts may not be cost prohibitive.[50]

3.7.3.3 Future Acreage

Humboldt Bay currently has two facilities that that ship woodchips, the Eureka Forest Products terminal in Eureka and the California Redwood Chip Export Dock in Samoa. The Eureka Forest Products property encompasses 19.5 acres, of which 15.3 acres is land. The California Redwood property encompasses 23.7 acres, of which 19.3 acres is land.

According to vessel data maintained by the Harbor District, the Eureka Forest Products terminal has handled as much as 9,600 metric tons of woodchips per acre of land, and the California Redwood

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[49] "BDT" means bone dry tons, a measurement of biomass that has zero percent moisture content.

[50] The Beck Group, *Dead Tree Utilization Assessment*, May 2017. Completed for CALFIRE & California Tree Mortality Task Force.

terminal has handled approximately 11,100 metric tons per acre of land. Based on these tonnage factors and the existing acreage, the active terminals have a combined throughput capacity of at least 361,000 metric tons per year.

The highest combined woodchips tonnage that these terminals have handled in the past is approximately 251,000 metric tons in 2016 and 253,000 metric tons in 2017. This implies that the existing terminals have the capacity to export 43% more, or 108,000 metric tons.

Some other ports on the West Coast have demonstrated much higher throughput, and the Humboldt Bay woodchip terminals may be capable of handling higher volumes. For example, Coos Bay has an estimated 40 acres of woodchip terminals which have handled combined volumes of nearly 30,000 metric tons per acre. The Fibreco Terminal in Vancouver, BC, is capable of 3 million metric tons of throughput with approximately 12 acres of woodchip storage, or 245,000 metric tons per acre.

There does not appear to be future demand for additional CDI lands for woodchip terminals. Given the throughput at the two existing terminals, it may also be feasible to consolidate all woodchip shipments into a single terminal. Current usage of CDI lands is 36 acres, and projected demand ranges from 20 acres to 36 acres. (See Table 3-13).

Table 3-13: Demand for CDI Land – Woodchips

	Current	Future Acres		Change in Acres	
Land Use	**Acres**	**Low**	**High**	**Low**	**High**
Woodchips	36	20	36	-16	0

Source: BST Associates

3.7.4 Grain and Oilseeds

U.S. grain terminals export a variety of grains, oilseeds, and related products. These include wheat, corn, barley, soybeans, grain sorghum, and some animal feeds such as beet pulp pellets and DDGS.[51]

Wheat is primarily used for human consumption, as opposed to the coarse grains (corn, barley, sorghum), which are primarily used as animal feed. Demand for human food is less affected by changes in personal income than demand for animal feed, but currency exchange rates do have a strong impact on wheat sales. Competition for wheat exports is intense, particularly with Canada and Australia, among other countries.

Soybeans are used both for animal feed and for human consumption. The export markets are large and growing, particularly in China. As with other crops, there is strong international competition (mainly from Brazil and Argentina).

Coarse grains, including corn and sorghum, are used primarily for animal feed. Competition is intense in the world coarse grain market, and U.S. exporters vie for sales against Brazil, Argentina, and others. West Coast ports also face competition from other U.S. regions, specifically ports on the Gulf Coast.

Most West Coast exports of grain and oilseeds are shipped through ports in the Pacific Northwest. Pacific Northwest exports grew from less than 20 million metric tons in 2000 to nearly 35 million metric tons in 2015. Volumes fluctuate from year to year, depending on annual harvest and other factors, but the long-term trend has been one of strong growth.

On the West Coast, essentially all grain moves to export terminals by train or barge. In the Pacific Northwest, much of the exported wheat is grown in the Great Plains and shipped to port by rail. In addition, substantial volumes of wheat are grown in the Pacific Northwest and shipped to port by rail, or by barge on the Columbia-Snake River system.

A significant deepening of the Columbia River navigation channel was completed in recent years, which has led to significant investments grain terminals expansions. These investments have increased annual export capacity from approximately 21 million metric tons to more than 37 million metric tons.

In addition to bulk shipments of grain, an increasing volume of grain is loaded into containers for export. Although the volume of this type of movement is still small relative to bulk shipments, it does provide shippers with additional options. Grain can be loaded into containers near the farming areas if empty containers are available, or it can be shipped by rail to the vicinity of container ports (such as Los Angeles / Long Beach), where empty containers are available for transloading.

The recent opening of the larger third set of locks at the Panama Canal also increases the competition for West Coast ports. The new locks allow significantly larger vessels to transit the seaway, which reduces transportation costs and from Gulf Coast and South American ports. In addition, the Corps of Engineers is studying the potential to deepen the Mississippi River channel as far upstream as Baton Rouge, thereby allowing larger, more efficient vessels.

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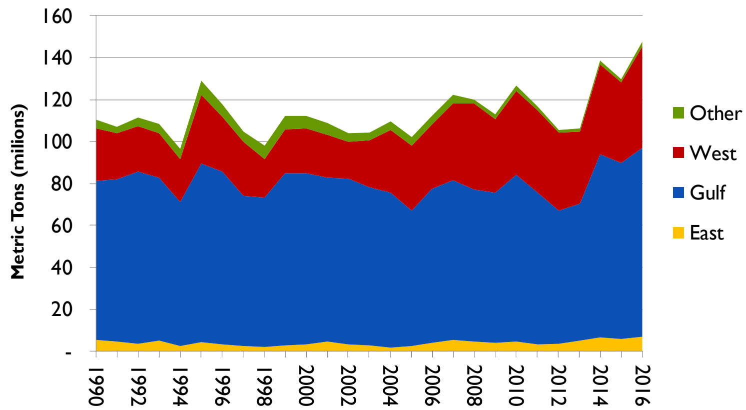
[51] DDGS is distiller's dried grains with solubles, the nutrient rich co-product of ethanol production used as a feed ingredient.

Figure 3-35: U.S. Grain and Oilseed Export Trends



Source: BST Associates using data from the Pacific Maritime Association

3.7.4.1 Forecast

Bulk shipments of grain and oilseeds from the West Coast are likely to continue to be concentrated in the Pacific Northwest.

3.7.4.2 Future Acreage

Humboldt Bay is unlikely to become a bulk export facility for grains and oilseeds. The primary reason for this is that essentially all grain and oilseed exports are shipped to export terminals by rail, or by barge on the Columbia-Snake River system. Humboldt Bay does not have a rail connection to grain growing regions, and is not located on the Columbia-Snake River system. Future acreage needed for this use is zero. (See Table 3-14).

Table 3-14: Demand for CDI Land – Grain and Oilseeds

Land Use	Current Acres	Future Acres Low	Future Acres High	Change in Acres Low	Change in Acres High
Grain & Oilseeds	0	0	0	0	0

Source: BST Associates

3.8 Other Cargo Types

3.8.1 Liquid Bulk Cargo

Waterborne liquid bulk traffic on the West Coast is dominated by crude oil and refined petroleum products. A variety of other liquid commodities (e.g. animal fats, vegetable oils, chemicals, and fertilizers) are also handled, but in much smaller volumes.

3.8.1.1 Historical Trends

Liquid bulk movements through West Coast ports dropped steadily from 1992 through 2016. From a high of more than 146 million metric tons in 1992, total volume dropped to less than 112 million metric tons in 2016, a decline of 24%.

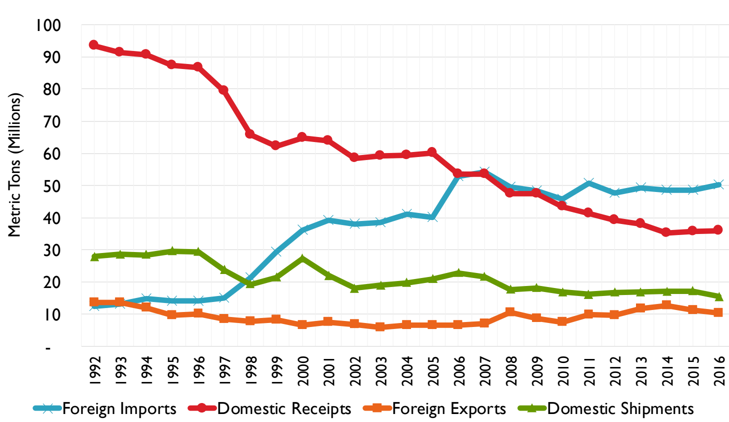
Liquid bulk cargo moving inbound from domestic locations (i.e. domestic receipts) fared the worst, dropping by more than 16% over the period. Domestic inbound tonnage fell from 93 million metric tons in 1992 to 26 million metric tons in 2016, and domestic receipts share of total liquid bulk tonnage fell from 63% in 1992 to 32% in 2016. (See Figure 3-36).

Foreign imports of liquid bulks increased sharply over the period, particularly during the period of 1997 through 2006, and are now the highest-volume liquid bulk movement on the West Coast. Foreign imports totaled approximately 12 million metric tons in 1992 and averaged less than 15 million metric tons from 1992 through 1997. From 1997 through 2007 the volume of imports jumped to more than 54 million metric tons. Imports dropped 49 million metric tons in 2008 and averaged 49 million metric tons from 2008 through 2016.

Outbound movements of liquid bulks (both domestic and foreign movements) are substantially smaller than inbound movements. Domestic shipments represent the third-largest liquid bulk movement on the West Coast, with approximately 15 million metric tons shipped in 2016. This figure represents a decline of nearly 45% from 1992, when nearly 28 million metric tons were shipped.

Exports to foreign destinations declined 24% from 1992 through 2016, falling from approximately 14 million metric tons to less than 11 million metric tons. However, export volumes were actually lower from 1997 through 2007, averaging 7 million metric tons per year; from 2011 through 2016 exports averaged 11 million metric tons.

Figure 3-36: West Coast Liquid Bulk Trends (Million metric tons)



Source: BST Associates using data from the U.S. Army Corps of Engineers

In Southern California liquid bulks are primarily composed of crude oil (inbound) and petroleum products (outbound).

The increase in domestic and Canadian oil production has caused a drop in the importation of crude oil. There is only one high-volume commodity associated with liquid bulk exports, which is refined products that are exported from the local refineries in Southern California.[52]

In Northern California waterborne liquid bulk traffic is dominated by crude oil and refined petroleum products, which account for a 96% of all liquid bulk movements. A variety of other liquid commodities (e.g. animal fats, vegetable oils, chemicals, and fertilizers) are also handled, but in much smaller volumes.

Between 1990 and 2016 the volume of liquid bulks moving through Northern California ports dropped by approximately 30%, due to declining crude oil receipts. Crude oil from domestic sources (primarily Alaska) dropped from more than 27 million metric tons in 2000 to less than 4 million metric tons in 2016 as production in Alaska continued a long-term decline. This drop was partially offset by an increase in imports from foreign sources, which grew from less than 2 million metric tons in 1990 to nearly 18 million metric tons in 2016.

Petroleum products peaked in 1993 at more than 23 million metric tons before dropping to less than 12 million metric tons in 1998. By 2006 and 2007 volumes had increased to nearly 20 million metric tons, but after 2007 they declined slowly, reaching less than 18 million metric tons in 2016.

In the Pacific Northwest waterborne liquid bulk traffic is dominated by crude oil and refined petroleum products, which account for a 98% of liquid bulk movements. A variety of other liquid commodities (e.g. animal fats, vegetable oils, chemicals, and fertilizers) are also handled, but in much smaller volumes.

Between 2000 and 2015 the volume of liquid bulks moving through Pacific Northwest ports dropped substantially, due to a decline in crude oil. Crude oil receipts by water declined due to increased imports of crude by pipeline, and from receipts of crude by rail from North Dakota and Canada.

In Humboldt Bay waterborne movements of liquid bulks have trended downward for more than 25 years. Total volume dropped from approximately 400,000 metric tons in 1990 to less than 180,000 metric tons in 2016.

Much of the decline was due to the closures of the pulp mills on the Samoa Peninsula. As illustrated in Figure 3-37, essentially all waterborne liquid bulk movements on Humboldt Bay are now comprised of petroleum products, primarily gasoline and diesel fuel. Early in the period, however, terminals in Humboldt Bay received sodium hydroxide and inorganic chemicals for use in the mills. These receipts dropped sharply between 1990 and 1993, and then continued at limited volumes until 2002.

Since 2002 the only liquid bulk movements on Humboldt Bay have been petroleum products. Between 2002 and 2016 the volume of petroleum products trended downward, dropping from 241,000 metric tons to as little at 160,000 metric tons in 2015.

All of the petroleum products are received at the Chevron Eureka Terminal.

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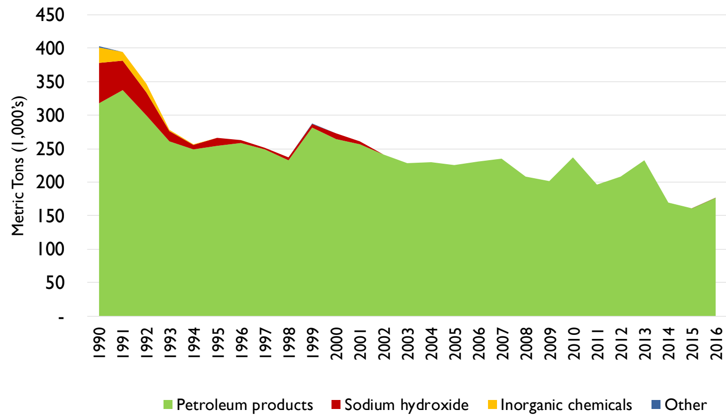
[52] Mercator International and Oxford Economics, *Executive Summary for San Pedro Bay.*

Figure 3-37: Humboldt Bay Liquid Bulk Trends (1,000 metric tons)



Source: BST Associates using data from the U.S. Army Corps of Engineers

3.8.1.2 Forecast

Under its mid-case forecast, the California Energy Commission projects that statewide demand for gasoline peaked in 2016 and will trend downward from 2017 through 2030 while demand for diesel fuel will remain flat.[53]

Assuming that demand in the Humboldt Bay region for these fuels changes at a rate similar to that of the rest of the state, the volume of petroleum products shipped by water to the region is likely to slowly decline.

3.8.1.3 Potential demand in Humboldt Bay

As discussed previously, the Chevron Eureka Terminal dock is a 3.5-acre site south of downtown Eureka, located on the 38-foot North Bay Channel. This terminal receives refined petroleum products via ocean barge for Chevron and other fuel companies, with barges arriving every 10 to 12 days. Approximately 80% of the fuel used by the greater Eureka area is delivered via barge to the Chevron Terminal.[54]

Previously there was a second 4-acre petroleum products terminal operated by Philips Petroleum, also located on the Eureka waterfront. This terminal was inactive at the time of the 2003 *Port of Humboldt Bay Harbor Revitalization Plan*.[55] It has since changed ownership several times, the storage tanks and equipment have been removed, and contamination on the site has been remediated.

Given the forecast of falling demand, the existing Chevron terminal should be able to handle the necessary volumes of fuels. As a result, the existing terminal (or one of similar size) is sufficient to meet demand, and no additional CDI lands will be needed in the future. Current and projected demand is four acres of CDI land. The existing Chevon terminal is capable of handling current volumes, and has handled higher volumes in the past.

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[53] California Energy Commission, *Transportation Energy Demand Forecast, 2017-2030*, June 20, 2017.

[54] Pacific Affiliates, *Chevron Eureka Terminal MOTEMS Inspection Repairs*, May 15, 2015.

[55] PB Ports & Marine, *Port of Humboldt Bay Harbor Revitalization Plan.*

In addition to the liquid bulks historically handled at marine terminals in Humboldt Bay (i.e. petroleum products, chemical for pulp manufacturing) there was a proposal in the early 2000's to construct a terminal for receiving liquefied natural gas ("LNG"). This terminal would have been located on the Samoa Peninsula. However, the project was cancelled in 2004, and this forecast assumes that LNG will not move via Humboldt Bay in the future. (See Table 3-15).

Table 3-15: Current CDI Use and Future Demand, Liquid Bulk

	Current	Future Acres		Change in Acres	
Land Use	**Existing**	**Low**	**High**	**Low**	**High**
Liquid Bulk	4	4	4	0	0

Source: BST Associates

4 DEMAND – OTHER

4.1 CRUISE

Humboldt Bay has hosted cruise ship calls in the past and is expected to continue to do so in the future.

Humboldt Bay is one of several areas that serve as ports of call during what are known as "repositioning" trips. Repositioning trips occur when a cruise ship is moved from one seasonal homeport to another. Cruise ship calls in Humboldt Bay typically occur in the spring or fall, when vessels shift between southern itineraries and the Alaska market.

The Alaska cruise market is based in Vancouver, British Columbia and Seattle, Washington. At the beginning of the season and the end, each vessel must be repositioned from or to its winter homeport. These repositioning cruises that present an opportunity to coastal ports such as Humboldt Bay, Coos Bay, and Astoria.

Cruise line itinerary directors are constantly seeking new ports to offer to their passengers, and coastal ports such as Humboldt Bay, Astoria, and Grays Harbor have been successful in attracting calls. A port call typically lasts for eight hours. During this time, passengers typically have between three and seven hours to participate in local activities. At the same time, the ship will often take on fresh water and dispose of trash.

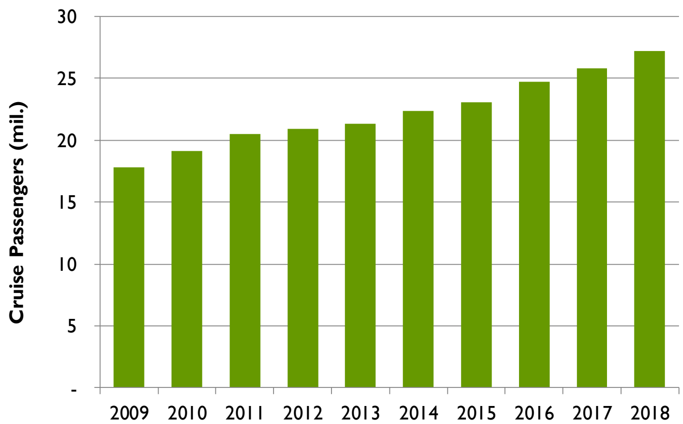
Activities are what draw the cruise lines to a port and proximity to the Redwoods is the primary draw for Humboldt Bay. Local attractions are also critical, especially an attractive town within walking distance for elderly people, with shops selling local goods near the dock. Old Town Eureka provides such an attraction.

4.1.1 Historical Trends

According to the Cruise Lines International Association, the world cruise market has seen substantial and sustained growth for nearly a decade[56]. Total cruise passenger counts jumped from 17.8 million in 2009 to 25.8 million in 2017 and is expected to reach 27.2 million in 2018. Annual growth averaged 4.8% per year, and passenger counts increased in each year.

[56] Cruise Lines International Association, *2018 Cruise Industry Outlook*, December 2017.

Figure 4-1: World Cruise Market Trends

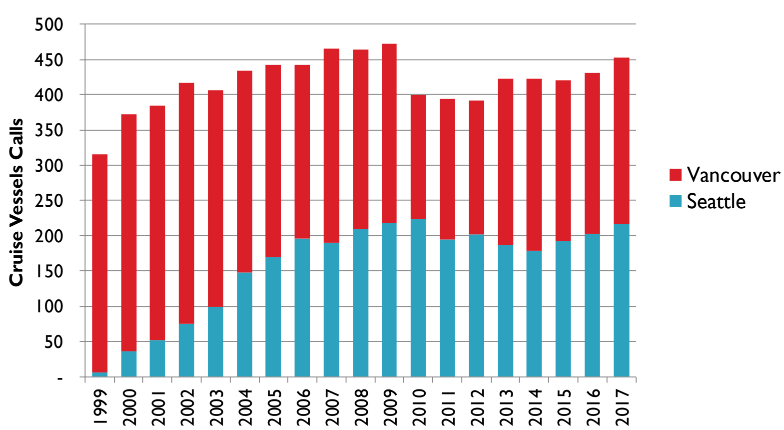


Source: Cruise Lines International Association

During the 1990's nearly all Alaska cruises were based out of Vancouver. Seattle's first homeport cruises occurred in 1999, when the port saw a total of six vessel calls; that year Vancouver hosted 309 vessels calls. From 1999 through 2009 the market saw strong growth, with total vessel calls rising from 315 to 472 calls.

The Alaska cruise market was strongly impacted for several years due to the economic recession, with vessel calls averaging fewer than 400 per year from 2010 through 2012. Recovery in the market started in 2013 and continued through 2017, when Seattle and Vancouver handled a combined 452 vessel calls. (See Figure 4-2).

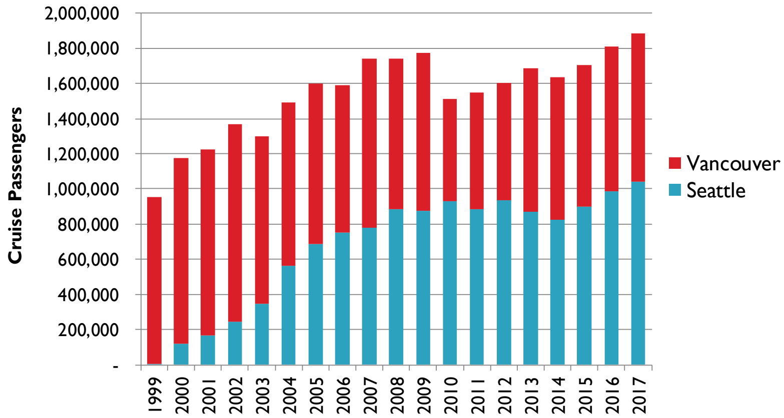
Figure 4-2: Northwest Cruise Trends – Vessel Calls



Source: Port of Seattle, Port Metro Vancouver

Passenger counts rose from fewer than 1.0 million in 1999 to a peak of nearly 1.8 million in 2009. In 2010 the number of passengers dropped to approximately 1.5 million, a decline of nearly 15%. Passenger counts started to recover in 2011 and, with the exception of 2014, grew in each year through 2017. In 2016 the passenger count exceeded the 2009 record and exceeded 1.8 million for the first time, and in 2017 the passenger was nearly 1.9 million. (See Figure 4-3).

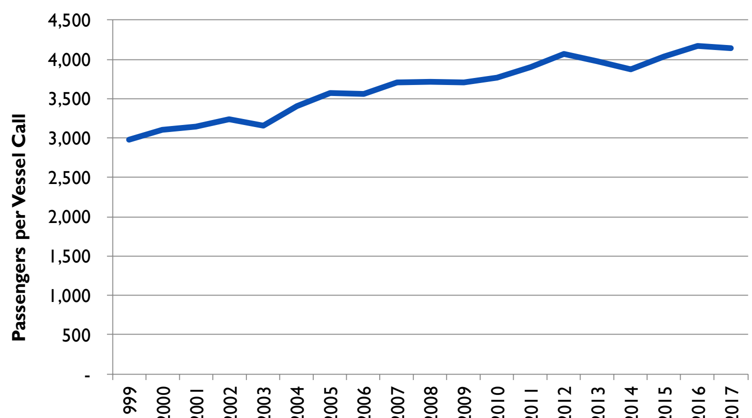
Figure 4-3: Northwest Cruise Trends – Passengers



Source: Port of Seattle, Port Metro Vancouver

A major trend in the cruise industry is the move to larger ships with greater passenger capacity. As illustrated in Figure 4-4, the average number of passengers per vessel call rose from approximately 3,000 in 2009 to more than 4,100 in 2016 and 2017. It should be noted that these passenger counts include both embarking and disembarking passengers and are therefore approximately double the ship capacity.

Figure 4-4: Northwest Cruise Trends – Passengers per Vessel Call



Source: Port of Seattle, Port Metro Vancouver

As shown in Table 4-1, the number of vessels based in Seattle and Vancouver has not changed substantially over time but the average capacity of vessels has. In 2004 there were a total of 35 vessels that operated out of Seattle or Vancouver. This dropped to 29 vessels during the recession-caused downturn in cruise traffic in 2010, but the forecast for 2018 is for 35 to again operate in the Alaska market.

The Alaska cruise fleet is comprised of a variety of vessel sizes, which can be grouped into three general categories. The largest vessels are 700 feet or longer, the mid-size fleet includes vessels between 400 feet and 700 feet, and the small vessels are less than 400 feet.

Large vessels account for most of the fleet operating from Seattle and Vancouver. Of the 35 vessels projected to operate in 2018, 29 are 700 feet or longer; this is unchanged from 2004. Mid-size vessels are a relatively small part of the fleet, accounting for five vessels in 2018, but this represents an increase over both 2004 and 2010. The number of small vessels operating from Seattle and Vancouver dropped from four in 2004 to two in 2010, and just one small vessel is scheduled to operate from the two ports in 2018.

The number of vessels in the fleet directly impacts the number of potential vessel calls for Humboldt Bay. Because each vessel makes two repositioning trips per year (i.e. one in spring and one in fall) the number of potential calls for Humboldt Bay is equal to the fleet size times two.

Across the entire fleet the average number of passenger berths per vessel grew from 1,542 in 2004 to 1,864 in 2018. This means that the same number of ships operating in 2018 as in 2004 can carry nearly 21% more passengers per trip.

Table 4-1: Cruise Fleet Trends in Seattle and Vancouver

	2004	2010	2018
Homeported Vessels			
Small (Under 400')	4	2	1
Mid-Size (400' to 700')	2	2	5
Large (700' and longer)	29	25	29
Total	35	29	35
Average # of Berths			
Small (Under 400')	146	115	144
Mid-Size (400' to 700')	470	436	398
Large (700' and longer)	1,808	1,823	2,176
Total	1,542	1,610	1,864
Average Length			
Small (Under 400')	284	261	354
Mid-Size (400' to 700')	586	579	550
Large (700' and longer)	849	883	914
Total	769	820	846
Average Draft			
Small (Under 400')	12.2	11.0	14.3
Mid-Size (400' to 700')	18.5	21.8	23.5
Large (700' and longer)	26.3	26.4	26.3
Total	24.5	25.0	24.9

Source: Port of Seattle, Port Metro Vancouver

Two key dimensions of the Humboldt Bay navigation channel that potentially limit the size of cruise vessels that can are the channel depth and the size of the turning basin.

The turning basin at the upper end of the Samoa Channel 1,000 feet deep by 1,100 feet long. According to the local harbor pilot[57], the maximum length for cruise vessels to use the turning basin is currently limited to 800 feet, but could potentially be higher with additional assist from tugboats. Based on the projected fleet for the 2018 Alaska cruise season, 23 of the 29 large vessels are 800 feet or longer, and six are less than 800 feet. The number of vessels 800 feet or longer has grown over time, from 19 out of 35 vessels in 2004 to 20 out of 29 vessels in 2010, and to 23 out of 35 vessels in 2018. The number of

[57] Petrusha, Tim, interview with the authors, January 25, 2018.

vessels less than 800 feet fell from 16 in 2004 to nine in 2010 (at the height of the recession) but rose to 12 vessels in 2018. (See Table 4-1)

The Samoa Channel and most of the Eureka Channel have authorized depths of 38 feet. This is not a limiting factor, as cruise ships typically draw less than 30 feet of water. Only two of the ships scheduled for the 2018 Alaska cruise season draw more than 28 feet of water, and this has not changed substantially over time. Over the entire fleet (including small, mid-size, and large vessels), the average draft ranged from 24.5 feet in 2004 to 25.0 feet in 2010, and is 24.9 feet in 2018. For large vessels the average draft of 26.3 feet in 2018 is the same as in 2004, despite the fact that the passenger capacity has continued to increase.

4.1.2 Forecast

According to one cruise industry analyst, Humboldt Bay could potentially see 10 vessels or more per year over the long run.

4.1.3 CDI Land Required

Most ports that handle limited numbers of cruise ship calls do not have a dedicated facility for cruise ships, but instead are able to use existing terminals on a temporary basis. For example, in Astoria cruise ships call at Pier 1, which is also used for lay berthing of ships, topside repair berthing, and also serves the seasonal fishing industry. Pier 3 has approximately three acres of uplands. If one vessel is in port at Astoria it ties up at the pier, and if a second arrives the passengers are carried between ship and shore using the ship's tender vessels. Astoria typically see approximately 20 cruise vessel calls per season.

In Humboldt Bay, cruise ships typically tie up at the Schneider dock, but will use tenders if necessary. The main requirement for a temporary cruise facility include: 1) the ability to physically separate the cruise operation from other activities in order to provide the required marine security (MARSEC), 2) sufficient room for shuttle busses to pick up and drop off passengers, and 3) clean and safe ramps, walkways, etc.

With a forecast of 10 vessels per season it is unlikely that Humboldt Bay requires an additional cruise ship berth. Based on the three acres used for cruise ships in Astoria, the same acreage should be sufficient in Humboldt Bay. (See Table 4-2).

Table 4-2: Current CDI Use and Future Demand, Cruise Ships

	Current	Future Acres		Change in Acres	
Land Use	**Existing**	**Low**	**High**	**Low**	**High**
Cruise ships	3	3	3	0	0

Source: BST Associates

4.2 Commercial Fishing & Recreational Boating

This section addresses the facility requirements of commercial fishing and recreational boating, which share moorage and repair facilities.

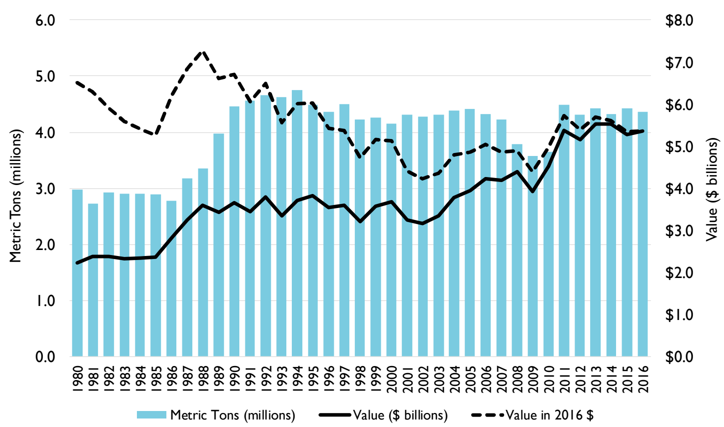
4.2.1 Historical Trends

4.2.1.1 Commercial Fishing

In the United States, the annual commercial fish harvest was 4.1 million metric tons or more per year in all but three years from 1990 through 2016. This level was relatively consistent from 1990 through 2016 and represented a major increase over earlier years. From 1980 through 1986 the harvest averaged less than 3.0 million tons per year.

The nominal value of the national fish harvest grew from approximately $2.2 billion in 1980 to more than $5.5 billion in both 2014 and 2015 and was nearly $5.4 billion in 2016. Adjusted for inflation (to 2016 dollars) the national harvest value peaked in 1998 at nearly $7.3 billion (2016 dollars), and then started a slow decline; by 2002 the value had dropped to a low of $4.2 billion (2016 dollars). Since 2002 the value has trended upward, reaching as high as $5.7 billion in both 2011 and 2013, and was nearly $5.4 billion in 2016. (See Figure 4-5).

Figure 4-5: U.S. Commercial Fish Harvest



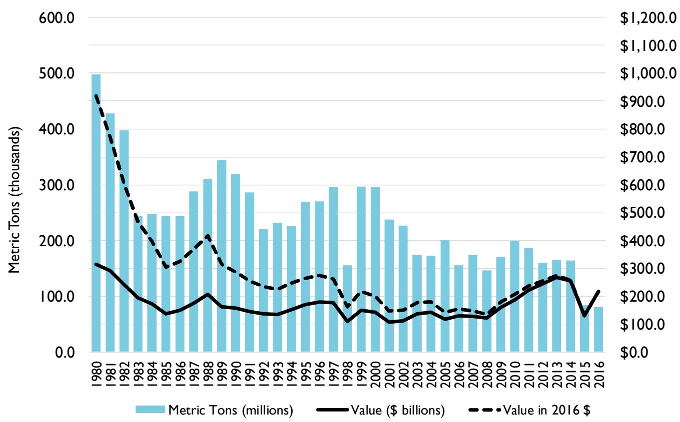
Source: NMFS

In contrast to the national figures, in California the commercial fish harvest has been declining for nearly four decades. California's annual harvest dropped from nearly 500,000 metric tons in 1980 to just 80,000 metric tons in 2016, the lowest level in the past 37 years. During that time there were periods where volumes recovered somewhat, but the long-term trend has been one of steep decline. (See Figure 4-6).

The value of the California commercial fish harvest has also dropped sharply since 1980, falling from $315 million dollars (in current dollars) to $216 million in 2016. However, the lowest value (i.e. $108 million) was reached in 2001. After 2001 the harvest value remained relatively stable for several years, then climbed each year from 2009 through 2013 and reached $266 million, fell in 2014 and 2015, and climbed again in 2016 to $216 million.

Adjusted for inflation (in 2016 dollars), the California harvest value fell from $918 million in 1980 to a low of $135 million in 2008, a drop of 85%. Inflation-adjusted harvest values climbed back to $275 million in 2013, but dropped back to $131 million in 2015, the second lowest inflation-adjusted value since 1980.

Figure 4-6: California Commercial Fish Harvest

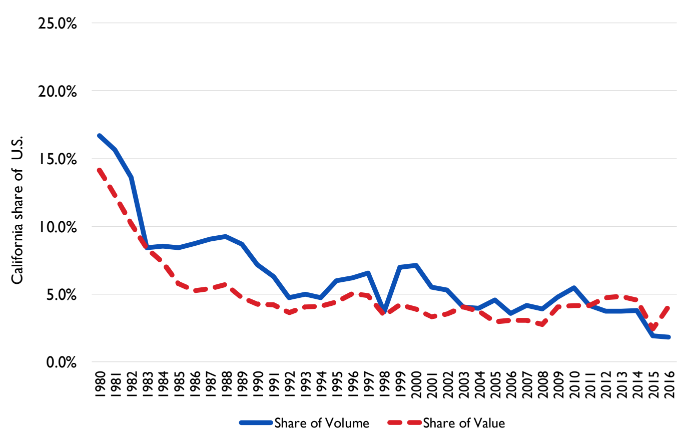


Source: NMFS

California's share of U.S. commercial fishing harvest has dropped sharply, in terms of both volume and value. In terms of volume, California's share of U.S. harvest dropped from 16.7% in 1980 to just 1.8% in 2016. As recently as 2010 California's share was 5.5%, but it fell in all but one year after that.

California's share of harvest value fell from a high of 14.1% in 1980 to a low of 2.4% in 2015. Most of the decline in share of harvest value occurred during the 1980's; since 1988 California's share has generally varied fluctuated between 3.0% and 5.0%. In 2016 California accounted for 4.0% of U.S. commercial fish harvest value. (See Figure 4-7).

Figure 4-7: California Share of U.S. Commercial Fish Harvest

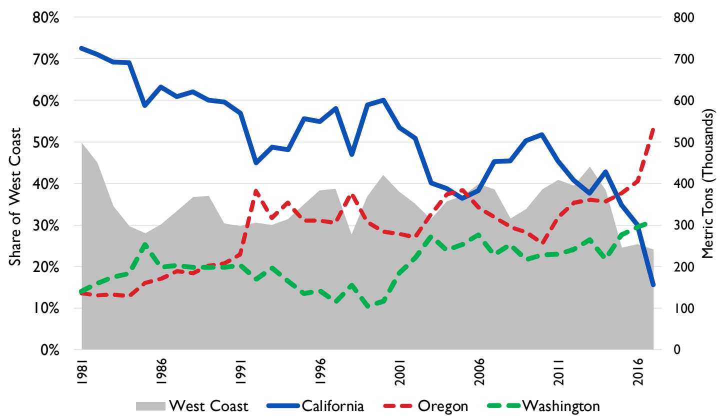


Source: NMFS

California's share of the U.S. West Coast commercial fish harvest declined from approximately 73% in 1981 to just 30% in 2016, and to 15% in 2017. At the same time, Oregon's share grew from less than 14% in 1981 to 40% in 2016 and 53% in 2017, and Washington's share grew from 14% in 1981 to 31% in 2017.

For most of that period, the total volume of fish commercially harvested on the West Coast generally fluctuated between 300,000 and 400,000 metric tons. Volumes were greater than 450,000 metric tons at the beginning of the period (i.e. in 1981 and 1982) and dropped below 300,000 in only three years between 1983 and 2014. Despite the relatively steady harvest during this time, California's share continued to decline. (See Figure 4-8).

Figure 4-8: California Share of West Coast Commercial Fish Harvest

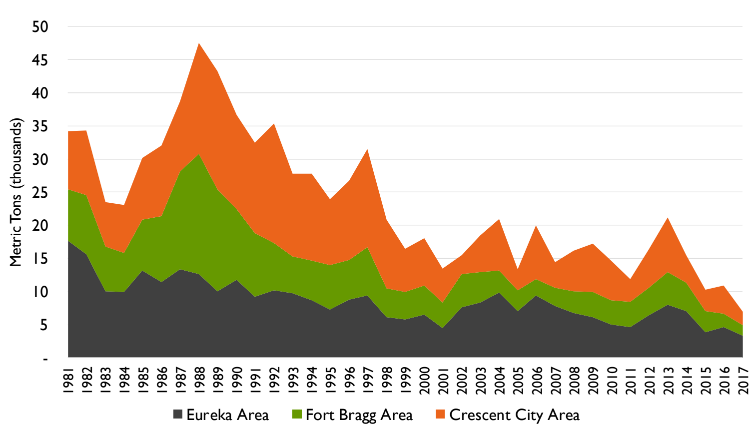


Source: PacFIN

Fish landings at the three port regions on the Northern California Coast (i.e. Eureka area, Fort Bragg area, and Crescent City area) have dropped significantly over the past several decades. From a high of 47,500 metric tons in 1998, landings in the region dropped to just 18,000 metric tons in 2000, a decline of more than 62%. Landings fluctuated over the next decade, averaging approximately 16,000 metric tons per year. Volumes jumped to 21,100 in 2013 but dropped to less than 11,000 in 2015 and 2016, and to 7,000 metric tons in 2017. (See Figure 4-9).

Eureka-area ports accounted for an average of 38% of regional landings from 1981 through 2017. During this period landings in the Eureka area fell from a high of 17,500 metric tons in 1981 to less than 5,000 metric tons per year from 2015 through 2017.

Figure 4-9: Fish Landings in Northern California

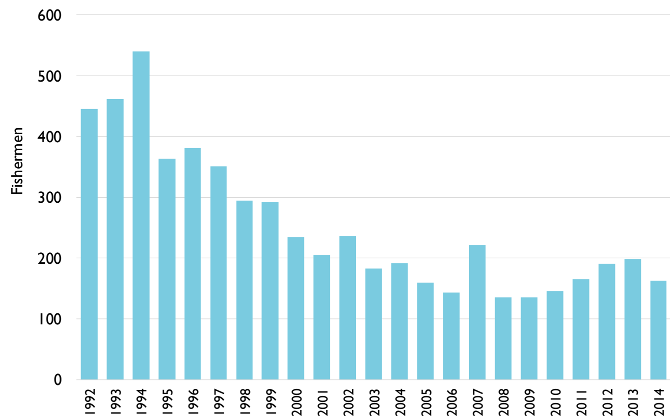


Source: PacFIN

The number of fishermen active at Eureka area ports peaked at 540 in 1994, and then fell steadily over the next 12 years. By 2006 the number of active fishermen had dropped to just 143, a decline of more than two-thirds. After increasing in 2007 the number of active fishermen fell to 135 in both 2008 and 2009, but then grew during most subsequent years, nearly reaching 200 in 2013.[58] (See Figure 4-10).

[58] Oceanspaces, http://oceanspaces.org/, (accessed February 12,2018).

Figure 4-10: Number of Fishermen, Eureka Area Ports



Source: oceanspaces.org

The local fishery is changing from a focus on large volume / low value species to lower volume but higher value species. According to a recent report prepared for the City of Eureka:

> Declining oceanic resources, strict fishing quotas and increasing costs have significantly reduced the size and changed the character of Eureka's fishing fleet. Rather than providing inexpensive, bulk products, the industry has shifted to specialty and "sustainably harvested" products. Oysters and other seafood stocks such as squid are also gaining market share.[59]

4.2.1.2 Recreational Boating

The number of recreational boats registered in Humboldt County increased rapidly from the early 1980s until 2007, growing from approximately 4,000 boats to approximately 7,700 boats. The recession had major negative impact on boating throughout the country, and Humboldt County was not immune from the decline. Boating is a discretionary activity, and boat ownership rates are sensitive to changes in household income. Recreational boat ownership in Humboldt County has not recovered from the recession, and in 2017 there were 12% fewer boats registered in the county than there were in 2007.

The rate of boat ownership has also declined in Humboldt County. In 2007 there were 58 boats registered per 1,000 residents in Humboldt County, but in 2017 there were just 50 boats per 1,000 residents in 2017.[60] One of the issues facing recreational boating throughout the U.S. is that as older boaters (baby boomers and older) give up boating they are not being replaced with younger boaters (i.e. Generation X and Millennials).

Humboldt County has consistently accounted for around 11% of the registered boats in the Northern California region. Most of the boats moored at Humboldt Bay marinas are from Humboldt County (estimated at 85% from the County) with the remaining 15% from counties to the east, particularly the Redding area in Shasta County.

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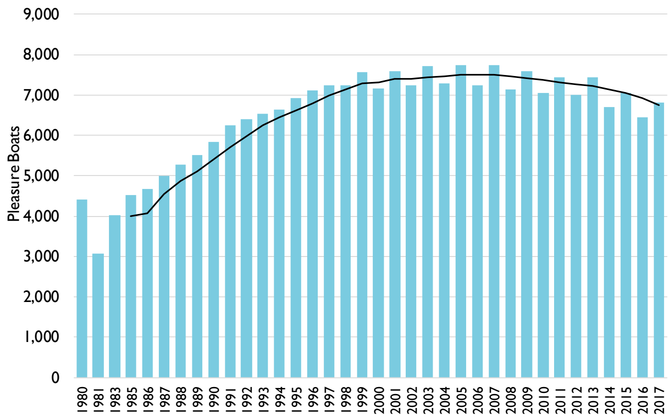
[59] Greenway Partners, *Regional Cold Storage Facility, Technical Study*, September 15, 2015. Prepared for the City of Eureka.

[60] California Department of Boating and Waterways; includes all boat lengths.

Figure 4-11: Recreational Boats in Humboldt County



Source: California Department of Boating and Waterways

4.2.2 Existing Facilities

Humboldt Bay has a number of shoreside facilities that support commercial fishing and recreational boating, most of which are located in CDI areas.

4.2.2.1 Marinas

Two small boat harbors provide moorage for commercial boats: Woodley Island Marina, owned by the Harbor District, and the Eureka Public Marina, owned by the City of Eureka.

Most of the Humboldt Bay commercial fishing fleet is based at Woodley Island Marina. This marina has room for approximately 240 boats and is used by both commercial and recreational vessels. Approximately 120 commercial vessels and 120 recreational boats are currently based at Woodley Island.

The marina sits on two tax parcels of approximately 40 acres each and that contain a total of approximately 80 acres. A substantial portion of the one of these parcels (405-031-009) consists of tidelands, as does a smaller portion of the other parcel (405-031-010). The marina moorage basin is located on approximately 20 acres of tidelands, while parking, buildings, and other developed upland facilities use approximately 15 acres. The remaining acreage is predominantly undeveloped, with the exception of a portion used for roadway. Woodley Island is zoned "Public Facilities – Marina", as opposed to "MC", or coastal-dependent industrial.

Dredged material disposal is a critical issue at the Woodley Island Marina. The boat basin tends to silt in without regular dredging, and the loss of water depth can make certain slips unusable. In past years the material dredged from the boat basin has been disposed on the beach on the Samoa Peninsula, where tidal action then disperses it. However, beach disposal has not been permitted in recent years and dredge spoils have been barged to an offshore location, which substantially increases the cost of disposal. In order to minimize the cost of maintenance, a disposal site nearby is needed where dredge spoils can be pumped from the Harbor District's suction dredge.

The Eureka Public Marina provides 150 moorage slips that accommodate vessels from 20 to 70 feet in length. Approximately 10 commercial fishing vessels are based there, a number that has remained relatively steady. These commercial boats are 40 to 70 feet long, and all participate in the crab fishery, and a number of the vessels also participate in other fisheries. The rest of the moorage slips are used by recreational boats. This marina has a two-lane boat ramp with vehicle and trailer parking. The Public Marina is also home to two oil spill response vessels, and is the operating base for a tour boat from April through October.

The Eureka Public Marina is located on one tax parcel of approximately 11.5 acres (#003-011-001) and another of 1.5 acres (#003-021-007). Approximately one acre of the large parcel is used by the Commercial Street Wharf and the EDA Fish Plant building, and one acre of the smaller parcel is also used by the EDA Fish Plant building. Net acreage of the marina is approximately 11 acres. These parcels are zoned for CDI use.

Moorage occupancy is full during the period from May to September and declines during the off-peak season as boats are removed from the water and trailered to storage or home.

4.2.2.2 Processing

Commercial Street Wharf is a 660-foot city-owned dock located at the foot of Commercial Street used by commercial fishing vessels to offload fish and to load supplies. The only vessel fuel facility on Humboldt Bay is located at the wharf.

Adjacent to Commercial Street wharf is the EDA Fish Plant building, which sits on approximately two acres. The EDA building is a fish processing facility that is currently leased to Pacific Choice Seafood. This plant has been in operation for more than 30 years, and processes a wide variety of species, including bottomfish, salmon, shrimp, crab, and albacore tuna in a 50,000 sq. ft. operation center. Pacific Seafoods also acquired Eureka Fisheries in 2001, which included numerous West Coast landing stations in Brookings OR, Crescent City, Bodega Bay, Fort Bragg, and San Francisco.

Fishermen's Terminal is located on a 2.5-acre site at the foot of C Street. Two seafood processors use this building (Coast Seafoods and Wild Planet foods). The building also houses Jack's Seafood restaurant. The building is adjacent to a new dock that was constructed in 2005-2006, and which consists of a 460-foot by 40-foot concrete wharf with jib cranes, as well as a 920 square foot floating dock with gangway.

Caito Seafoods operates a facility leased from the City located on Commercial Drive at the foot of I Street. This facility is located on approximately one acre, and is adjacent to a 160-foot dock used for receiving fish.

4.2.2.3 Fishing Gear Storage

Currently the City rents space at the foot of C Street for fishing gear storage, this is a popular service used by many fishermen. Rental includes free usage of a high capacity hoist at the Fishermen's Terminal.

There is a seasonal opportunity to create a similar program at the parking lot near the EDA Plant. Tenants there use a City-owned parking lot for gear storage, although this usage is not authorized and tenants are not paying rent for the space.[61]

[61] City of Eureka Harbor Division, *Leveraging Waterfront Assets into Revenue and Cost Saving Opportunities*, March 2017.

4.2.2.4 Cold Storage

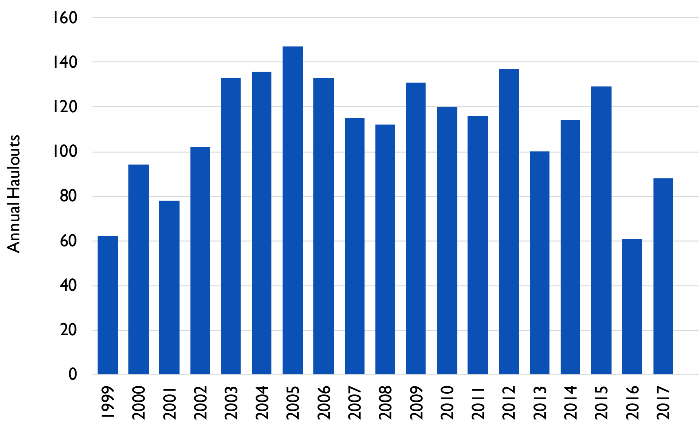
According to a recent analysis of a proposed cold storage facility, demand for cold storage of fish products is expected to vary throughout the season.[62] This analysis assumed a facility with a maximum capacity of 800 tons of cold storage, resulting in excess capacity in some months, and excess demand in others. The facility would require a site of one to three acres site with a boat dock or a site where a dock could be constructed. The frozen/cold storage rooms would occupy the bulk of the facility, which would have the capacity to hold approximately 200 tons of product. This number was chosen because that is approximately the current, base, unmet demand for fish/seafood storage and for cube and block ice storage.

4.2.2.5 Boat Repair

There are two boat repair facilities on Humboldt Bay, the Fields Landing Boatyard and the Zerlang and Zerlang (Z&Z) yard.

The Fields Landing boatyard, owned by the Harbor District, is available for owners to perform their own work vessels. There is also one commercial boat repair operation at the yard. Lifting equipment is a 150-ton mobile hoist. The yard encompasses approximately seven acres. The boatyard accommodates between 61 and 147 boats per year, with an average of 111 boats per year. Most of the boatyard activity is by commercial fishing boats undertaking necessary do-it-yourself improvements.

Figure 4-12: Number of Haulouts at Fields Landing Boatyard



Source: Humboldt Bay Harbor, Recreation and Conservation District

The Zerlang and Zerlang boatyard is located on the Samoa Peninsula, in the Finntown area. Z&Z concentrates on wooden boats, including both commercial and recreational vessels. The yard encompasses approximately two acres and has three marine rails for moving boats into and out of the water. Interviews with boat repair operators suggested that there may be demand for two to three more acres of boatyard space.

[62] Greenway Partners, *Regional Cold Storage*.

4.2.3 Forecast

The local fishery has declined in vessel numbers and catch but appears to have reached a level of stability.[63] The utilization rate of the marinas has been consistent over the past decade and there are no plans to expand facilities.[64,65]

4.2.4 CDI Land Required

Estimated current acreage in the Humboldt Bay area for commercial fishing and recreational boating is 60. In the future, the addition of a cold storage facility may increase demand for CDI land by four acres. Total long-term demand for CDI land is 64 to 65 acres. (See Table 4-3).

Table 4-3: Current CDI Use and Future Demand, Commercial Fishing & Recreational Boating

	Current	Future Acres		Change in Acres	
Use	Acres	Low	High	Low	High
Moorage	46	46	46	0	0
Processing	5	5	5	0	0
Cold Storage	0	3	3	3	3
Gear Storage	0	1	1	1	1
Vessel Repair	9	9	12	0	3
Total	60	64	65	4	5

Source: BST Associates

[63] Hackett, Steven and Richmond, Laurie, interview with the authors, January 22, 2018. Dr. Hackett and Dr. Richmond are with Humboldt State University.

[64] Raimey, Jeff and Wilkes, Donald, interview with the authors, January 24, 2018. Raimey and Wilkes are employed by the City of Eureka.

[65] Petrusha, Tim and Howser, Suzie, interview with the authors, January 25, 2018. Petrusha and Howser and employed by the Humboldt Bay Harbor, Recreation and Conservation District.

4.3 MARICULTURE

Mariculture is a specialized branch of aquaculture involving the cultivation of marine organisms for food and other products in the open ocean, an enclosed section of the ocean, or in tanks, ponds or raceways which are filled with seawater.[66] Marine aquaculture offers many environmental benefits compared to other forms of animal proteins: generates fewer greenhouse gas emissions, has a smaller carbon footprint, uses less land and fresh water, and is efficient at converting feed into edible protein.[67]

Humboldt Bay has a well-established mariculture industry focusing on mollusks (oysters and clams) and expansion of this activity is underway. In addition, there is interest in developing finfish mariculture. This section reviews trends and forecasts for mariculture and evaluates the opportunities for mariculture in Humboldt Bay and specifically for use of coastal-dependent industrial land.

The NOAA Office of Aquaculture describes the farming process for shellfish and fish as follows:

> The farming of shellfish is typically done by placing bivalves, such as oysters and clams, in bags set in tidelands, bays, or rivers. Usually these come from a hatchery, but some operations rely on a natural "set" of wild larvae. These shellfish are left to grow for a year or more in suspended bags or on the bottom. Mussels, another type of shellfish, are grown on ropes hanging off rafts in rivers or bays and on submerged lines anchored to the bottom of the ocean. In order to grow, shellfish feed on microscopic plankton that they filter out of the water. When the shellfish reach market size, they are harvested and sold to seafood processors, grocery stores, seafood markets, restaurants, or directly to consumers.
>
> A variety of techniques and technologies – each with its own advantages and disadvantages – can be used to raise finfish:
>
> - Hatcheries – most aquaculture fish begin their lives in a hatchery. In fact, the populations of many fish caught by traditional fishing are augmented in hatcheries, then released.
> - Pond culture – one or many earthen ponds are used to culture freshwater fish, shrimp, and some marine species.
> - Cage culture – enclosed cages are submerged in aquatic environments. Careful protocols and monitoring help to minimize potential interactions with the environment.
> - Recirculating systems – fish, shellfish, and or plant-life are raised in "closed-loop" production systems that continuously filter and recycle water and waste.
> - Integrated Multi-Trophic Aquaculture – several species are raised together in a way that allows one species' by-products to be recycled as feed for another.
> - Integrated agriculture & aquaculture –ponds or recirculating systems are used to raise both seafood and other organisms (for example, fish and lettuce).[68]

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[66] U.S. Department of Agriculture, *Census of Agriculture*.

[67] National Oceanographic and Atmospheric Administration, SeaGrant and the Aquarium of the Pacific, *Offshore Aquaculture in the Southern California Bight*, April 2015.

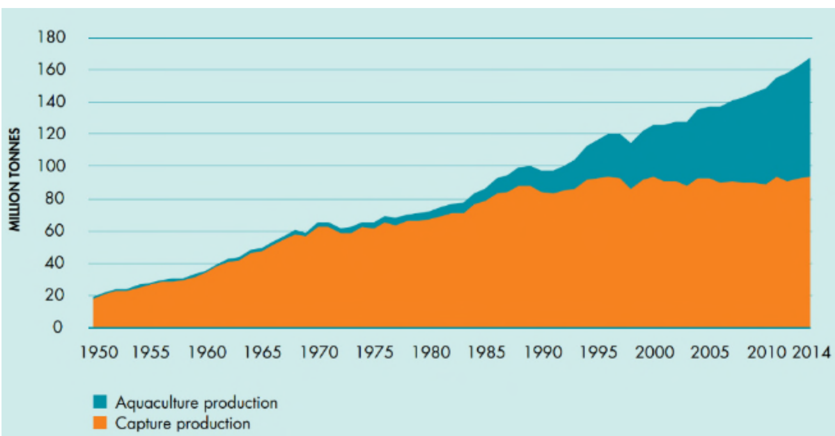
[68] National Oceanographic and Atmospheric Administration, *Basic Questions about Aquaculture,* https://www.fisheries.noaa.gov/topic/aquaculture (accessed February 15, 2018).

4.3.1 International Trends

According to the U.S. Department of Agriculture, "Seafood (fish and shellfish) is a nutrient-dense source of dietary protein, which is relatively low in calories and saturated fat, compared to some other protein sources, and rich in key nutrients, including vitamins A, B12, and D; iron; zinc; magnesium; phosphorous; and potassium. Seafood is the primary food source of the beneficial omega-3 fatty acids, EPA and DHA."[69] As discussed in greater detail below, aquaculture (and mariculture) represents the best opportunity for producing fish and seafood. Due to these beneficial traits, the global demand for fish for human consumption has increased rapidly, averaging annual growth of 3.2% from 1961 to 2013, which is approximately twice the rate of growth of the population base. Per capita consumption of fish has increased from an average of 9.9 kg in the 1960s to 19.7 kg in 2013, driven largely by growing demand linked to population growth, rising incomes, urbanization and increases in international trade.

However, the sources of the supply of fish has changed markedly. According to the United Nations Food and Agriculture Organization (FAO), production from the capture fishery has remained relatively static since the mid-1980s.[70] A 2016 report from the United Nations found that the capture fisheries are under pressure, with 31.4% of the world's stocks overfished and another 58.1% fully fished.[71] Nearly all of the increased production over the past 25 years has come from aquaculture.

Figure 4-13: World Capture Fisheries and Aquaculture Production



Source: U.N. Food and Agriculture Organization

Worldwide aquaculture production increased from 24.3 million tons in 1995 to 73.8 million tons in 2014 or at an average annual rate of 6.0%. All regions exceeded 3% annual growth between 1995 and 2014 but growth was fastest in Africa, the Americas and Asia. In the Americas, aquaculture production increased most rapidly in Chile (11.4% per year from 1995 to 2014) and the rest of Latin America (9.9% per year from 1995 to 2014). Trends in the U.S. are examined in greater detail below.

[69] U.S. Department of Agriculture, *Americans' Seafood Consumption Below Recommendations*, October 2016

[70] U.N. Food and Agriculture Organization, *The State of World Fisheries and Aquaculture*, 2016.

[71] Shanker, Deena, "How We'll Eat Fish in the Future", *Bloomberg News*, May 26, 2017.

Table 4-4: Trends in Aquaculture Production by Region (1,000 tons)

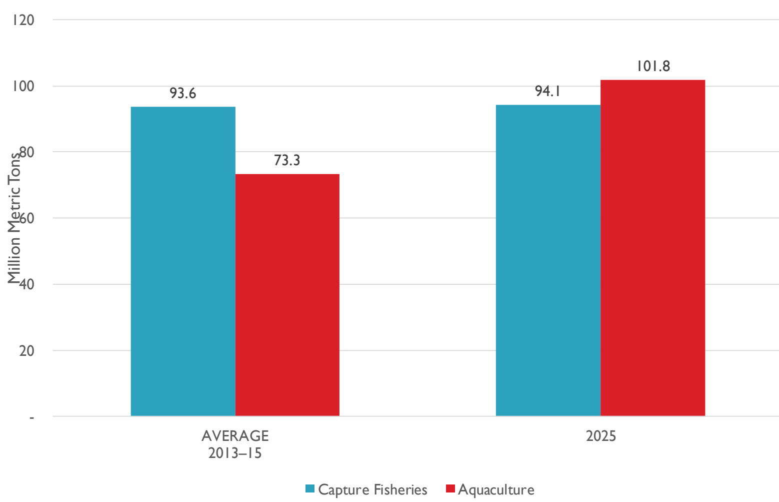
Regions	1995	2000	2005	2010	2012	2014	CAGR 1995 – 2014
Africa	110	400	646	1,286	1,484	1,711	15.5%
Americas	920	1,423	2,177	2,514	2,988	3,352	7.0%
Asia	21,678	28,423	39,188	52,439	58,955	65,602	6.0%
Europe	1,581	2,051	2,135	2,544	2,852	2,930	3.3%
Oceania	94	122	152	190	186	189	3.7%
WORLD	24,383	32,418	44,298	58,973	66,466	73,784	6.0%

CAGR is compound annual growth rate

Source: UN Food and Agriculture Organization

The FAO is projecting that capture fisheries are expected to remain constant at approximately 94 million tons from 2013-2015 to 2025. Aquaculture is projected to grow at 3.0% per year on average from 2013-2015 to 2025; from 73.3 million tons in 2013-2015 to 101.8 million tons in 2025. As a result, aquaculture is projected to increase from 43.9% of total production in 2013-15 to 51.9% in 2025.

Figure 4-14: World Fish Production



Source: UN Food and Agriculture Organization

Most aquaculture production is expected continue to occur in Asian countries, which are projected to account for 90% of total production by 2026 (e.g., China alone is expected to account for 63% of total aquaculture production by 2026). Fish consumption is expected to increase at a faster pace in developing countries than in developed countries, where the overall slowdown in consumption growth will continue.

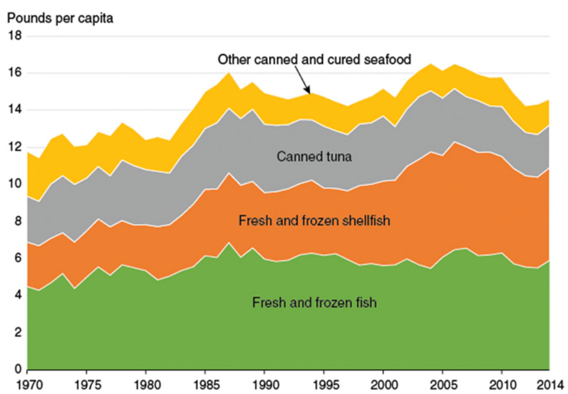
The potential for aquaculture is under-scored by industry experts. Árni M. Mathiesen, Assistant Director-General of FAO's Fisheries and Aquaculture Department, asserts that unlocking the potential of aquaculture could have long-lasting and positive benefits: "With the world's population predicted to increase to 9 billion people by 2050 - particularly in areas that have high rates of food insecurity -

aquaculture, if responsibly developed and practiced, can make a significant contribution to global food security and economic growth".[72]

4.3.2 U.S. Trends & Forecast

The U.S government recommends that Americans eat at least two servings of seafood per week (8 ounces), or about 20% of total consumption from the protein foods group[73]. The U.S. Department of Agriculture Economic Research Service (USDA ERS) estimates that the average American is eating less than the recommended amount. Fish consumption increased from 12 pounds in 1970 to a peak of 16.5 pounds in 2006, then declined to 14.5 pounds in 2014. This represents about one-third of recommended levels.[74]

Figure 4-15: US Consumption of Fish and Seafood



Source: USDA, Economic Research Service, Food Availability data

The USDA identified five fish/seafood products that accounted for 75% of US consumption in 2014: shrimp, salmon, canned tuna, tilapia, and Alaska pollock. These choices were largely made due to lower product prices, particularly for imports (farm-raised shrimp, salmon, and tilapia) and wild-caught Alaska pollock in a variety of products (fast-food fish sandwiches, frozen fish sticks, and imitation crab meat, among others). NOAA estimates that, on a value basis, imported products account for a large share of U.S. consumption. Approximately 50% of the imported fish is produced in aquaculture facilities.[75]

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[72] World Bank, *Fish Farms to Produce Nearly Two Thirds of Global Food Fish Supply by 2030, Report Shows,* press release, February 5, 2014. http://www.worldbank.org/en/news/press-release/2014/02/05/fish-farms-global-food-fish-supply-2030 (accessed February 15, 2018).

[73] U.S. Department of Health and Human Services and U.S. Department of Agriculture, *2015 – 2020 Dietary Guidelines for Americans*, 8th Edition, December 2015.

[74] U.S. Department of Agriculture, *Americans' Seafood Consumption Below Recommendations*.

[75] National Oceanographic and Atmospheric Administration, *Fisheries of the US*., 2016. NOAA estimates that imported products may account for 90% or more of US consumption. However, this includes US seafood products that are processed overseas and shipped back to the US as finished consumer products.

According to the US Department of Agriculture, sales of aquaculture products in the United States totaled $1.37 billion in 2013, up 26 percent since 2005.[76]

U.S. aquaculture products ranked by sales were as follows:[77]

- Food fish, which includes fish raised for consumption (catfish, tilapia, trout, salmon and other species) as well as fish eggs, accounted for more than 50% of aquaculture sales in 2013, with a sales value of $732 million, up 9% from 2005.
- Mollusks production (oysters, clams and mussels) reached $329 million in 2013, an increase of 62% from 2005. Oysters represent approximately 55% of mollusk production by value.
- Crustacean sales (shrimp, prawns, crayfish, lobster and crab) totaled $85 million in 2013, up 59% from 2005. Saltwater shrimp accounted for just over half of 2013 crustacean sales.
- The remaining aquaculture included ornamental fish, baitfish, sport fish and miscellaneous aquaculture (algae, alligators, caviar, eels, frogs, sea urchins, snails, tadpoles and turtles, among other products).

Table 4-5: Aquaculture Sales by Type of Product, 2005 and 2013 ($millions)

	$ millions		
Group	**2005**	**2013**	**% Change**
Food fish	672.4	732.1	9%
Mollusks	203.2	328.6	62%
Crustaceans	53.4	84.9	59%
Ornamental fish	51.3	41.5	-19%
Baitfish	38.0	29.4	-23%
Sport fish	18.1	23.8	32%
Miscellaneous	56.0	131.4	135%
Total	1,092.4	1,371.7	26%

Source: 2013 Census of Agriculture Highlights

Forty-eight states produce and sell aquaculture products. However, the top ten states account for more than three-fourths of sales, ranked as follows:

- Washington - $233 million (17.0% of US)
- Mississippi - $203.6 million (14.9%)
- Alabama - $111.2 million (8.1%)
- Louisiana - $90.6 million (6.6%)
- California - $83.6 million (6.1%)
- Florida - $77.9 million (5.7%)
- Texas - $69.8 million (5.1%)

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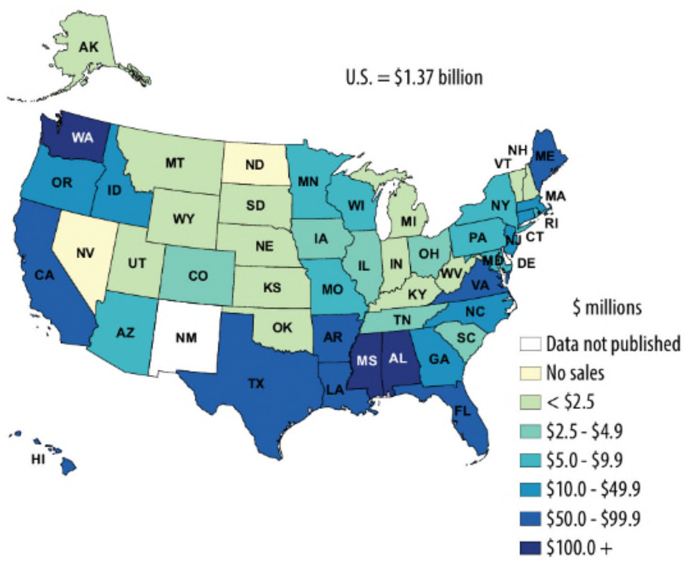
[76] U.S. Department of Agriculture, National Agricultural Statistics Service, *2013 Census of Agriculture Highlights, ACH12-21*, February 2015. The aquaculture census defines an aquaculture farm as any place from which $1,000 or more of aqua-culture products were produced and sold, or distributed for conservation, recreation, enhancement, or restoration purposes, during the census year.

[77] National Marine Fisheries Service Office of Science and Technology, Fisheries Statistics Division, *Fisheries of the United States, Current Fishery Statistics No. 2016*. August 2017.

- Arkansas - $61 million (4.5%)
- Hawaii - $58.7 million (4.3%)
- Maine - $57.3 million (4.2%)
- Other - $323.3 million (23.6% of US)

Figure 4-16: Aquaculture Sales by State, 2013



Source: National Marine Fisheries Service Office of Science and Technology

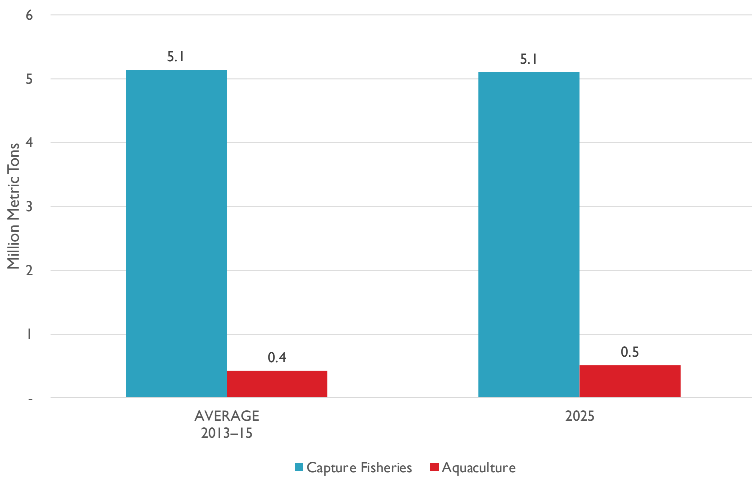
According to NOAA Office of Aquaculture, there are several reasons to support aquaculture:[78]

- Marine aquaculture in the United States contributes to seafood supply, supports commercial fisheries, restores habitat and at-risk species, and maintains economic activity in coastal communities and at working waterfronts in every coastal state.
- The United States is a minor aquaculture producer, on a global scale—but it is the leading global importer of fish and fishery products. Driven by imports, the U.S. seafood trade deficit grew to $14 billion in 2016.
- In the United States, marine aquaculture production increased an average of 3.3% per year from 2009-2014, however, globally, the U.S. remains a relatively minor aquaculture producer. The United States is a major player in global aquaculture, supplying advanced technology, feed, equipment, and investment to other producers around the world.

The FAO projects that U.S. capture fisheries will remain stable at approximately 5.1 million tons. Aquaculture is projected to increase at an average annual rate of 1.6% per year from 2013-2015 to 2025, increasing from 425,000 tons (average of 2013 to 2015 volumes) to 568,000 tons in 2025. As a result, U.S. aquaculture is expected to increase from 7.6% of total production in 2013-15 to 9.0% in 2025.

[78] National Oceanographic and Atmospheric Administration Office of Aquaculture, "U.S. Aquaculture", https://www.fisheries.noaa.gov/national/aquaculture/us-aquaculture (accessed February 15, 2018).

Figure 4-17: Fish Production in the United States



Source: U.N. Food and Agriculture Organization

Further development of aquaculture is expected to continue to be slow due to a cumbersome permitting process. According to experts in the field, designation of a lead federal agency to address issues could increase aquaculture production.[79]

4.3.2.1 California

As noted above, California was the fifth largest aquaculture producer in the U.S. with sales of $85.6 million in 2013. Aquaculture sales increased by 2.3% per year between 2005 and 2013, up from $69.6 million in 2005. The number of aquaculture farms also increased slightly between 2005 and 2013, from 118 farms in 2005 to 124 farms in 2013. In 2013, California accounted for 41% of the farms along the US mainland West Coast (California, Oregon and Washington) but only accounted for 25% of aquaculture sales. The number of aquaculture farms declined along the U.S. West Coast from 359 in 2005 to 304 in 2013 as farms became larger.

Sales on the U.S. West Coast, driven largely by growth in Washington, increased significantly from $175.3 million in 2005 to $328.7 million in 2013. As a result, California's share of value along the U.S. West Coast dropped from 40% in 2005 to 25% in 2013.

California accounted for 2% of the U.S. aquaculture farms in 2013, up from 1% in 2005; by sales value, California has remained at 3% of the U.S.

[79] Schubel, Jerry R. and Thompson, Kimberly, *Marine Finfish Aquaculture in the U.S. and California: A Story of Lost Opportunities for Leadership and Economic Development*, December 2, 2016. Jerry R. Schubel is president and CEO, Aquarium of the Pacific and Kimberly Thompson is program manager, Seafood for the Future.

Table 4-6: California Aquaculture Production

	Number of Farms			Sales ($1,000s)		
Total	**2005**	**2013**	**CAGR**	**2005**	**2013**	**CAGR**
California	118	124	0.6%	$69,607	$83,583	2.3%
US West Coast	359	304	-2.1%	$175,288	$328,676	8.2%
United States	8,618	6,186	-4.1%	$2,182,640	$2,741,386	2.9%
California % of						
USWC	33%	41%		40%	25%	
US	1%	2%		3%	3%	

Source: Census of Aquaculture 2013, USDA

In California aquaculture occurs throughout the state and across several diverse product groups. Sacramento County, the largest producer of caviar in the U.S., is the leading California county by sales value. Imperial County producers use geo-thermal energy to raise catfish and bass among other species. Humboldt, San Luis Obispo and Marin counties were third, fourth and fifth largest by value in 2012, based primarily on production of shellfish. The value of production in Riverside County is sixth largest, and is based on production of catfish, tilapia, goldfish and koi, among other species. Stanislaus County (7th highest value) produces catfish and bass, while Shasta, Kern and San Bernardino Counties (8th, 9th and 10th, respectively) produce food fish. The remaining counties of California accounted for 43% of the sales in 2012; these producers focus on all aquaculture categories with the exception of food fish.

Table 4-7: California Aquaculture Production by County – number of farms and reported sales value ($millions) in 2012

		Number of Farms						
Rank by Value	**County**	**Food Fish**	**Mollusks**	**Ornamental Fish**	**Other Aquaculture Products**	**Other**	**Total**	**Estimated Sales $mils**
1	Sacramento	11	1	2	-	3	17	$15.0
2	Imperial	3	-	-	6	-	9	$11.4
3	Humboldt	2	7	1	1	-	11	$7.5
4	San Luis Obispo	-	7	-	2	-	9	$6.9
5	Marin	2	5	-	-	-	7	$4.8
6	Riverside	17	-	10	4	-	31	$4.2
7	Stanislaus	16	-	3	5	-	24	$3.5
8	Shasta	9	-	-	-	3	12	$3.2
9	Kern	7	-	-	-	-	7	$1.5
10	San Bernardino	3	-	-	-	-	3	$1.0
	Other	-	7	30	18	9	152	$44.0
	Total	158	27	46	36	15	282	$103.0

Notes: Other aquaculture products include: alligators, frogs, leeches, eels, salamanders, and turtles.
Other includes: bait fish, sport fish and crustaceans.
Source: California Census of Agriculture 2012, USDA, County Agriculture Reports

4.3.2.2 Opportunities for growth in California

Opportunities to increase aquaculture in California appear to be positive with "favorable oceanographic conditions, proximity to markets, and scientific expertise necessary to support environmentally responsible aquaculture."[80] Aquarium of the Pacific President and CEO Jerry Schubel said:

[80] White, Cliff, "Aquaculture in California Has Promising Future", seafoodsource.com, September 29, 2016, https://www.seafoodsource.com/news/aquaculture/report-aquaculture-in-california-has-promising-future (accessed February 21, 2018).

> With our planet's growing human population and rising demand for food, aquaculture will play a pivotal role in increasing the safe supply of healthy protein in our global food systems, and California could serve as a model for states looking to develop a robust aquaculture industry.
>
> "However, development opportunities are currently constrained by problems associated with obtaining necessary permits. According to experts: California "has some of the strongest opposition from a misinformed public and a permitting process that discourages innovation and investment."[81]

4.3.2.3 Humboldt Bay

Oysters have been cultivated in Humboldt Bay since the early to mid-1900s, utilizing as much as 1,000 acres. These historical operations used "on-bottom" methods that relied on the placement of loose oysters and shell directly on intertidal mudflats with subsequent harvest via suction dredging and excavation. This style of aquaculture continued until the late 1990s, when it was replaced with more environmentally friendly methods "off-bottom" methods for growing oysters (i.e., rack-and-bag culture, long-line culture, and basket culture).

The value of aquaculture production in Humboldt County has increased nearly every year, growing from $6.7 million in 2011 and reaching $10.3 million in 2016, most of which is attributed to shellfish production.

Table 4-8: Humboldt County Aquaculture Production –reported sales value ($millions) 2011-2016

Year	$ Millions in Sales
2011	$6.7
2012	$7.5
2013	$7.6
2014	$9.7
2015	$17.5
2016	$10.3

Source: Humboldt County Agriculture Reports, various years

According to the Pacific Shellfish Institute, there were 16 shellfish aquaculture farmers in 2013 that operated along the California coast. Including shellfish growers and seed producers, these firms reported $25.9 million worth of total revenue and $23.9 million worth of revenue from shellfish sales in 2011.[82] As indicated in Table 4-9, there were 6,201 acres available for use in 2013 but only 740 (i.e. 12%) were actually in use for shellfish cultivation. Humboldt County had the most reported acreage (4,577 acres) but only 343 acres were actually being farmed (i.e. 7% of available acres). These industry conditions were verified in 2015.[83]

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[81] Schubel and Thompson, December 2, 2016.

[82] Northern Economics, *The Economic Impact of Shellfish Aquaculture in Washington, Oregon and California*, April 2013. Prepared for Pacific Shellfish Institute. The report excluded abalone growers.

[83] JSI, *Coast Seafoods Company Recirculated Draft EIR Appendix J Economic Impacts*, July 2016. Prepared for the Humboldt Bay Harbor District.

Table 4-9: California Aquaculture Production by County 2013

County	Reported Acres	Not Farmed Acres	Farmed Acres	Farmed Acres (%)
Humboldt	4,577	4,234	343	7%
Marin	1,413	1,071	342	24%
San Luis Obisbo	135	120	15	11%
Santa Barbara	70	35	35	50%
Other	6,036	0	6	99%
Total	6,201	5,460	740	12%

Source: Pacific Shellfish Institute

4.3.2.4 Coast Seafood Company

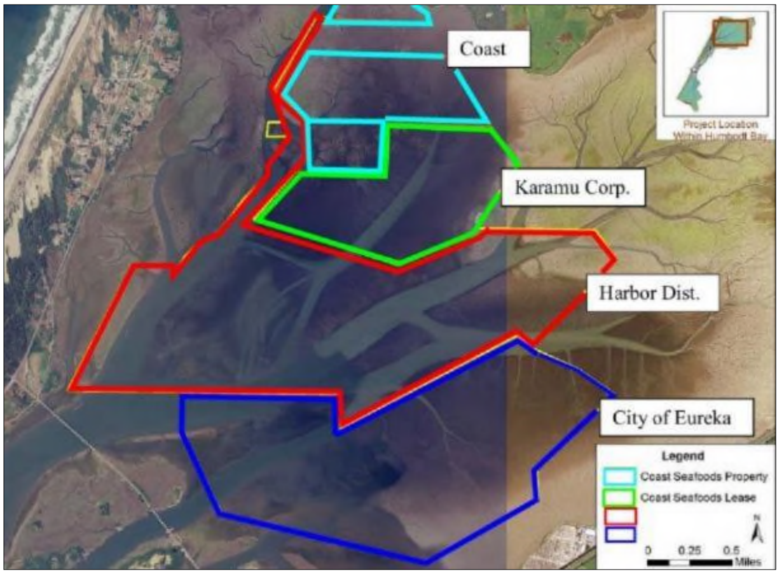
Pacific Seafood Company, which purchased Coast Seafood Company in 2011, has extensive mariculture operations throughout the U.S. West Coast. Pacific Seafood farms more than 17,000 acres in California, Oregon and Washington, and also operates hatcheries and research facilities in California, Washington, and Hawaii that produce oyster, clam, and mussel larvae and seed for company operations.

The Coast Seafood Eureka operation has existed since the 1950s, and is focused on growing and harvesting Pacific and Kumamoto Oysters, and Manilla clams on federal and state certified shellfish growing areas of Humboldt Bay. The company's area of operation encompasses 4,313 acres in Arcata Bay, including nearly 3,300 acres of public trust land managed by the City of Eureka or the Humboldt Bay Harbor District, over 500 acres of privately owned lands primarily held by the Karamu Corporation, and 514 acres of intertidal and submerged lands owned by Coast Seafood. The 4,313 acres is roughly half of the total intertidal area of Arcata Bay.[84] Coast Seafood utilizes three "off-bottom" methods for growing oysters including rack-and-bag culture, long-line culture and basket culture.

Coast Seafoods proposed to expand its overall cultivation area from 300 acres to about 560 acres in 2016/7. However, after an extensive permit process, Coast Seafoods agreed to limit farming of shellfish to 279 acres. The new permit expires in 2025.

[84] California Coastal Commission, *Report W22b, Applicant: Coast Seafood Company*, August 14,2017.

Figure 4-18: Project Area showing Coast Seafood's Owned and Leased Areas



Source: Humboldt Bay Harbor District[20]

Coast Seafood's operations also include two *FLUPSYs (Floating Upwell System).* One FLUPSY for oysters is located south of the Simpson wood chip loading dock in Fairhaven and another for clam seed is located at Redwood Marine Terminal 2.

Coast Seafood has an oyster nursery (approximately 4.8 acres) in Humboldt Bay on mudflats north of Gunther Island and along Arcata Channel. The nursery is used to allow the shellfish seed to gain size and strength prior to planting, a process called "beach hardening".

4.3.2.5 Taylor Shellfish

Taylor Shellfish produces Manila clams, Mediterranean mussels, and geoducks, as well as a variety of oysters on approximately 11,000 acres of tidelands on the Washington Coast and in British Columbia. Taylor also operates seed hatcheries in Washington, California, and Hawaii. Products are shipped to domestic and international markets.[85]

Taylor Mariculture, LLC. (Taylor) established an aquaculture operation to support shellfish seed cultivation operations in Humboldt Bay in 2013. The facility is located at Redwood Marine Terminal 2, which is owned by the Harbor District. The berth was improved to allow safe transit by the equipment needed to move products from the building to the waterside activities. The operation takes free-swimming oyster and clam larvae (spawned in a hatchery at a separate location) and grows them to between four and twelve millimeters in size. The shellfish seed operation includes: a seed setting facility, nursery rafts, FLUPSYs, pier upgrades, a seed wash facility, a wash water discharge system, parking and storage, and an access road. (See Figure 4-19).

[85] California Coastal Commission, *Application No. E-11-029, Applicant: Taylor Mariculture LLC*, 2013.

Figure 4-19: Taylor Mariculture Co Facilities in Humboldt Bay

Source: California Coastal Commission

The nursery rafts and FLUPSYs encompass approximately 44,000 square feet, and are connected to the existing pier by a gangway. The seed wash system is located onshore near the base of the pier. The wash water discharge/disposal system is located in an upland area near the base of the pier.

4.3.2.6 Hog Island Oyster Company

Hog Island Oyster Co. currently leases one hundred and sixty acres in Tomales Bay and sells over 5 million oysters, Manila clams, and mussels per year. Hog Island developed their first California-based oyster seed hatchery and nursery in Humboldt Bay, CA in 2014.[86] (See Figure 4-20). Hog Island Oyster Co. also operates restaurants in San Francisco and Napa.

The Humboldt Bay operation focuses on Manila clams, Pacific oysters, and Kumamoto oysters. The project was constructed on a previously undeveloped 3.5-acre parcel and adjacent to a pier owned by Sequoia X, LLC. The tidelands around the pier are owned by the Harbor District. Hog Island has ten-year leases from the Harbor District and Sequoia X LLC.

The shellfish hatchery is used to breed adult shellfish in order to generate large numbers of larvae that can be grown to larger sizes or transported and sold to aquaculture operations offsite. The hatchery, seed setting operation, storage tanks and office facility are housed in a mariculture building. Other facility components (i.e., covered work area, algae greenhouse, septic system, shellfish seed wash facility, parking area, and access road) are constructed on the 3.5 acre project site. The nursery rafts and FLUPSYs (approximately 16,500 square feet) are connected to the pier by way of the 40-foot long floating gangway. Proposed rafts would allow the shellfish seed to be submerged in the waters of Humboldt Bay during grow-out.

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[86] Hog Island Oyster Co. Inc., "*About Hog Island Oyster Co. Inc.*", https://www.bcorporation.net/community/hog-island-oyster-co-inc (accessed February 23, 2018).

Figure 4-20: Hog Island Company Facilities in Humboldt Bay[87]

Source: Hog Island Company

4.3.2.7 Harbor District

The Harbor District worked with local shellfish companies and regulatory agencies to pre-permit aquaculture activities in Humboldt Bay. This effort included subtidal areas and tidal areas.

In 2016, the Harbor District sought the necessary state and federal authorization to allow shellfish and macroalgae aquaculture on three areas of submerged lands within Humboldt Bay.[88] The three project areas, shown in Figure 4-21, are comprised of:

- Subtidal 1 (located north of Redwood Marine Terminal Berth 2) consists of 6.6 total acres proposed to support a maximum of 0.87 acres of aquaculture activities,
- Subtidal 2 (located north of Redwood Marine Terminal Berth 2) consists of 8.6 total acres proposed to support a maximum of 0.96 acres of aquaculture activities, and
- Subtidal 3 (located at the southside of Redwood Marine Terminal Berth 2) consists of 6.0 total acres proposed to support a maximum of 1.25 acres of aquaculture activities.

The three project areas include existing pier or wharf structures and are located within a ¾ mile stretch of subtidal waters within Humboldt Bay adjacent to the Samoa Peninsula. Shellfish structures are expected to include: FLUPSYs for growing young shellfish and nursery rafts for growing small, immature shellfish that would be sold or transferred elsewhere for grow-out to consumer sizes, rafts and macroalgae longline processes. The Coastal Commission approved Coastal Development Permit 9-16-0204 on November 4, 2016 with special conditions.

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[87] California Coastal Commission, *Application No. 9-13-0500, Applicant: Hog Island Oyster Company*, November 2013.

[88] California Coastal Commission, *Application No. 9-16-0204, Applicant: Humboldt Bay Harbor, Recreation, and Conservation District*, May 2016.

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Figure 4-21: Sub-tidal Sites proposed by Harbor District

Source: Harbor District

The Harbor District also sought the necessary state and federal authorization to allow shellfish and macroalgae aquaculture on four intertidal areas within Humboldt Bay.[89] The three project areas, shown in Figure 4-22, are comprised of:

- Intertidal 1 consists of 99 total acres with use of up to 30 acres of surface waters,
- Intertidal 2 consists of 364 total acres with use of up to 109.2 acres of surface waters,
- Intertidal 3 consists of 14 total acres with use of up to 4.2 acres of surface waters, and
- Intertidal 4 consists of 50 total acres with use of up to 15 acres of surface waters.

The general types of aquaculture expected to occur in these areas includes rack-and-bag, cultch-on-longline, and basket-on-longline methods.

Figure 4-22: Intertidal Culture Sites proposed by Harbor District

[89] Humboldt Bay Harbor, Recreation and Conservation District, *Final Environmental Impact Report for the Humboldt Bay Mariculture Pre-Permitting Project, Volume 1, SCH #2013062068*. February 8, 2016.

Source: Harbor District

4.3.3 Finfish Mariculture

The Harbor District is also evaluating opportunities for upland finfish mariculture at Redwood Berth 2. The scale of these facilities is not yet known.

4.3.4 Potential Demand in Humboldt Bay

4.3.4.1 Subtidal

Subtidal aquaculture operations that include hatcheries and nurseries using FLUPSYs, rafts, and macroalgae longline processes appears to be an acceptable (permittable) activity in Humboldt Bay, as evidenced by the current operations of Hog Island Oyster and Taylor Mariculture as well as approvals by the California Coastal Commission to allow these activities in certain subtidal areas in Humboldt Bay. As described below, Humboldt Bay has a potential future in exporting shellfish seed and larvae.

> Humboldt Bay is one of the few places that can export seed and larvae of oysters and clams anywhere on the West Coast, thanks to a monitoring program called the High Health Plan that ensures bivalves grown there are free of damaging parasites and diseases. Larvae, which are produced in hatcheries, are the earliest life-history stage of oysters and clams, and are especially susceptible to ocean acidification.
>
> Humboldt Bay is an excellent place to be doing this work because aquaculture is already a major, important industry here. It's got really good growing conditions for oysters, and based on measurements taken in the region, we believe the acidity of seawater in the Bay is somewhat buffered – likely by eelgrass," said Tyburczy, noting that shellfish hatcheries in other locations must often resort to artificially buffering acidic water with chemical additives to keep their larvae alive. "We hope to get a handle on how buffered the Bay is, how much of that buffering is done by eelgrass, and how oyster growers can get the most benefit from this natural buffering and protect their product."[90]

The footprint of existing facilities includes:

- Harbor District Redwood Marine Terminal 2:
  - Taylor Shellfish - 14,000 square feet of building space with 8 acres of subtidal land.
  - Coast Seafood- 20,000 square feet of building space with 6 acres of subtidal land.
- Sequoia Investment Fairhaven Terminal:
  - Hog Island Oyster Company – 20,000 square feet of building space on 3.5 acres of uplands with 8 acres of subtidal land.

Future upland demand that is currently permitted includes 21.2 acres of subtidal area with an allowed surface area of 3.08 acres. If these sites are developed it could require up to 10 acres of uplands (three projects at an average of 3.5 acres per project).

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[90] California Sea Grant, "Changing waters in Humboldt Bay: Extension Specialist Joe Tyburczy awarded funds to track ocean acidification", California Sea Grant website, December 2016. https://caseagrant.ucsd.edu/news/changing-waters-in-humboldt-bay-extension-specialist-joe-tyburczy-awarded-funds-to-track-ocean (accessed March 2, 2018).

4.3.4.2 Intertidal

The limits that Coast Seafood agreed to in their recent permit process application indicate that development of additional shellfish growing areas in Humboldt Bay may be difficult.

As described above, Coast Seafoods proposed to expand its overall cultivation area from 300 acres to about 560 acres in 2016/7 but was granted approval for 279 acres. The new permit, which expires in 2025, included a number of special conditions. These included:

- creation of monitoring plans for eelgrass, black brant and herring in coordination with regulatory agencies,
- limiting operations during brant hunting season,
- submission of an annual report to the state on the status of oyster beds,
- monitoring, marking and cleanup of equipment, and
- creating a plan for transit lanes to reduce potential impacts of boats and barges on wildlife et al).

One condition would also require Coast Seafood to maintain its extensive lease-holdings (approximately 3,800 acres) for eight years but to only make use of the small fraction of them. This would effectively limit the possibility of other development in these areas and therefore protect them for shorebirds and other wildlife and habitats.

The status of the Harbor District's efforts to expand intertidal growing areas is uncertain at this date.

4.3.5 Finfish

The status of finfish projects in unknown at this time.

4.3.6 CDI Land Required

Current upland mariculture operations use approximately seven acres of CDI land. Planned expansion could raise this to a total of 10 to 20 acres. In addition, in-water operations (i.e. FLUPSYs) occupy approximately 21 acres of CDI water area. (See Table 4-10).

Table 4-10: Current CDI Use and Future Demand, Mariculture

Land Use	Current Existing	Future Acres Low	Future Acres High	Change in Acres Low	Change in Acres High
Shellfish	6	9	17	3	11
Finfish	1	1	3	0	2
Total	7	10	20	3	13

Source: BST Associates

4.4 MARINE RESEARCH

This chapter reviews the use of CDI lands by marine research facilities. It includes an overview of selected U.S. West Coast marine research facilities as well as descriptions of potential marine research facilities in Humboldt Bay.

4.4.1 U.S. West Coast Marine Research Facilities

According to the National Association of Marine Laboratories (NAML), there are 16 marine research facilities located on the U.S. West Coast. (See Table 4-11). These facilities range from:

- Operations with small land areas that have extensive building space on a small footprint (e.g., the Monterey Bay Aquarium Research Institute has 175,000 square feet of space on just 3.3 acres) to
- Operations with extensive property but little building space (e.g., Blakely Island Field Station is a marine reserve with little building space). The facilities with larger acreages are largely, if not entirely, used as a reserve.

Table 4-11: Selected Marine Research Facilities on US West Coast

Institution	Lab Name	State	Acres
Aquarium of the Pacific	Aquarium of the Pacific	CA	5.0
California State University	Moss Landing Marine Laboratories	CA	9.2
Mendocino College	Coastal Field Station	CA	15.0
Monterey Bay Aquarium Research Institute	Monterey Bay Aquarium Research Institute	CA	3.3
San Francisco State University	Estuary & Ocean Science Center	CA	53.0
Stanford University	Hopkins Marine Station	CA	11.0
University of California, Davis	Bodega Marine Laboratory	CA	362.0
University of California, San Diego	Scripps Institute of Oceanography, UCSD	CA	170.0
University of California, Santa Cruz	Long Marine Lab	CA	100.0
University of Southern California	Wrigley Marine Science Center	CA	14.0
Oregon State University	Hatfield Marine Science Center	OR	40.0
University of Oregon	Oregon Institute of Marine Biology	OR	100.0
Seattle Pacific University	Blakely Island Field Station	WA	900.0
University of Washington	Friday Harbor Laboratories	WA	370.0
Walla Walla University	Rosario Beach Marine Laboratory	WA	40.0
Western Washington University	Shannon Point Marine Center	WA	78.0

Source: National Association of Marine Laboratories and individual institution websites, list is organized by state and name of the institution.

These facilities are utilized for a variety of research purposes:

- They provide access to the environment.
- They provide logistical support for a wide range of activities including individual research projects; networking of research on larger scales; science, technology, engineering, and mathematics (STEM) training; and public outreach.
- Through time they become model ecosystems in which the steady accumulation of site-specific knowledge becomes a powerful platform for future research.

- They foster a community of scholars that promotes the exchange of ideas, collaboration, and the integration of knowledge, and can facilitate the flow of information between the scientific community and decision makers about environmental issues.[91]

Several marine labs have recently completed or are planning improvements. As an example, Oregon State University (OSU) is currently planning additional facilities at the Hatfield Marine Science Center in Newport, Oregon to help implement OSU's Marine Studies Initiative, a 10-year program to foster innovative approaches to addressing key issues involving the coast, the ocean and ocean literacy. The new marine research building (72,000 square feet) will not only enhance marine science education and research capacity but will also serve as a vertical tsunami evacuation site, via the roof of a building (at a height of 47 feet), which is designed to serve as a vertical evacuation site for more than 900 people.[92]

Figure 4-23: Proposed New Research Building at Hatfield Marine Science Center

4.4.2 Opportunities in Humboldt Bay

Opportunities in Humboldt Bay appear to be positive. However, the strategy for future development is still evolving.

4.4.2.1 Existing Facilities at Humboldt State University[93]

Humboldt State University's existing marine science facilities include Telonicher Marine Laboratory in Trinidad Bay, approximately 14 miles north of Arcata. The Telonicher Lab consists of a multi-purpose 16,200 square feet building on a 1.4 acre site overlooking the Pacific Ocean, near Trinidad Bay, Trinidad Beach, and Trinidad Headland. Specialized facilities include a culture room, a wet lab, and a shop for design and fabrication of experimental equipment. The Lab also contains several holding tanks (ranging

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[91] National Association of Marine Laboratories (NAML) and the Organization of Biological Field Stations (OBFS), *Field Stations and Marine Laboratories of the Future: A Strategic Vision*, 2013.

[92] Nealon, Sean, *OSU Marine Studies Building to Be a National Model for Tsunami "Vertical Evacuation",* November 22, 2017. http://today.oregonstate.edu/news/osu-marine-studies-building-be-national-model-tsunami-%E2%80%9Cvertical-evacuation%E2%80%9D (accessed April 2, 2018).

[93] Humboldt State University Marine Sciences website. http://www2.humboldt.edu/marinesciences/facilities.html (accessed April 2, 2018).

in size from 30 gallons to 1400 gallons). Seawater water is pumped in from Trinidad Bay with a capacity of 150,000 gallons. The Lab was originally built in 1965 and expanded in 1975 to its current size.[94]

HSU also has a research vessel, the *R.V. Coral Sea*. This vessel enables the study the biology, chemistry and geology of the coastal Pacific Ocean. Built in 1974 and refit in 2006 with new engines, the *R.V. Coral Sea* is used by all departments with marine science programs to support undergraduate instruction and student and faculty research. In addition, there are several smaller boats available for inshore and near shore coastal research (e.g., waterfowl and eelgrass in Humboldt Bay, to sea birds and marine mammals offshore).

4.4.2.2 National Marine Research and Innovation Park

In 2017, a concept to build a National Marine Research and Innovation Park (NMRIP) was proposed by the Humboldt Bay Harbor Recreation and Conservation District (HBHRCD) in conjunction with Humboldt State University (HSU) and other potential partners, including:

- Humboldt Bay Municipal Water District,
- Educational institutions (PK-20),
- Local, regional and tribal governments,
- Natural resource and planning agencies, and
- Multiple private and nonprofit partners.

The NMRIP concept currently in development envisions the repurposing of the Samoa pulp mill into a multi-use facility housing both research and commercial opportunities in aquaculture, biomass conversion, and renewable energy.

The original concept site drawing and building redevelopment concept are shown in Figure 4-24 and Figure 4-25. Although details of the proposal are in early stages, these figures illustrate the redevelopment of the Redwood Marine Terminal 2, warehouse and uplands that is envisioned.[95]

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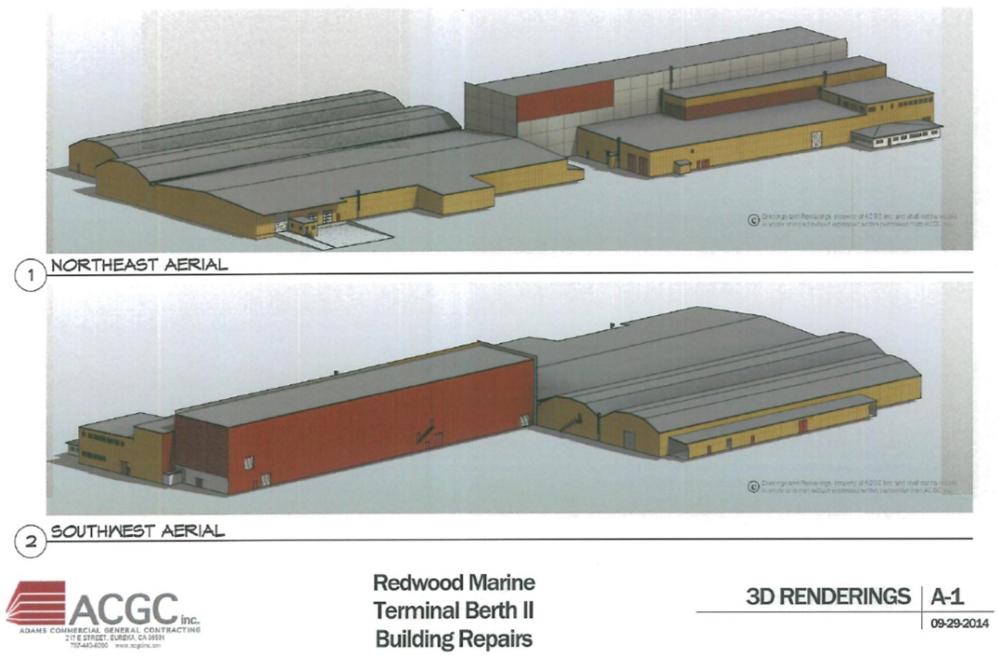
[94] Soden, Tabitha, "Humboldt State's Marine Lab Celebrates 50 Years", *Eureka Times Standard*, November 16, 2015.

[95] Williamson, Rhea L., *Northern California's Marine Research and Innovation Park: from Extraction to Sustainability*. http://conference.ifas.ufl.edu/nwwws/documents/Presentations/4%20Williamson%20B3%20REVISED.pdf, (accessed February 21,2018).

Figure 4-24: NMRIP Site Concept Drawing

Source: Humboldt Bay Harbor, Recreation and Conservation District

Figure 4-25: NMRIP Building Concept Drawings



Source: Humboldt Bay Harbor, Recreation and Conservation District

The current planning at HSU calls for public-private partnerships in which HSU would develop appropriately sized research facilities at sites belonging to public and/or private developer, as required. Research would be focused on aquaculture, energy (wind and wave) and other coastal research opportunities.[96] These efforts would be augmented by existing facilities at HSU.

An existing example of this type of public-private partnerships is research currently being conducted on water quality in Humboldt Bay. California Sea Grant, Humboldt State University researchers, and Hog Island Oyster Company are working together to study the impacts of ocean acidification and the extent

[96] Karp, Steven, interview with the authors, March 29, 2018. Dr. Karp is Interim Dean of Research at Humboldt State University.

to which eelgrass may reduce acidification. The research includes use of a monitoring instrument, located at Hog Island's oyster hatchery, to track Humboldt Bay's chemistry.[97],[98]

4.4.2.3 Space Requirements

Plans for marine research are facilities are currently evolving to and are constrained by budgets. At a minimum there would be no new stand-alone facilities, but development would occur within existing. If development of a stand-alone facility occurred, it could range from 5 to 10 acres, in line with the smaller marine labs along the U.S. West Coast. Future demand for CDI land for marine research ranges from a low of zero acres (i.e. the activity does not occur on Humboldt Bay) to a high of 10 acres. (See Table 4-12).

Table 4-12: Current CDI Use and Future Demand, Marine Research

	Current	Future Acres		Change in Acres	
Land Use	**Acres**	**Low**	**High**	**Low**	**High**
Marine Research	0	0	10	0	10

Source: BST Associates

[97] California Sea Grant, "*Changing Waters in Humboldt Bay*".

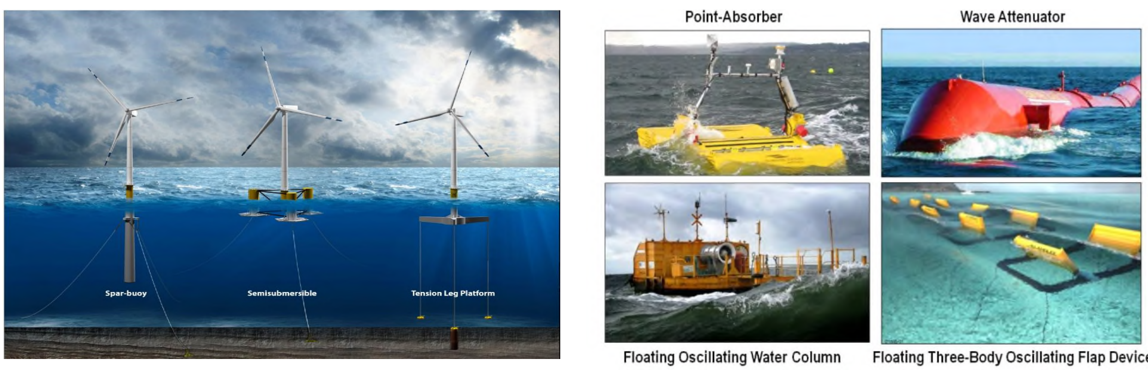
[98] Tyburczy, Joe, interview with the authors, March 29, 2018. Dr. Tyburczy is an Extension Specialist with California Sea Grant.

4.5 Offshore Energy

The offshore energy industry represents a potential future use of CDI lands in Humboldt Bay. Although this use currently does not exist in Humboldt Bay, the offshore areas near Humboldt Bay have been identified as an important energy resource.

Offshore energy devices include offshore floating wind systems (OFW) and wave energy systems, called marine hydrokinetic systems (MHK)[99]; both types of devices represent potential opportunities for Humboldt Bay. Offshore wind energy is widespread in Europe and is beginning to be developed on the U.S. Atlantic Coast. On the U.S. West Coast, a test installation is currently in the planning process for coastal waters near Humboldt Bay. Wave energy, which is still in developmental stages, is being tested near Newport, Oregon. Figure 4-26 presents some of the devices for these two energy options.[100]

Figure 4-26: Offshore Wind System and Wave Energy Devices



Source: National Renewable Energy Laboratory

4.5.1.1 Global Market

The global market for wind energy is strong, driven by the increasing competitiveness of wind power and opportunities to reduce emission of greenhouse gases by renewable energy sources. BP Energy Economics projects that subsidies required to support these systems will be phased out by the mid-2020s and that the gain in market share from renewables will be more rapid than for any other energy source over a similar period, with the closest parallel being the build-up of nuclear power in the 1970s and 1980s.[101]

The International Energy Agency (IEA) estimates the average annual growth in development of wind energy was 24% per year from 1990 to 2015.[102] In 2016, wind turbines accounted for 23.2% of renewable electricity in the Organization for Economic Cooperation and Development (OECD). Most of

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[99] Coast & Harbor Engineering, *Determining the Infrastructure Needs to Support Offshore Floating Wind and Marine Hydrokinetic Facilities on the Pacific West Coast and Hawaii*, March 3, 2016.

[100] National Renewable Energy Laboratory, *Potential Offshore Wind Energy Areas in California: An Assessment of Locations, Technology, and Costs*, December 2016.

[101] BP Energy Economics, *BP Energy Outlook*, 2018 Edition.

[102] International Energy Agency, *Renewables Information 2017 Overview*, July 20. 2017.

the growth also occurred in OECD Europe. However, the United States is the largest producers of electricity from wind within the OECD producing 229.3 TWh.

A growing portion of this capacity is occurring in offshore wind farms. Europe has installed offshore wind capacity of more than 12,600 megawatts generated by 3,589 grid-connected wind turbines in 10 countries. The leading countries are:

- The U.K. accounts for about 36 percent of installed capacity,
- Germany (29 percent)
- China (11 percent)
- Denmark (8.8 percent),
- The Netherlands (7.8 percent),
- Belgium (5 percent), and
- Sweden (1.4 percent of capacity).

One of the key factors supporting development of offshore wind power is the falling cost of capital development, which is estimated to have decreased from $3.8 million per megawatt of electricity in 2016, to $2.2 million per megawatt at the end of 2017, driven by increased turbine capacity and platform technology.

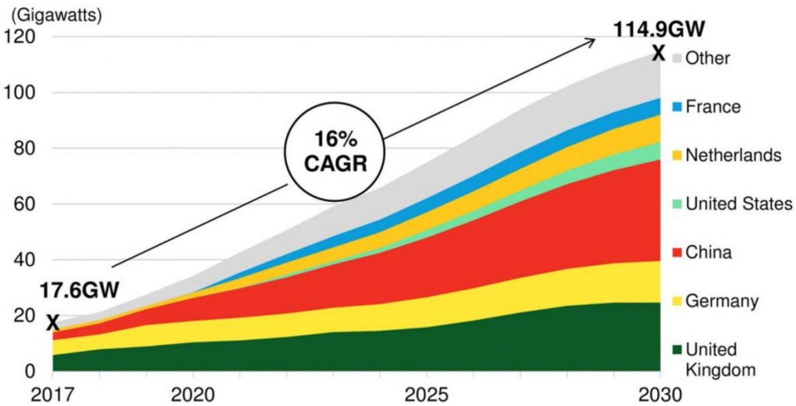
Estimates of the annual growth in offshore wind power include:

- Research and Markets projects growth of 12.0% per year from 2017 to 2025, growing from 15.0 GW in 2017 to 65.5 GW by 2025.[103]
- Bloomberg New Energy Finance projects growth of 16.0% per year from 2017 to 2030, growing from 17.6 GW in 2017 to 114.9 GW by 2030. Bloomberg expects the U.S. to expand into offshore wind power.[104] (See Figure 4-27).

[103] Research and Markets, G*lobal Offshore Wind Energy Market Size, Market Share, Application Analysis, Regional Outlook, Growth Trends, Key Players, Competitive Strategies and Forecasts, 2017 to 2025*, December 12, 2017. As reported in Business Wire.

[104] Bloomberg New Energy Finance Business Wire, *Global Offshore Wind Market Set to Grow Sixfold by 2030*, January 8, 2018.

Figure 4-27: Expected Growth in Offshore Wind Power



The market for wave or tidal energy is less well developed.[105] In 2016, 1,008 GWh of electricity were generated from tide, wave and ocean motion, with France and Korea each producing approximately 500 GWh and Canada produced 13 GWh. Wave energy appears to be in the same place technologically as wind power was 30 years ago. There is no consensus on the best design. In the U.S., much of the research on wave energy has occurred via the Northwest National Marine Renewable Energy Center with facilities in Oregon, Washington and Alaska.

4.5.1.2 United States Market

Analysts expect U.S. offshore wind energy to enjoy significant growth in the coming decade, due primarily to falling capital costs and operating costs. According to the U.S. Energy Information Administration (EIA), generation from renewable sources is projected to grow under all forecast scenarios, led by growth in wind and solar photovoltaic generation.[106]

Although only one offshore project has been developed in the United States to date (in Rhode Island), planning is underway for 25 offshore wind projects with a combined capacity of 24 gigawatts. Most of these projects are located along the U.S. Northeast and mid-Atlantic coasts.

The U.S. Department of Energy's (USDOE) *Wind Vision Roadmap* found that "deployment of wind technology for U.S. electricity generation provides a domestic, sustainable, and essentially zero-carbon, zero-pollution and zero-water use U.S. electricity resource." [107] The report documented a tripling of growth in wind energy capacity (including land-based, offshore, and distributed) between 2008 and 2014. The report projects that U.S. wind power could potentially supply 10% of the nation's electrical demand in 2020, 20% in 2030, and 35% in 2050. (See Figure 4-28).

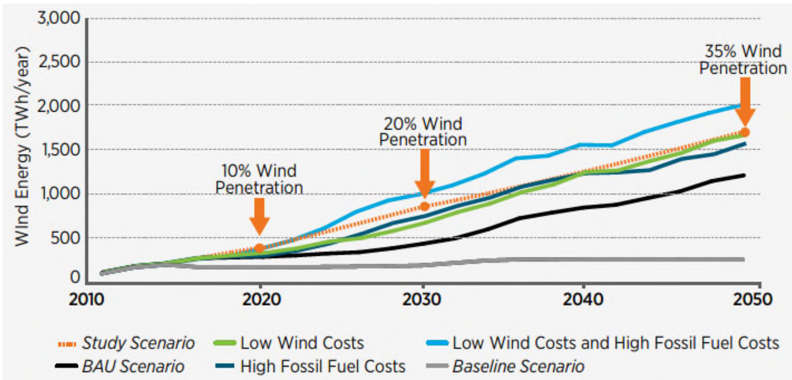
[105] Levitan, Dave, "Why Wave Power Has Lagged Far Behind as Energy Source", Yale Environment 360, April 28, 2014.

[106] Drouin, Roger, "After an Uncertain Start, U.S. Offshore Wind Is Powering Up", Yale Environment 360, January 11, 2018.

[107] U.S. Department of Energy Wind and Water Power Technologies Office, *Wind Vision: A New Era for Wind Power in the United States*, March 2015.

The USDOE prepared a follow-up report in 2017, which validated the results of the *Wind Vision Roadmap* but also suggested new actions to further support the sector.[108]

Figure 4-28: Wind Vision Study Scenario



The Wind Energy Technologies Office focused on opportunities for development of the offshore wind systems in another recent report.[109] Key findings included:

- U.S. offshore wind resources are abundant with technical potential of 2,058 gigawatts (GW) of offshore wind resource capacity accessible in U.S. waters using existing technology.
- Offshore wind could be competitively priced with other forms of generation within the next decade.
- Offshore wind could enable benefits for system operators, utilities, and ratepayers due to:
    - Lower marginal costs of production and
    - In certain locations (including offshore of Humboldt bay), it is possible to generate power during periods of peak use.
- Offshore wind provides numerous environmental and economic external benefits, including:
    - Reduced greenhouse gas emissions,
    - Decreased air pollution from other emissions,
    - Reduced water consumption,
    - Greater energy diversity and security, and
    - Increased economic development and employment

4.5.1.3 California Market

The State of California has made a strong commitment to reduce greenhouse gas emissions:

- The Clean Energy and Pollution Reduction Act of 2015 requires that electric utilities increase retail sales of qualified renewable energy to at least 50 percent by 2030, via the.

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[108] U.S. Department of Energy Wind and Water Power Technologies Office, *2016–2017 Status Assessment and Update on the Wind Vision Roadmap*, October 2017.

[109] U.S. Department of Energy Wind and Water Power Technologies Office, *National Offshore Wind Strategy, Facilitating the Development of the Offshore Wind Industry in the United States*, September 2016.

- In 2016, Senate Bill 32 put into law a statewide goal to reduce greenhouse gas (GHG) emissions 40 percent below 1990 levels by 2030.[110]

Development of offshore wind systems could be a prominent part of this transition.

The National Renewable Energy Laboratory, in conjunction with United States Department of the Interior Bureau of Ocean Energy Management (BOEM), produced detailed evaluations of the wind resources available at various locations along the California coastline. As shown in Figure 4-29, there are several areas along the California coast with favorable conditions for offshore wind systems, including the area offshore of Humboldt Bay.

The U.S. Navy reviewed the report and stated its intention to veto offshore wind energy systems in the ocean area off San Luis Obispo and Santa Barbara counties as well as the entire offshore zone stretching from Los Angeles north to Big Sur. Because of this, efforts are now focused farther north, in the Humboldt Bay area. While wind conditions are favorable in the Humboldt Bay region, the area is not close to the large population centers in California.

A recent report by the University of California Berkeley finds that "as California accelerates its transition to a low-carbon future, one of its challenges is to choose "high-road" policies that not only cut emissions but spur broad-based growth, create quality jobs, and benefit communities. The state and federal governments have recently launched a planning process for one emerging clean energy source with significant high-road potential: offshore wind."[111]

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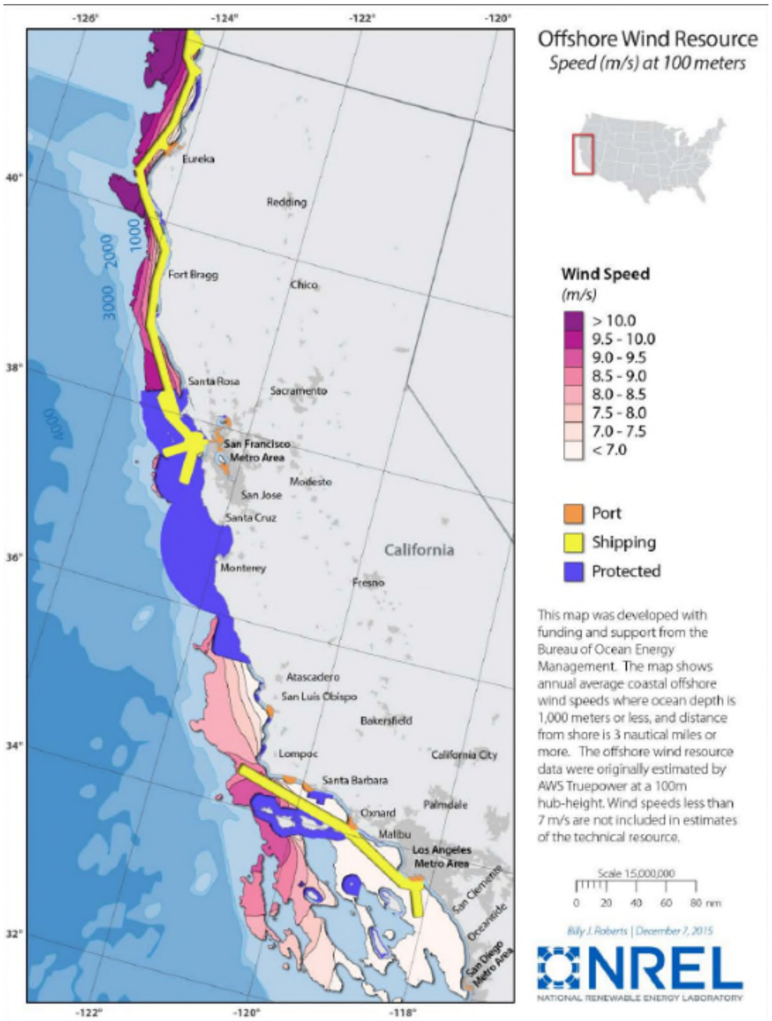
[110] California Energy Commission, *Offshore Renewable Energy - Docket # 17-MISC-01*. http://docketpublic.energy.ca.gov/PublicDocuments/17-MISC-01/TN222736_20180226T113840_Notice_of_Webinar_on_Offshore_Renewable_Energy_3122018.pdf (accessed 4/2/2018).

[111] Green Economy Program, Center for Labor Research and Education, University of California, Berkeley. *High Road for Deep Water Policy Options for a California Offshore Wind Industry*, November 2017.

Figure 4-29: Wind speed map of California offshore technical resource area with competing use and environmental conflicts overlaid[112]



Source: National Renewable Energy Laboratory

4.5.1.4 *Humboldt Bay*

The Redwood Coast Energy Authority (RCEA) is a local government joint powers agency whose member agencies include: Humboldt County, the Cities of Arcata, Blue Lake, Eureka, Ferndale, Fortuna, Rio Dell, Trinidad, and the Humboldt Bay Municipal Water District. The mission of RCEA is to develop and implement sustainable energy initiatives that reduce energy demand, increase energy efficiency, and advance the use of clean, efficient and renewable energy resources available in the region. In 2012, RCEA adopted the Humboldt County Comprehensive Action Plan for Energy (CAPE), that established specific strategic action items relevant to the development of the region's offshore wind energy resources, including:

- Large-Scale Wind Energy: Work with utilities and private companies to develop off-shore wind energy demonstration projects.

[112] National Renewable Energy Laboratory, *Potential Offshore Wind*.

- Emerging Energy Technologies: Support the development of emerging energy technology from local innovators and inventors, as well as from non-local sources.
- Business Development: Collaborate with local economic development entities to attract technology developers, manufacturers, and energy service providers to locate operations in the County when appropriate.
- Proactive Development Support: Collaborate with local jurisdictions to identify and pre-assess locations and facilities that could appropriately support energy generation projects and/or other energy-related business ventures.
- Local Energy Investment: Work with local economic development entities and financial institutions to develop programs and resources that facilitate local community investment in and/or ownership of energy efficiency and renewable energy projects.

One technical issue that will need to be addressed is transmission capacity. Existing transmission capacity out of Humboldt County is approximately 60 MW, but according to the National Renewable Energy Laboratory (NREL) the maximum technical potential for the Humboldt County coast is 1100 MW with a capacity factor (annual average of maximum output) of 55 percent. Full development of the offshore resource would require a major upgrade to the transmission lines. If Humboldt's capacity were fully developed, it could supply twenty times the total electricity consumption of Humboldt County.

In alignment with its priories of developing local renewable resources as well as supporting energy-related local economic development, RCEA has begun actively exploring the potential to move forward with a local offshore wind energy project.[113] The RCEA issued a request for qualifications from potential bidders in February 2018.[114] Principle Power was the winning bidder, and a Memorandum of Understanding (MOU) was approved in October 2017. This MOU establishes a collaborative effort to work together on the key requirements needed to develop Humboldt's offshore wind energy potential, which will take a number of years to complete.[115]

4.5.2 CDI Land Required

Humboldt's most promising sites for offshore wind development are approximately 15 to 20 miles offshore in deep water, so the turbines would be mounted on floating platforms. The development of offshore wind energy off the coast of Humboldt Bay would likely require the redevelopment of new port facilities.

A report prepared for BOEM by Hatch Mott MacDonald[116:] identified the different types of ports that are involved in wind energy projects:

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[113] Kalt, Jen, "Redwood Coast Energy Authority Proposes Offshore Wind Project", EcoNews Report, Feb 22, 2018.

[114] Redwood Coast Energy Authority, *Request for Qualifications for Humboldt County Offshore Wind Energy Development Partners*, February 2018.

[115] Winkler, Michael, "Renewable Energy Potential in Humboldt Includes Offshore Wind", Northcoast Environmental Center website, December 13, 2017. http://www.yournec.org/node/10819 (accessed 4/2/2018).

[116] Coast & Harbor Engineering, *Determining the Infrastructure Needs*.

- Quick Reaction Port (QRP): QRPs are intended to be the homeport for operations and maintenance vessels. The ports must be close enough to the energy development site to allow vessels to reach the site in less than two hours. QRPs are estimated to require 1 to 2 acres.
- Assembly Port (AP): This type of port will be utilized during final assembly of the entire devices for marine tow out to the installation location. Direct access to a high capacity deep water dock is required. Marine navigation access to the energy development site from the AP should be deep draft, and in the case of OFW not have any air draft restrictions. APs will likely be located as near as possible to the installation site. APs are estimated to require 50 to 100 acres.
- Fabrication and Construction Port (FCP): This type of port will be utilized during the installation or construction phase. FCPs may handle device components or serve as a transport hub for overland or marine transport. They may also provide fabrication of turbine or MHK components, or construction of the floating foundation. FCPs are estimated to require 100 to 200 acres.

The Hatch Mott MacDonald reviewed existing marine terminals in Humboldt Bay facilities and made several observations:

> The port was classified as a potential QRP for OFW and MHK, a potential fabrication and construction port for OFW and MHK, and an assembly port for OFW Semi-Sub and TLP, and MHK. The port's biggest assets related to OFW and MHK development (land, no air draft restriction, and navigation channel geometry, proximity to the ocean), show that assembly and quick reaction facilities appear feasible with some significant facility upgrades. Anchor handling tugs, bulk carriers, and other offshore construction vessels would likely be able to be accommodated, but may require upgrades to upland facilities such as crane capability.
>
> Manufacturing and fabrication at the port is less likely due to the remote location and limited overland transport connections. OFW assembly could potentially be conducted quayside at one of the Redwood terminals but would potentially require purpose-built facilities such as construction of a new concrete wharf, and potential berth dredging. Channel depth may limit tow-out operations to high tide. Schneider dock may require lengthening and other various upgrades prior to use. MHK construction and assembly at these sites is also possible, but would likely require wharf upgrades (bearing capacity, crane)."[18]

As shown in Figure 4-30, Humboldt Bay port facilities meet all the requirements for various offshore wind components with exception of the spar system which requires far greater depth.

Figure 4-30: Humboldt Bay Assessment and Cursory Gap Analysis

Port Classification	Technology	Score	Potential Gap
Quick Reaction	OFW & MHK	3	May require berth rehabilitation. Vessel specific moorage may be required. Helipad may be required
Fabrication & Construction	OFW Turbine	2	Exclusive-use area (10+ acres) with direct quayside access. New berth. Crane/SPMT.
	OFW Foundation	2	New Crane, exclusive upland area development (50+ acres depending on throughput). New berth. Crane/SMPT.
	MHK	2	Fabrication facility (1-5 acres). Likely a new berth. Crane/SPMT.
Assembly	OFW Semi-Sub	2	Berth dredging may be required. New crane. Rehabilitation and strengthening of existing docks or construction of new facility.
	OFW TLP	2	Berth dredging may be required. New crane. Rehabilitation and strengthening of existing docks or construction of new facility.
	OFW Spar	0	Spar draft does not allow for assembly with existing technology within the port.
	MHK	2	10 acre facility with berth. Likely a new crane. Berth may need rehabilitation and strengthening.

Notes on scoring
0 Does not meet primary criteria and is not suitable with existing technology due to not meeting one or more of the primary criteria (e.g. air draft restriction, upland area restrictions)
1 May not meet all primary criteria (such as available upland area), but temporary use of facilities will allow demonstration-scale project (e.g. staging area for 1 device is temporarily cleared at port).
2 Meets primary criteria. Land redevelopment, new purpose built marine terminal or berth required.
3 Meets primary criteria, and some secondary criteria. Moderate level of improvements needed, such as new high capacity (500+ tons) crane, existing berth upgrades, or berth bearing capacity investigation
4 Meets all primary criteria and most if not all secondary criteria. Minimal improvements are needed such as new small cargo crane (<10 tons), warehouses, helipad.
Source: Hatch Mott MacDonald

A report developed by the Green Economy Program at the University of California, also evaluated California's options for wind energy ports:

> California has several options for siting a supply chain, but all are complicated by the fact that under current floating wind technologies, the final assembly must be done in protected waters at a port, then towed directly out to the final operations site. Because offshore turbines by the mid-2020s could be at least 700 feet high, no bridges can stand in the way. One option is for different sites to be used for manufacturing, then final assembly at a separate location.
>
> Ideally, however, one site would be used for integrated manufacturing and assembly, as with major European offshore wind hubs such as Cuxhaven in Germany and Grimsby in northern England. California's only viable site for manufacturing as well as assembly is the Port of Humboldt Bay, which has vast expanses of vacant industrial land but would need upgrading of its dock and transportation infrastructure.[117]

[117] Green Economy Program, *High Road for Deep Water.*

Because offshore wind energy production does not currently occur in the Humboldt Bay region, the scale and timing of development is uncertain at this time. As a result, the potential acreage that may be required in Humboldt Bay varies across a wide range.

According to discussions with Redwood Coast Energy Authority (RCEA) and its contractor Principle Power, a marine terminal designed for final assembly of wind turbines should be approximately 20 acres.[118] For this analysis, the amount of land required in the future is assumed to range from a low of 0 acres (i.e. the activity does not occur in Humboldt Bay) to 20 acres. (See Table 4-13).

A facility for assembling the floating hulls as well as final assembly would be substantially larger, ranging from 50 to 100 acres. It would not be necessary for the entire facility to be located on the water as long as there was adequate access to the water.[119] For this analysis, the amount of land required in the future for hull and turbine assembly is assumed to range from a low of 0 acres (i.e. the activity does not occur in Humboldt Bay) to a high of 100 acres.

If Humboldt Bay were to become the center of West Coast offshore wind energy, long-term demand could be as much as 300 acres, if all activities of the supply chain were to locate in the area. The 300 acres would not necessarily have to be contiguous, and would also not all need to be CDI property. It is also possible that portions of the work (fabrication of components, for example) could be performed at other water-served areas (such as the San Francisco Bay area) and then shipped to Humboldt Bay for assembly. For this analysis, the amount of land required in the future if all component production and assembly were to occur in Humboldt Bay is assumed to range from a low of 0 acres (i.e. the activity does not occur in Humboldt Bay) to a high of 300 acres.

Table 4-13: Current CDI Use and Future Demand, Offshore Energy

Land Use	Current Acres	Future Acres Low	Future Acres High	Change in Acres Low	Change in Acres High
Turbine assembly	0	0	20	0	20
Hull and turbine assembly	0	0	100	0	100
All component production and assembly	0	0	300	0	300

Source: BST Associates

[118] Principle Power and Redwood Coast Energy Authority, interview with the authors, April 25, 2018.

[119] Principle Power and Redwood Coast Energy Authority, interview with the authors, April 25, 2018.

5 COMPARISON OF SUPPLY AND DEMAND

Current demand for CDI land in Humboldt Bay is estimated to be 121 acres. Future demand for CDI is projected to range from 120 to 492 acres. The largest source of uncertainty is the offshore energy sector, for which demand may range from zero acres (i.e. the activity does not occur on Humboldt Bay) to 300 acres. (See Table 5-1).

Total existing supply is 1,100 acres. The current surplus of CDI land is 979 acres, while future surplus may range from a high of 980 acres to a low of 608 acres.

Sea level rise may impact a substantial portion of the supply of CDI land. Under the high estimate of sea level rise, the amount of CDI land lost may grow from 79 acres in 2030 to 400 acres in 2100. Under the high estimates of demand for CDI land and loss of CDI land due to sea level rise, the surplus of CDI land exceeds 200 acres; under lower levels of demand and/or land loss the surplus of CDI land increases.

Table 5-1: Summary of Current CDI Use, Future Demand, and Supply

		Current	Future Acres		Change in Acres		
Use Category/ Land Use		Acres	Low	High	Low	High	Notes
Marine Cargo							
	Logs	11	11	15	0	4	
	Other General	0	0	25	0	25	Single multi-use terminal may accommodate other general cargo, marine highway, and containers
	Vehicles	0	0	0	0	0	
	Containers	0	0	0	0	0	
	Marine Highway	0	0	0	0	0	
	Aggregates	0	8	12	8	12	
	Woodchips	36	20	36	-16	0	Potentially accommodated with one terminal
	Grain & Oilseeds	0	0	0	0	0	
	Other Dry Bulks	0	0	0	0	0	
	Liquid Bulks	4	4	4	0	0	
	Cruise ships	3	3	3	0	0	
	Sub-Total	54	46	95	-8	41	
Fishing & Recreational Boating							
	Moorage	46	46	46	0	0	
	Processing	5	5	5	0	0	
	Cold Storage	0	3	3	3	3	
	Gear Storage	0	1	1	1	1	
	Vessel Repair	9	9	12	0	3	
	Sub-Total	60	64	67	4	7	
Other Uses							
	Mariculture	7	10	20	3	13	
	Marine Research	0	0	10	0	10	
	Offshore Energy	0	0	300	0	300	Large range of uncertainty
	Sub-Total	7	10	330	3	323	
Total		121	120	492	-1	371	
Existing Supply							
Land		1,100	1,100	1,100			
Surplus							
Current		979	980	608			

Source: BST Associates

5.1 Multi-purpose dock

Based on projected demand, a single marine terminal may be able to handle a large share of future cargo volumes on Humboldt Bay. The design characteristics of this terminal depend on whether or not it would be used by the wind energy sector. The primary difference between a general-purpose terminal and one for wind equipment is the loading capacity of the dock and other areas where lift equipment carries heavy loads.

BST Associates estimated the need for additional marine terminal space could be as high as 41 acres. This could likely be accommodated at a general-purpose terminal capable of handling multiple cargo types (e.g. wood chips, aggregates, logs, etc.). One example of an existing general-purpose terminal is the Bellingham Shipping Terminal in Bellingham, Washington. This terminal handles breakbulk and bulk cargos, offers 1,250 feet of dock space, with approximately 85,000 square feet of covered storage and 35 acres of available uplands. Water depth in the shipping channel is 35 feet.

The most likely location for a terminal of 41 acres is the Samoa Peninsula. This conclusion is based on the location of the navigation channel and the size of existing parcels. The navigation channel is authorized to a depth of 38 feet MLLW to the Samoa Peninsula and to the Eureka waterfront. The Samoa Peninsula has a number of CDI properties that are 41 acres or larger, but the largest CDI properties in Eureka are 24 acres or less. Fields Landing has two properties large enough to accommodate such a terminal but the authorized channel depth of 26 feet is not sufficient for most ships.

Figure 1: Bellingham Shipping Terminal

5.2 Offshore Wind Dock

According to discussions with Redwood Coast Energy Authority (RCEA) and its contractor Principle Power, a marine terminal designed for assembling wind power equipment should be a minimum of 20 acres, with a dock length of 250-meters (820 feet) and designed for wheel loadings of 4,000 lb/sq ft. Some additional land behind the terminal for storage is also recommended. A new terminal in Massachusetts, the New Bedford Marine Commerce Terminal, provides a good example. This terminal offers 1,200 linear feet of bulkhead, including 800 feet of deep-draft berthing and 400 feet of barge berthing space, 29-foot controlling depth in the New Bedford Harbor (MLLW), and 26 acres of terminal storage.

Figure 2: New Bedford Marine Commerce Terminal

A facility for assembling the floating hulls would be substantially larger, ranging from 50 to 100 acres. It is not necessary for the entire property to be located on the water as long as there is adequate access to the water.

According to a representative of Principle Power, if Humboldt Bay were to become the center of West Coast offshore wind energy, long-term demand may be as much as 300 acres, if all activities of the supply chain were to locate in the area. The 300 acres would not necessarily have to be contiguous, and would also not all need to be CDI property. It is also possible that portions of the work (fabrication of components, for example) could be performed at other water-served areas, such as the San Francisco Bay area.

An example of a port where all facets of the wind energy supply chain are co-located is Esbjerg, Denmark. Esbjerg is a major center for offshore oil production as well as offshore wind energy, and is home to many manufacturers that serve both industries. The wind energy terminal in Esbjerg is approximately 300 acres, with water depth of 30 feet.

Figure 3: Esbjerg Wind Energy Terminal

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