US Army Corps of Engineers
-Alaska District

Appendix D: Economics

Unalaska (Dutch Harbor) Channels

Unalaska, Alaska

February 1, 2019

Iliuliak Bay

Navigation Improvements

Appendix D: Economics

Unalaska, Alaska

February 5, 2019

US Army Corps of Engineers
Alaska District

CONTENTS

1. OVERVIEW

Figure 1 *Shipping Traffic in Unalaska - Dutch Harbor, Courtesy: City of Unalaska*

1.1 Introduction

The purpose of this economic analysis is to evaluate whether the proposed improvements at Iliuliak Bay, Unalaska - Dutch Harbor, are economically justified. This analysis is conducted from a National Economic Development (NED) perspective, where NED benefits are defined as the decrease in transportation costs to shippers by constructing the project. NED costs are defined as the total economic costs of constructing and maintaining the project. The average annual economic benefits of the project are compared to the average annual economic costs to provide an estimated benefit-cost ratio. A project with a benefit-cost ratio greater than 1.0 is considered economically justified. Guidance is contained in U.S. Army Corps of Engineers (USACE) Engineering Regulation (ER) 1105-2-100, as well as recent Economic Guidance Memoranda (EGM's) issued by Headquarters USACE (HQUSACE).

1.2 Project Description

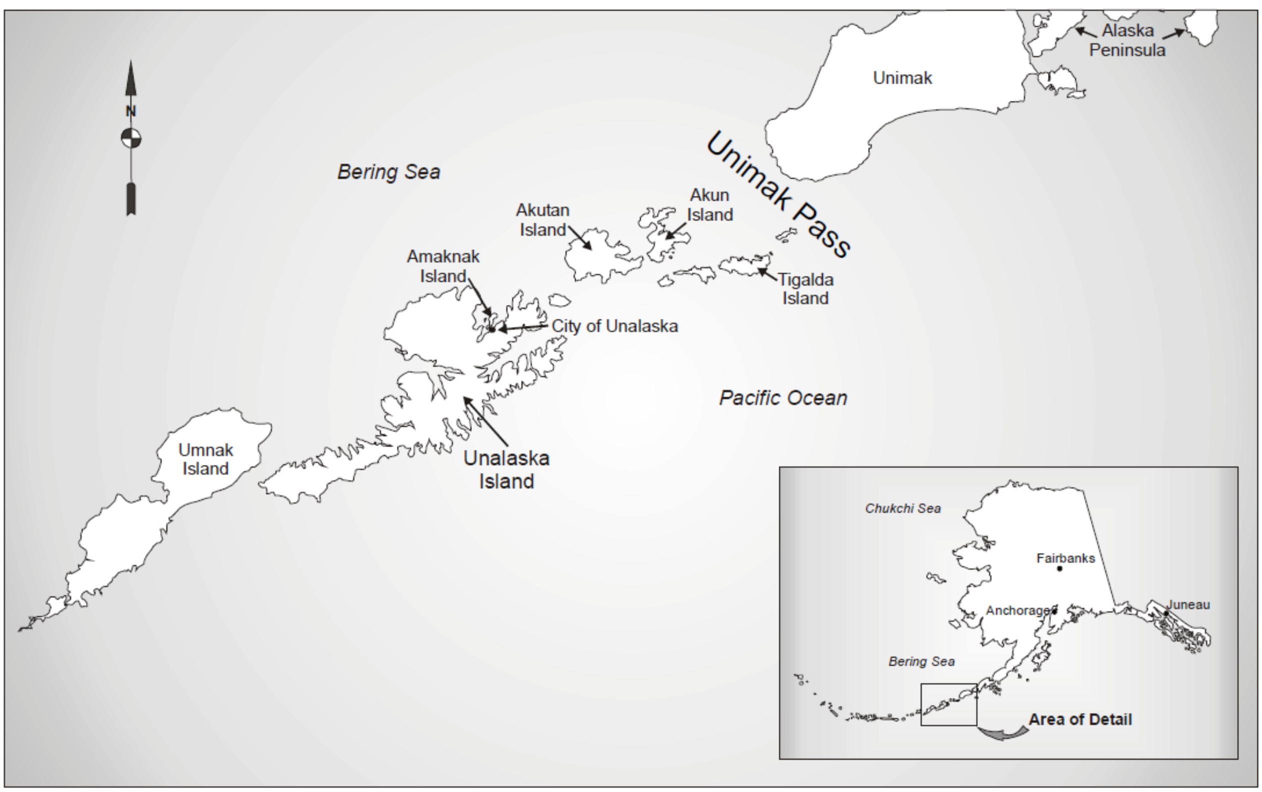
First, a point of clarification for those unfamiliar with the region: Is it Unalaska or Dutch Harbor?

> "The island and the town are both named Unalaska. There is a body of water called Dutch Harbor and many people refer to the town as Dutch Harbor or simply Dutch. Technically, there is no town named Dutch Harbor on Unalaska Island. But, there are good reasons for the confusion. Shipping companies and the FAA call it Dutch Harbor. If you fly here on a commercial airline, you book a ticket to Dutch Harbor (DUT), not Unalaska. The town is on the coasts of both Unalaska and Amaknak Islands, connected by a bridge

called ‘the Bridge to the Other Side.’ Many people erroneously believe that the town on the Unalaska Island side of the bridge is “Unalaska” and the town on the Amaknak Island side of the bridge is ‘Dutch Harbor’. This belief is enhanced by the existence of two U.S. Postal Service offices. The post office on Unalaska Island is Unalaska, AK 99685 and the post office on Amaknak Island is Dutch Harbor, AK 99692, even though all of the community and industrial areas on both islands are encompassed by the city limits of the City of Unalaska. So, it's really "Unalaska" but there are many who will always say ‘Dutch Harbor’ (City of Unalaska Public website, www.ci.unalaska.ak.us).

The port of Dutch Harbor is located on Amaknak Island in the Aleutian Island chain, 763 nautical miles (nm) from Anchorage. The port is the operations center for commercial fishing in the Bering Sea and Aleutian Islands, servicing the large fishing fleet for groundfish and crab. It also serves as the major transshipment point for the Western Aleutian chain. For more than 40 years, Unalaska’s economy has been based on commercial fishing, seafood processing, fleet services, and marine transportation. It has the western-most container terminal in the United States and provides ground and warehouse storage and transshipment opportunities for thousands of vessels that fish in the region including large commercial vessels. The port is located 50 miles off the Great Circle Route through the Pacific Ocean to Asia. This route passes through Unimak Pass located just to the east of Dutch Harbor (Figure 2).

Figure 2 *Vicinity Map, Unalaska, Alaska*



The natural depth of the port of Dutch Harbor is more than 75 feet mean lower low water (MLLW). However, a bar located at the entrance to Iliuliuk Bay currently limits access to the port. Based on the most recent NOAA bathymetry, the depth at the bar is 42 feet MLLW. This depth prevents the existing deep draft vessel fleet from passing over the bar at their designed draft, resulting in light loading practices. Thus, the bar causes inefficiencies in the delivery of imports and exports to and from the port.

2. MARINE RESOURCES

2.1 Introduction

The level of economic activity in Unalaska-Dutch Harbor has been closely linked to the Bering Sea and Aleutian Islands fishing industry since the early 1960's. The early development of Dutch Harbor as a commercial fishing port began with the United States development of the king crab fishery. The first participants in the Bering Sea king crab fishery were Japanese fishermen, who began to fish the eastern Bering Sea in 1930 and continued in the years 1932 through 1939. This fishery was discontinued by World War II. In 1947, U.S. fishermen began to fish king crab in the Bering Sea, but after the Japanese returned to the area in 1953, United States efforts ceased until 1963.

Beginning in 1959, Japanese success in fishing king crab in the Bering Sea had attracted fishermen from Russia. The United States began a series of bilateral treaty agreements in 1964 to reduce foreign harvests of king crab and other species in the Bering Sea. The bilateral agreements continued through the 1975-76 treaty; however, foreign fishing for king crab in the Bering Sea ended at the end of the 1973-74 treaty. In 1976, the Magnuson-Stevens Fisheries Conservation and Management Act of 1976 (MSA) was passed, which provided the United States with regulatory measures to control fisheries resources within the fisheries conservation zone (FCZ), also known as the 200-mile limit. Through management provisions of the MSA, all foreign fishing in the Bering Sea was phased out by 1988.

With the reduction and phase-out of foreign fishing effort in the Bering Sea, the United States king crab fishery developed quickly from a harvest of less than 450 metric tons (mt) in 1976 to over 34,920 mt in 1977. Unalaska-Dutch Harbor was a central part of the development of this fishery, which fueled the development and expansion of processing facilities in the community, as well as support facilities and services to support the increasing level of fishing activity. The growth of Dutch Harbor as one of the nation's most prominent ports happened very quickly. In 1975, Dutch Harbor was not even included in the list of the 39 largest commercial fishing ports. In 1976, Dutch Harbor was listed second in the nation in terms of value of fisheries produce landed. In 1977, Dutch Harbor gained prominence as the number one port in the nation in value of fish landed, mainly due to the growth of the rich king crab fishery.

From a high year in 1978 with fisheries landings of all fish species valued at $99.7 million, landings steadily decreased in value for several years. By 1984, fishery landings in Dutch Harbor totaled a mere $20.3 million. That year was the low point in the cycle and in 1985 fishery landings in Dutch Harbor began to increase again. By 1988, landings reached $100 million for the first time, and in 1992, the port regained its number one ranking in the nation, where it remains today. The 2015 commercial fishery landings were an all-time record of $218 million.[1] Part of the upward cycle was due to recovering crab stocks, as described below, and also to the developing groundfish fisheries in the Bering Sea.

Prior to 1980, almost all groundfish fishing in the Bering Sea was by foreign fleets. The Japanese began fishing pollock in the Bering Sea in the early 1960's and quickly developed a fishery that produced up to 1.9 million mt by 1972. The foreign harvest was reduced through bilateral treaty and then regulated by the MSA, similar to the shellfish fishery. In 1980, the first joint venture fisheries began to develop. Joint ventures were conceived as a bridge measure to increase the U.S. participation in the groundfish fisheries. Foreign factory processing ships received and processed groundfish caught by United States catcher boats. The development of the joint ventures was quick and spectacular. In just a few years, they grew to totally phase out foreign fishing. As United States fishermen gained expertise in the groundfish fishery, domestically-owned shore-based and at-sea processing facilities were developed. By 1991, joint ventures were phased out, and the groundfish was taken entirely by United States fishermen and processors.

Unalaska - Dutch Harbor was uniquely situated to become the center of much of the groundfish harvesting and processing activities through the joint-venture phase and assumed the major role in the domestic shore-based and factory-ship groundfish activities. Two major new shore plants were constructed in the late 1980's, and a third was completed in 1991 to process groundfish into surimi and other products, as well as process crab and other species. The demands of the factory ship groundfish fleet also fueled a rapid expansion of service facilities in Unalaska.

The one constant aspect of Bering Sea fishing industry is change. As one species declines in abundance, the commercial fishing effort is shifted to other species. Other changes occur as a result of new technology, shifts in markets or new regulatory regimes. In recent years, Unalaska - Dutch Harbor has developed into a regional center for transport of processed seafood products. Where processed fisheries products from areas such as Kodiak used to be shipped by barge to the Seattle area then transshipped to markets in Japan and other areas, they are now collected by barge and shipped through Dutch Harbor.

The following sections provide a brief review of the status of the fisheries resources upon which the continuing fishing economy of Unalaska-Dutch Harbor is based. They also discuss some of the regulatory changes that have occurred as they relate to long-term stability in Unalaska-Dutch Harbor.

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[1] *Fisheries of the United States,* NMFS, 2015.

2.2 Groundfish Resources in the Bering Sea

The National Marine Fisheries Service (NMFS) is responsible for overseeing and managing the groundfish fisheries around Unalaska via the North Pacific Fishery Management Council (NPFMC). For those purposes, the Bering Sea and Aleutian Islands fall into the Bering Sea and Aleutian Islands Subareas, which will be referred to collectively as BSAI.

The initial target species in the BSAI commercial fisheries was yellowfin sole. During the 1950's and 1960's, total catches of groundfish peaked at 674,000 mt in 1961. Following a decline in abundance of yellowfin sole, other species (principally walleye pollock) were targeted, and total catches peaked at 2.2 million mt in 1972. Pollock is now the principal fishery, with catches peaking at approximately 1.4-1.5 million mt in 2005-2006 due to years of high recruitment. After the MSA was adopted in 1976, catch restrictions and other management measures were placed on the fishery, and total groundfish catches have since varied from 1 to 2 million mt. In 2005, Congress implemented a statutory cap on total allowable catches (TACs) for BSAI groundfish of 2 million mt, which had previously been a policy adopted by the NPFMC. Total groundfish catches generally are well below the 2 million mt optimal yield (OY) cap. Total catches since 1954 for the BSAI are shown in Table 1 and Chart 1. Total BSAI catches were 81 percent of the cap in 2010; rose to 92 percent in 2011 and 2012; and were 96 percent in 2013, 2014, and 2015[2].

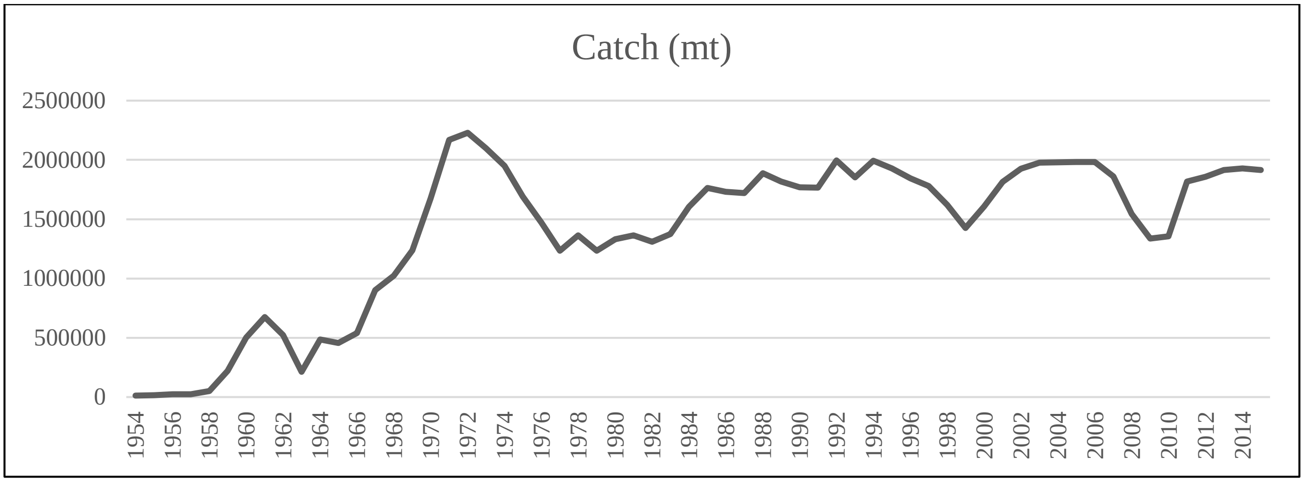
Table 1 *Groundfish Catches (mt) in the BSAI, 1954-2015*

Year	Catch (mt)	Year	Catch (mt)	Year	Catch (mt)	Year	Catch (mt)	Year	Catch (mt)
1954	12562	1968	1023106	1982	1309716	1996	1844578	2010	1354662
1955	14690	1969	1236029	1983	1374902	1997	1780878	2011	1817774
1956	24697	1970	1674259	1984	1605321	1998	1620886	2012	1857977
1957	24145	1971	2169444	1985	1762419	1999	1424757	2013	1914585
1958	51401	1972	2228809	1986	1730170	2000	1607850	2014	1928379
1959	221647	1973	2098450	1987	1720482	2001	1815221	2015	1914064
1960	500907	1974	1949432	1988	1887853	2002	1925209		
1961	673717	1975	1691785	1989	1816876	2003	1976485		
1962	525018	1976	1472030	1990	1768995	2004	1979752		
1963	212695	1977	1235492	1991	1765397	2005	1981119		
1964	486543	1978	1363601	1992	1996467	2006	1982564		
1965	456237	1979	1234742	1993	1854065	2007	1860418		
1966	539670	1980	1330475	1994	1994242	2008	1545687		
1967	903089	1981	1363865	1995	1929755	2009	1337116		

Source: NPFMC BSAI SAFE 2016.

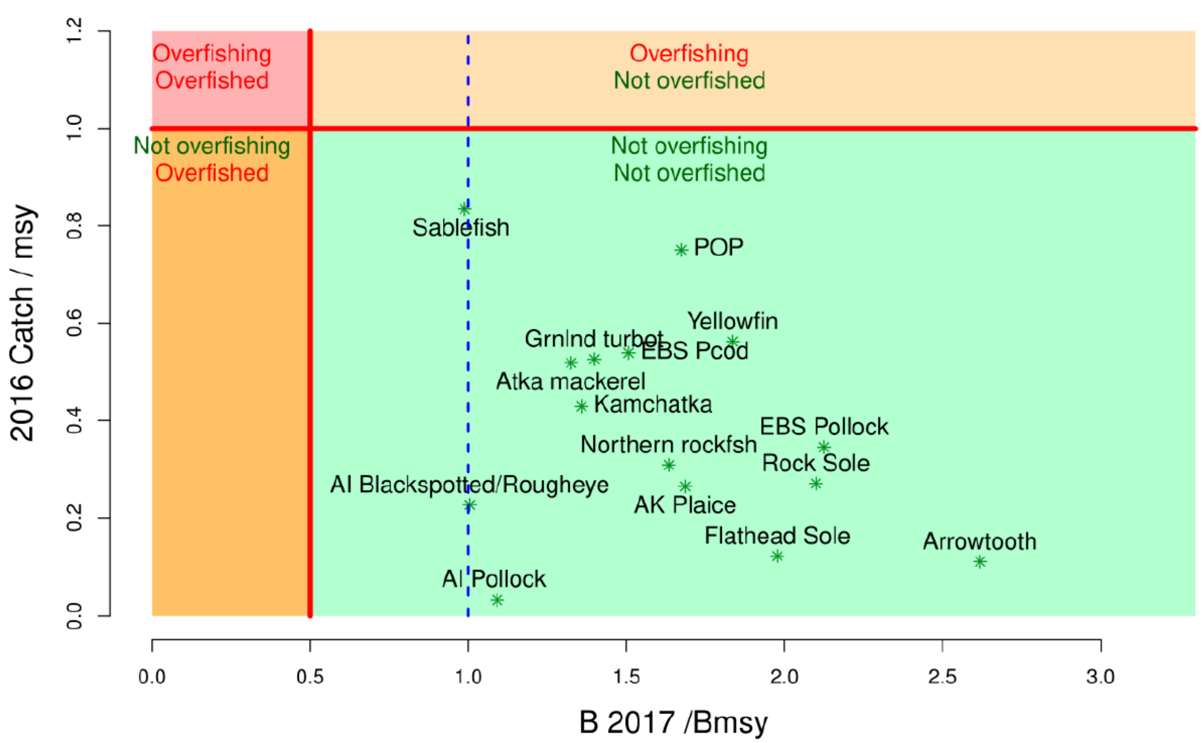
[2] *Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Bering Sea/Aleutian Islands Regions,* NPFMC, November 2016.

Figure 3 Groundfish Catches (mt) in the BSAI, 1954-2015



Maximum sustainable yield (MSY) for BSAI groundfish in 2017 and 2018 was estimated at 1.8-2.4 million mt. The TACs and OY for the groundfish fishery is constrained by the 2.0 million mt cap set by Congress. Because of this cap and their closeness with the biologically derived MSY, the status of the stocks of groundfish continues to appear favorable and stable, according to the NPFMC. Figure 4 below shows whether each species is currently being overfished in relation to its estimated population.

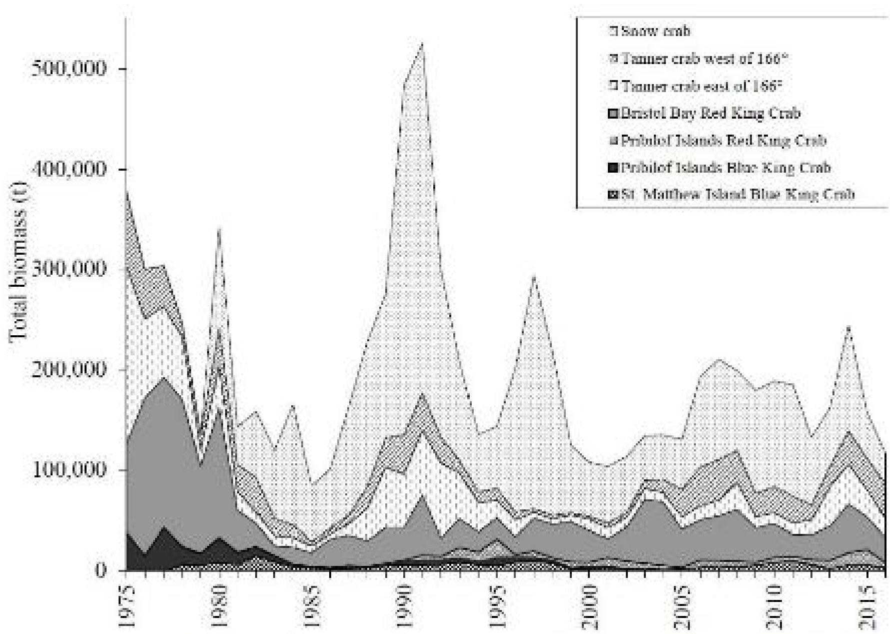
Figure 4 Source: NPFMC BSAI SAFE 2016



2.3 Shellfish Resources in the Bering Sea

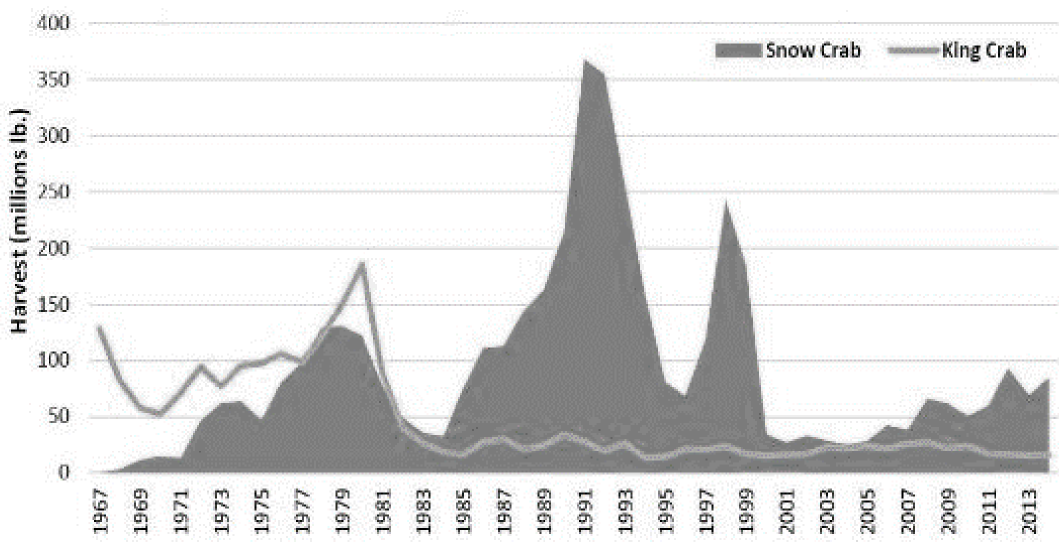
Commercial harvest of Alaska crab was pioneered by Japanese and Russian fleets using tangle nets starting in the 1930's. Domestic harvest began in the late 1940's, and by the early 1960's United States fishermen dominated the fishery. Around the same time, the use of trawl and tangle nets for harvesting crab were outlawed, and only males meeting a size requirement could be retained. With the passing of the 1976 MSA, foreign vessels were prevented from harvesting Alaska crab. The domestic fleet focused mainly on king crab harvest in these early years, with significant harvest of snow crab beginning in the mid-1970's. The snow crab fishery in Alaska increased substantially following the steep reduction in king crab harvest in the early 1980's. As shown in Figure 5, populations of the seven commercial crab stocks have fluctuated dramatically from 1975 to 2016, even after the United States gained management control through passage of the MSA in 1976. Overall commercial crab stock surveys decreased from approximately 300,000 mt in 1975, to below 100,000 mt in the mid-1980's. Levels then increased to just below 500,000 mt in the early 1990's due to increases in snow and Tanner crab populations. Between 2005 and 2015, the population leveled out around 200,000 mt, but dropped to approximately 100,000 mt in 2016.

Figure 5 *Source: The 2016 EBS Bottom Trawl Survey: Results for Commercial Crab Species, NMFS-AFSC, 2016*



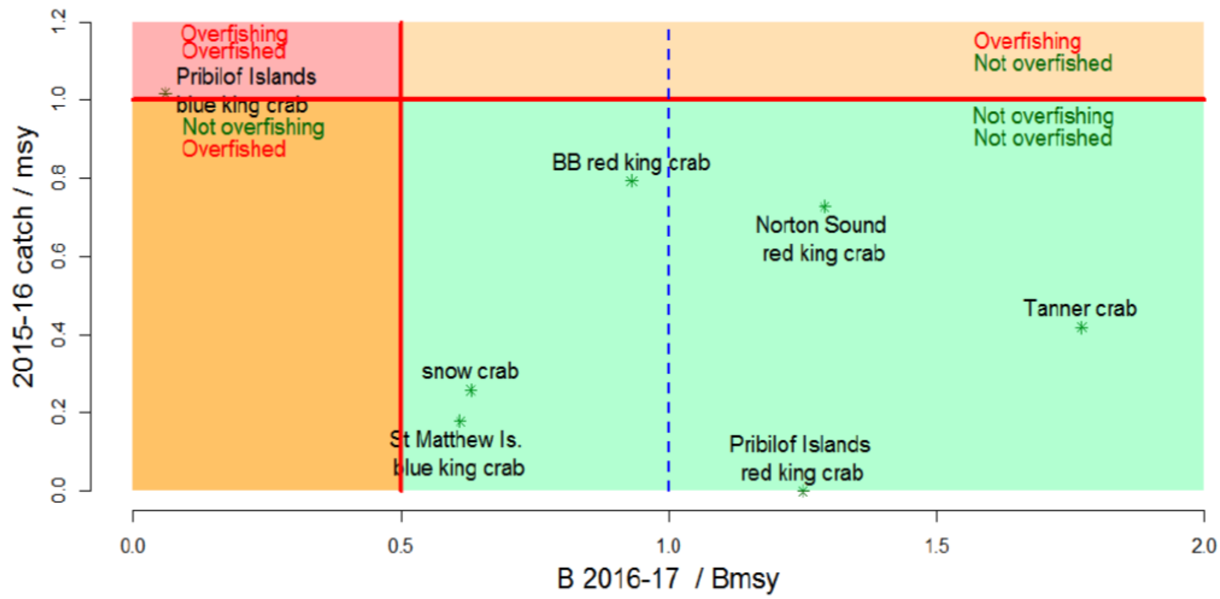
Landings (mainly in the Bering Sea) also grew steadily through the 1980's before peaking in 1991 with a record harvest of more than 368 million pounds, mirroring the total surveyed crab populations. Following this peak, volume fluctuated, climbing to approximately 243 million pounds before trending down to a low of 25 million in 2004. The NPFMC manages crab fisheries as well, and sets TACs and OYs to ensure their stability and sustainability, explaining the mirroring trends in surveys and landings. Since that time, harvests have trended upward, recovering to more than 93 million pounds in 2012 (Figure 6).

Figure 6 *Source: Alaska Groundfish and Crab Wholesale Market Profiles, NOAA/NMFS, May 2016.*



As of 2015, all BSAI crab fisheries currently open are landing over 98 percent of their TAC. Because of the NPFMC's TACs and their closeness with the biologically derived MSY, the status of the stocks of crab continues to appear low, but stable, according to the NPFMC. Figure 7 below shows whether each species is currently being overfished in relation to its estimated population.

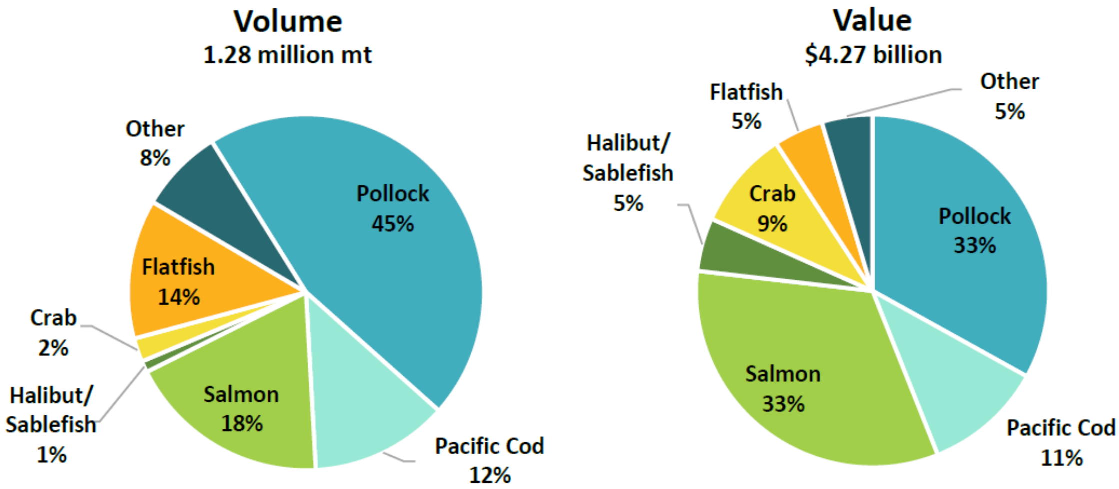
Figure 7 Source: NPFMC BSAI Crab SAFE 2016



2.4 Summary and Outlook

Most economic activity in Unalaska-Dutch Harbor can be attributed to some aspect of the fishing industry. The fishery resource data reviewed in the preceding sections show that resource fluctuations regularly occur. Much of the resource upon which the BSAI industry depends is in high levels of abundance. Pollock make up a large share of the groundfish resource and is in a stable and increasing trend in most areas. The crab fisheries throughout the BSAI are still at relatively depressed levels, but the numbers are stable over the last 10 to 15 years. Also, crab harvests only made up a small portion of the total seafood harvest by volume or by value in dollars, as shown in Figure 8.

Figure 8 *Composition of Total First Wholesale Volume and Value for Alaska Seafood, by Species, 2014. Source: Alaska Groundfish and Crab Wholesale Market Profiles, NOAA/NMFS, May 2016.*



Fisheries activities in Unalaska-Dutch Harbor will continue to fluctuate as resource abundance varies, regulations change or technical breakthroughs are made. However, Unalaska-Dutch Harbor is much more diversified in its overall economic structure than it was in the early 1980's. There are no new frontiers in the Bering Sea fisheries in the form of underdeveloped fisheries. Growth in one area results in a shifting of economic activity, not necessarily an overall increase.

3. SOCIOECONOMICS

3.1 Demographic Profiles

The City of Unalaska is located in the Aleutian Island chain in the southwestern portion of the state of Alaska. Table 2 provides population data for the United States, Alaska, and Unalaska City over the last 20 years for which data is available.

Table 1 *Unalaska City Geographical Area – Total Population Data, Source: 2000 Census, 2010 Census, 2016 Population Estimate; Census Bureau*

Area	% Change ’00-‘16	2016	2010	2000
United States	14.8%	323,127,513	308,745,105	281,421,906
Alaska	18.3%	741,894	710,231	626,932
City of Unalaska	3.5%	4,437	4,376	4,283

An estimated 4,437 residents lived in the City of Unalaska in 2016. This represents a population increase of 1.3 percent since 2010 and an increase of 3.5 percent since 2000. It should also be noted that Unalaska has many transient workers who are not counted by the U.S. Census. During the peak processing season (January – March) the number of transient workers increases the community population to nearly 10,000 people.[3]

The residents of Unalaska are racially and ethnically diverse. Based on 2015 census estimates, 48.3 percent of residents are Asian, and 11.4 percent are Hispanic or Latino. In the state of Alaska, 19.3 percent of the population is American Indian or Alaskan Native, while Asian/Pacific Islanders or other races amounted to 9.5 percent. Table 3 displays racial demographics for the Nation, State, and the City of Unalaska.

***Table 2** Population by Race, Source: 2011-2015 American Community Survey 5-Year Estimates, Census Bureau*

	City of Unalaska	Alaska	United States
Total	4,619	733,375	316,515,021
White alone	37.2%	73.4%	76.9%
Black or African American alone	5.9%	5.2%	13.3%
American Indian and Alaska Native alone	5.8%	19.3%	1.3%
Asian alone	48.3%	7.7%	5.7%
Native Hawaiian and Other Pacific Islander alone	2.9%	1.7%	0.2%
Two or more races	6.3%	8.4%	2.6%
Hispanic or Latino	11.4%	6.5%	17.8%
White alone, not Hispanic or Latino	28.7%	62.4%	61.3%

In 2015, approximately 83 percent of the Unalaska population was 16 years old and older. Of that population, 85.7 percent was in the labor force. According to the Census Bureau's *2011-2015 American Community Survey 5-Year Estimates*, the unemployment rate for the city was 1.7 percent, significantly lower than both the State of Alaska at 8.2 percent, and the United States at 8.3 percent. Table 3 lists occupational data for the study area.

[3] *Unalaska Comprehensive Plan 2020,* City of Unalaska Planning Department, February 2011.

Table 3 Civilian Labor Force by Occupation, Source: 2011-2015 American Community Survey 5-Year Estimates, Census Bureau

	City of Unalaska	Alaska	United States
Civilian employed population 16 years old and older	3,211	351,108	145,747,779
OCCUPATION			
Management, business, science, and arts occupations	466 / 14.5%	127,175 / 36.2%	53,433,469 / 36.6%
Service occupations	285 / 8.8%	61,419 / 17.4%	26,446,906 / 18.1%
Sales and office occupations	547 / 17.0%	79,623 / 22.7%	35,098,693 / 24.0%
Natural resources, construction, and maintenance occupations	434 / 13.5%	43,943 / 12.5%	13,038,579 / 8.9%
Production, transportation, and material moving occupations	1,479 / 46.1%	38,948 / 11.0%	17,730,132 / 12.1%

In 2015, the median household income of Unalaska was $90,500, significantly higher than the State of Alaska median income of $72,515, and the national median income of $53,889. The mean household income was $102,716. Table 5 shows the number of households in the City of Unalaska, Alaska, and the United States and the percentage of each by their respective incomes.

Table 4 Family Income, Source: 2011-2015 American Community Survey 5-Year Estimates, Census Bureau

	City of Unalaska	Alaska	United States
Total Households	874	250,969	116,926,305
Less than $10,000	2.1%	3.8%	7.2%
$10,000 to $14,999	2.6%	3.4%	5.3%
$15,000 to $24,999	2.6%	7.4%	10.6%
$25,000 to $34,999	5.7%	7.2%	10.1%
$35,000 to $49,999	10.1%	11.7%	13.4%
$50,000 to $74,999	13.5%	18.3%	17.8%
$75,000 to $99,999	21.4%	14.9%	12.1%
$100,000 to $149,999	20.4%	18.9%	13.1%
$150,000 to $199,999	13.0%	8.3%	5.1%

$200,000 or more	8.6%	6.1%	5.3%

3.2 Port of Dutch Harbor

Being the operations center for the Bering Sea commercial fishing fleet, there are multiple docks around Dutch Harbor that provide general moorage and other services to the fishing fleet. However, there only are three major terminals serving deep draft ships (Figure 8). Those are the focus of this economic analysis since only those docks handle vessels large enough to benefit from a deeper bar crossing.

Figure 9 *Deep Draft Docks in Dutch Harbor*

3.2.1 Facilities

Figure 10 *APL Dock looking south*

The APL dock faces southeast on Iliuliuk Bay and provides containerized cargo and fueling services to line haul vessels en route from the United States West Coast to Asia. The facility is owned and operated by APL, Ltd. The dock has one 40-ton, Post-Panamax-capable container crane. The dock's open storage area has capacity for approximately 1,000 containers stacked four high, with up to 420 outlets for refrigerated cargo. One 8-inch fuel-oil pipeline extends from the dock to storage tanks for onload/offload. It has one, 1050-foot berth that is currently 45 feet MLLW. Per the Alaska Marine Pilots, the largest vessel allowed at that dock is 965 feet long and 44 feet deep. Discussions with the Dutch Harbor Terminal Manager and the APL corporate office in Seattle during this study confirmed that there are currently no plans to expand or deepen the dock.

__Figure 11__ Unalaska Marine Center (UMC) and USCG Dock

The Unalaska Marine Center (UMC) and the USCG Dock consists of approximately 2,051 linear feet of dock face. The UMC offers cargo, passenger, and other port services. The marine terminal is owned by the City of Unalaska. Matson Lines operates both a 30-ton and a 40-ton crane and rail system for containerized cargo servicing their fleet of container ships on a Tacoma-Kodiak-Anchorage rotation. Maersk Services also has an agreement to use the dock and presently serves line haul ships from the west coast to Asia, as well as feeder ships and barges operated by others but providing service to Maersk. A second berth at UMC is used for loading and unloading fish and petroleum products transferred to and from nearby storage tanks. North Pacific Fuel operates fueling facilities, including their 6-inch fuel-oil pipeline, which extends from the dock to the storage tanks. The open storage area at the UMC has a capacity of 1,500 containers, including 467 positions for refrigerated cargo. Depths at MLLW alongside the berthing area vary from 32 feet to 45 feet. According to the Alaska Marine Pilots, the largest vessel allowed at the UMC is 1000 feet long and 39 feet deep.

The city have capital improvement plans to both lengthen and dredge the docks at the UMC. The proposed lengthening project would replace sections of dock between the UMC and the USCG station (where the passenger ship is docked in Figure 11 above). They will also extend the rails used by the container cranes to cover this area. This will provide an additional 220 feet to the 1000-foot capacity used by the pilots. Based on the city's FY2017-FY2021 Capital and Major Maintenance Plan (CMMP), engineering and design began in 2014 and was completed in FY2017. Construction was budgeted for completion in FY2018. As of October 2018, construction was still ongoing. Completion is scheduled for spring 2019.

Their proposed dredging project will create a constant 45 feet MLLW depth across the entire dock. According to the city, “The existing sheet pile is driven to approximately 58 feet and dredging to 45 feet will not undermine the existing sheet pile. This project is primarily to accommodate large class vessels. Many of the vessels currently calling the Port must adjust ballast to cross the entrance channel and dock inside Dutch Harbor,” (City of Unalaska FY17-21 CMMP, Approved March 16, 2016). Based on the City’s CMMP, funds have already been spent for preliminary designs of the work. By comparison, the dredging costs are approximately 5 percent of the costs of the completed dock expansion project. This dredging project is contingent on USACE completing a dredging project at the bar. Otherwise, dredging the dock is unnecessary, since vessels will still be limited by draft by the bar.

The Delta Western Fuel dock is the final deep draft dock that is used in this analysis. It is on the southerly shore of Dutch Harbor and provides shipment and receipt of petroleum products from larger vessels as well as fueling services for smaller vessels. It is currently owned and operated by Delta Western, Inc. One 12-inch, three 8-inch, and three 6-inch pipelines extend from the dock to 14 steel storage tanks at the rear of their facility. Those tanks have a capacity of 187,650 barrels (10,331,000 gallons). The dock also has another 8-inch fuel oil delivery line for fueling vessels. Depths at the dock range from 12 feet to 50 feet MLLW. According to the Alaska Marine Pilots, the largest ship allowed at the Delta Western dock is 600 feet long and 30 feet deep. There are currently no plans to expand or deepen the dock.

Below is a table displaying the current dimensions of the relevant docks. There are currently only two locations in Dutch Harbor where vessels are constrained by draft: the bar and the dock. The rest of Dutch Harbor is naturally at depths of 75-100 feet MLLW. It’s important to note that all three docks would benefit from a deeper bar. All three docks would be able to utilize their full depth, where it cannot with a combination of the 42-foot bar and prevailing conditions.

Table 5 *Deep Draft Dock Summary*

Dock Name	Length (ft)	Depth (ft)	Notes	Benefits from Deeper Bar (Y/N)
APL	1,050	45	No expansion planned	Y
UMC	2,000	40	3,000 long after expansion in 2019	Y
Delta Western	600	30	No expansion planned	Y

3.3 Purpose and Scope

3.3.1 General Methodology

The basic methodology utilized in the compilation of this report consisted of three steps. First, a review of published information was conducted on the history, present status, future prospects for port operations, and vessel traffic management at Dutch Harbor. Next, local port officials, shippers, and maritime specialists located in Dutch Harbor were interviewed. Finally, selection and description of NED benefits and related construction and life cycle costs were made for the proposed improvement alternatives that appear cost effective and achievable.

NED benefits will be assessed for the measures identified in the Project Alternatives section and follow the methodology for deep draft commercial navigation analysis described in the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies[4] and other relevant Corps of Engineers regulations and policy guidance. Benefits equal the difference between without- and with-project transportation costs. All costs were calculated using Fiscal Year (FY) 2019 (October 2018) price levels and then converted to Average Annual Equivalent (AAEQ) values using the FY 2019 Federal discount rate of 2.875 percent, assuming a 50-year period of analysis. The benefits estimated for each measure were compared to its cost to determine its economic justification. The plan that maximizes net benefits (benefits less cost) is the NED plan. The NED plan is usually the Federal recommended plan, and may or may not be equal to the locally preferred plan.

3.3.2 Problems and Opportunities

The primary problem identified in this analysis relates to the inefficient operation of deep draft vessels, which affect the Nation's international trade transportation costs. The entrance to Iliuliuk Bay limits access to Dutch Harbor, creating economic inefficiencies to the region and Nation.

A number of opportunities were identified in the initial and subsequent steps and iterations of the planning process:

- Lower the transportation costs of commodities
- Provide access for deeper draft vessels
- Reduce vessel delays at the bar
- Reduce the need for lightering fuel and other goods
- Lower the cost of durable goods and fuel consumed by the community
- Increase regional economic activities

[4] https://planning.erdc.dren.mil/toolbox/guidance.cfm?Id=269&Option=Principles and Guidelines

- Increase regional employment opportunities
- Provide for beneficial use of dredged material
- Provide environmental habitat protection and enhancement
- Increase port infrastructure
- Reduce navigation restrictions from storm surge

4. ECONOMIC ANALYSIS

The purpose of this economic analysis is to evaluate a proposal to place a deepened entrance channel at the mouth of Dutch Harbor. Doing so would alleviate inefficiencies currently occurring with deep draft vessels that call on the port. It would reduce delays waiting on favorable tides to enter and exit the harbor. It would also make the current voyages of deeper draft vessels more efficient by allowing them to load closer to their maximum draft. This would likely result in fewer trips overall to Dutch Harbor, resulting in transportation cost savings.

4.1 Existing Condition

The following sections describe the current conditions at the Port of Dutch Harbor.

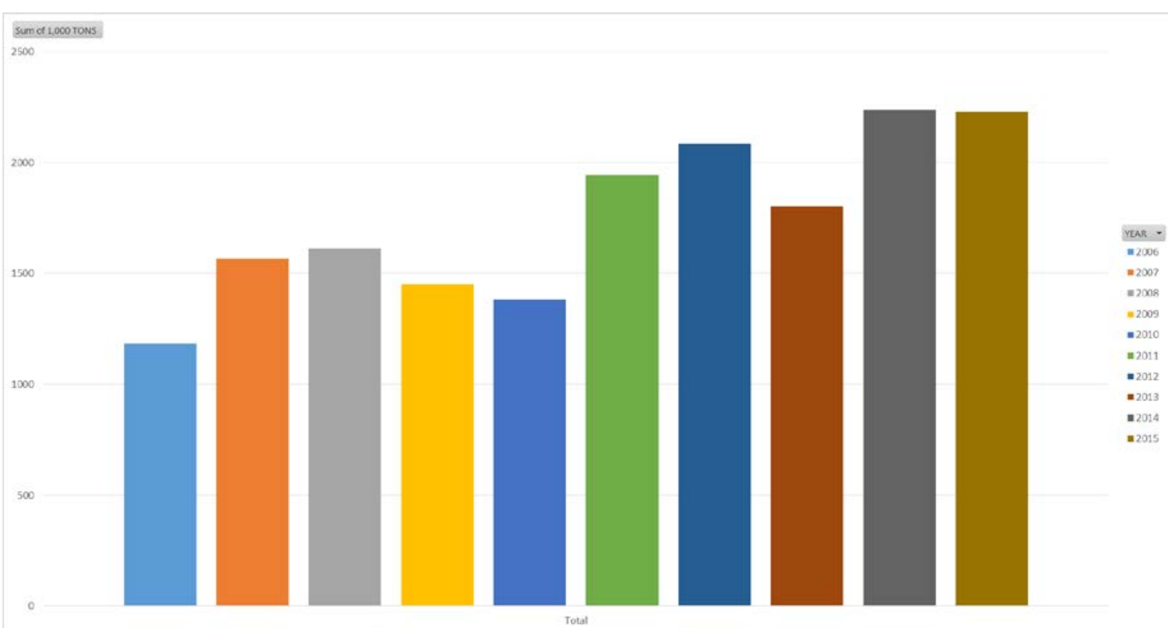
4.1.1 Port Commerce

The Port of Dutch Harbor is the operations center for the commercial fishing fleet in the Bering Sea and also a major transshipment point for the Western Aleutian Island chain. Most economic activity there can be attributed to some aspect of the fishing industry. The table below shows the history of waterborne commerce in the port in recent years. Not surprisingly, the numbers that stand out are ones associated with the fishing industry: Fish, Distillate Fuel Oil, Gasoline, Manufactured Products (repair parts for boats and processing plants).

__Table 6__ Commodity Freight through Unalaska (1,000 short tons), Source: Waterborne Commerce of the United States, 2006-2015

Sum of 1,000 TONS Commodity Name	YEAR 2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Grand Total
Animal Feed, Prep.	4	8	4	6	4	8	8	15	53	69	179
Animals & Prod. NEC	2	0	2	2	1	3	0		12	13	35
Chem. Products NEC	0	0	0	0	3	0	2		10	0	15
Distillate Fuel Oil	226	418	365	228	436	659	800	470	494	495	4591
Electrical Machinery	0	0	0	0	2	0	1	4	2	12	21
Fab. Metal Products	3	6	8	10	12	8	16	14	10	8	95
Fish (Not Shellfish)	518	751	724	595	510	752	788	674	730	784	6826
Fish, Prepared	135	143	178	100	74	126	160	135	223	153	1427
Food Products NEC	1	0	2	0	0	1	0	14	4	4	26
Fuel Wood								6	2	10	18
Gasoline	98	62	104	128	141	157	48	91	134	109	1072
Iron Ore				58							58
Kerosene				1	8		10			22	41
Lumber	0	0	0	0	4	2	2	2	2	10	22
Machinery (Not Elec)	1	2	2	4	7	4	6	6	6	49	87
Manufac. Prod. NEC	99	112	87	98	111	111	112	143	213	270	1356
Manufac. Wood Prod.	0	0	2	1	4	6	4	10	15	9	51
Meat, Prepared	0	1	0	0	0		0	0	1	1	3
Misc. Mineral Prod.	0	0	0	0	2	0	2	0	0	0	4
Naphtha & Solvents		0				0	2	6	12	2	22
Natural Fibers NEC					0	1	1				2
Non-Metal. Min. NEC	2	5	8	6	7	8	10	6	8	8	68
Paper Products NEC	44	8	13	12	9	13	15	15	23	18	170
Petro. Products NEC	0	0	0	0	2	0	22	0	2	0	26
Phosphatic Fert.	4	3	2	4	2	4	6	1			26
Plastics	1	0	0	0	0	0	0	0	0	0	1
Residual Fuel Oil			17	72	4	22					115
Rubber & Plastic Pr.	0	0	0	2	0	1	0	0	3	2	8
Sand & Gravel		0	0	68	9		0	54	0	0	131
Shellfish	10	17	33	28	9	28	48	27	37	43	280
Ships & Boats	0	0	0	0	4	2	0	0	0	0	6
Slag						0	1	1	0		2
Soil & Fill Dirt						12					12
Sugar	0	0	0		0	1	1	1	0		3
Tallow, Animal Oils	5	8	6	11	6	8	11	15	18	20	108
Textile Products	1	1	0	0	0	0	0	0	9	2	13
Unknown or NEC	1	8	4	15	6	1	2	61	185	103	386
Vegetable Oils	0	0					0	24	22	2	48
Vegetables & Prod.	0	0	0	0	0			0	2	2	4
Vehicles & Parts	0	1	0	2	1	0	1	1	0	2	8
Wheat Flour					1	2	1				4
Wood in the Rough	0	13	45	0	0	0	0	0			58
Grand Total	**1155**	**1567**	**1606**	**1451**	**1379**	**1940**	**2080**	**1796**	**2232**	**2222**	**17428**

__Figure 12__ Commodity Freight through Unalaska (1,000 short tons), Source: Waterborne Commerce of the United States, 2006-2015

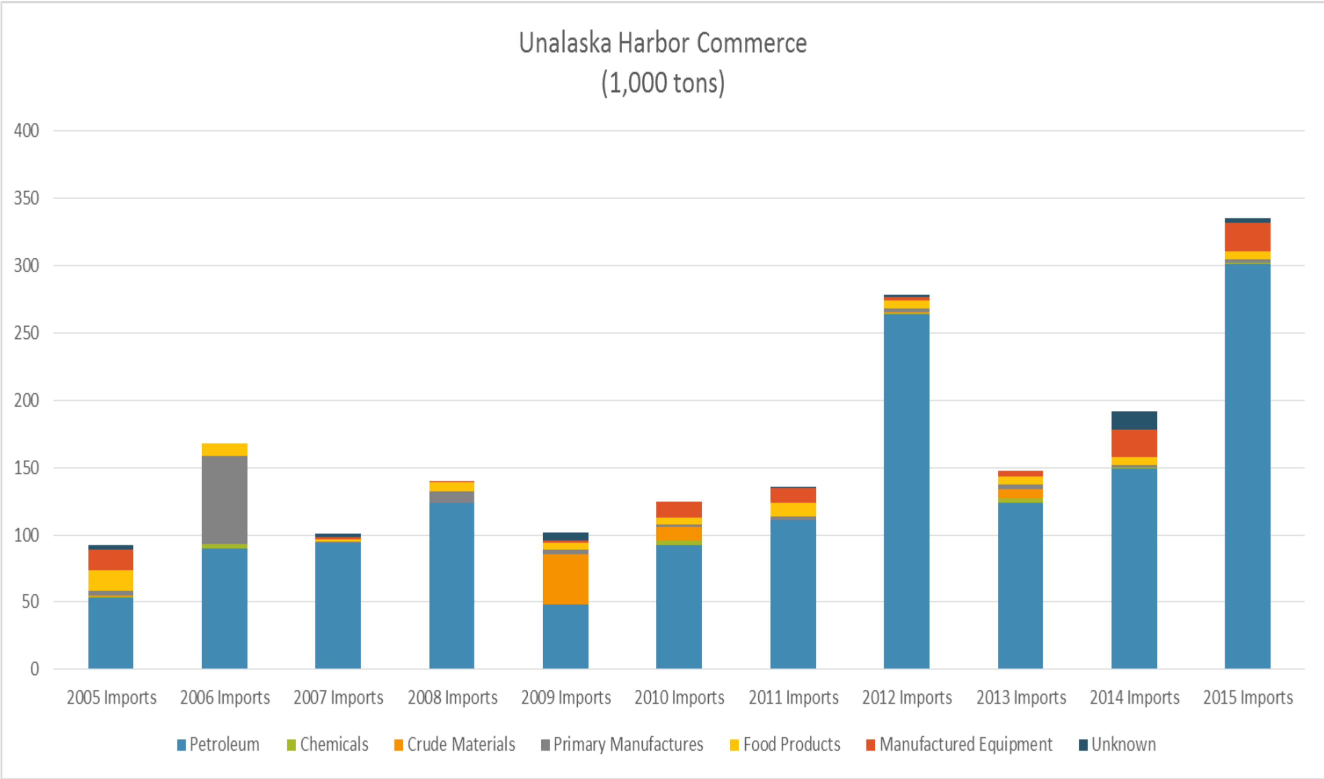


The last 2 years have represented all-time highs in total freight moved through Dutch Harbor. This is mainly due to near-record high levels in fish, shellfish, gasoline, and manufactured products. Since tonnages in these categories have the largest effect on total tonnage through the harbor, the analysis will focus mainly on those commodity categories—both now, and in the future. This correlation can also be seen when the commodity freight is broken down into imports and exports. The table and chart below shows the breakdown of Unalaska imports from 2005-2015.

Table 7 *Unalaska Harbor Import Commodities by Percentage of Total, Source: WCUS.*

	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Share of total imports (%)	**97%**	**99%**	**95%**	**100%**	**94%**	**100%**	**99%**	**99%**	**100%**	**86%**	**99%**
Petroleum	58%	53%	91%	89%	47%	74%	82%	95%	84%	72%	90%
Chemicals	1%	2%	0%	0%	0%	3%	0%	0%	2%	0%	0%
Crude Materials	1%	0%	0%	0%	37%	8%	0%	0%	5%	0%	0%
Primary Manufactures	3%	39%	1%	6%	3%	2%	2%	1%	2%	1%	1%
Food Products	17%	5%	2%	5%	5%	4%	7%	2%	4%	3%	2%
Manufactured Equipment	16%	0%	1%	1%	2%	10%	8%	1%	3%	10%	6%

Figure 13 *Unalaska Harbor Import Commodities by Percentage of Total, Source: WCUS.*

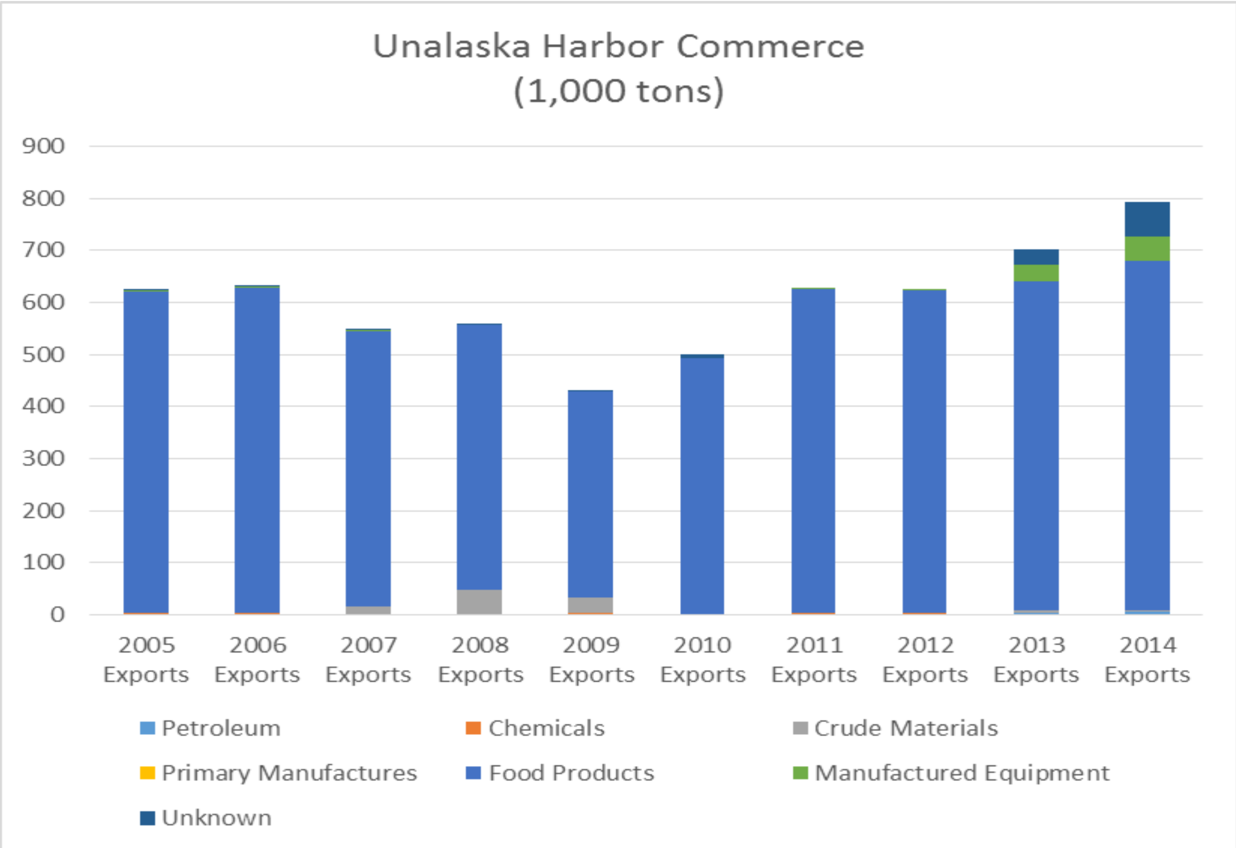


The following table and chart shows the breakdown of exports from 2005-2015. Food products (fish) dominate the movements.

Table 8 *Unalaska Harbor Export Commodities by Percentage of Total, Source: WCUS.*

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Share of total exports (%)	100%	100%	99%	99%	99%	98%	99%	99%	94%	92%
Petroleum	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
Chemicals	1%	1%	0%	0%	1%	0%	0%	0%	0%	0%
Crude Materials	0%	0%	2%	8%	7%	0%	0%	0%	0%	0%
Primary Manufactures	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Food Products	99%	99%	97%	91%	92%	98%	99%	99%	90%	85%
Manufactured Equipment	0%	0%	0%	0%	0%	0%	0%	0%	4%	6%

Figure 14 *Unalaska Harbor Export Commodities by Percentage of Total, Source: WCUS*



Focusing on these commodity categories will give a representative sample for the overall tonnage through the port. Levels of these commodities seem to have recovered well and stabilized from the economic downturn of 2008-2009.

The non-liquid commodities listed above have traditionally been moved as containerized cargo. Below is a table that shows domestic and foreign container traffic through Unalaska – Dutch Harbor from 2005-2015.

Table 9 *Waterborne Container Traffic through Unalaska 2005-2015, Source: U.S. Waterborne Container Traffic, WCSC, 2005-2015*

Year	Domestic Inbound Loaded	Domestic Inbound Empty	Domestic Outbound Loaded	Domestic Outbound Empty	Domestic Total	Foreign Inbound Loaded	Foreign Outbound Loaded	Foreign Total	Grand Total Loaded
2005	9,505	741	10,292	285	20,822	209	30,671	30,880	50,676
2006	7,516	2,072	12,369	234	22,192	118	26,183	26,301	46,187
2007	7,247	2,454	12,413	1,007	23,121	80	24,851	24,931	44,590
2008	7,069	1,228	9,782	1,413	19,492	51	24,125	24,175	41,026
2009	6,413	2,288	10,518	259	19,478	97	24,839	24,936	41,867
2010	7,738	459	9,406	748	18,351	32	26,716	26,748	43,892
2011	8,644	2,761	11,788	788	23,982	156	34,856	35,012	55,445
2012	9,559	2,766	13,710	1,434	27,469	93	34,413	34,506	57,775
2013	7,072	2,475	12,944	1,144	23,635	645	33,660	34,305	54,320
2014	10,939	3,157	13,145	2,459	29,700	2,282	37,831	40,113	64,197
2015	8,582	1,408	12,180	988	23,159	507	38,461	38,968	59,731

By tonnage, the vast majority of non-liquid commodities is made up of fish. Not surprisingly, the correlation between the movements in groundfish landings/wholesale fish produced in the BSAI and total number of loaded containers moved are greater than 90 percent.

4.1.2 Harbor Transit Rules

All vessel traffic into and out of the port is managed by the Alaska Marine Pilots Association. They typically embark/debark vessels approximately 2 nautical miles outside the bar. Due to the current shallow depth at the bar, traffic is restricted to one large ship movement at a time in the port, in any direction. This typically applies to container vessels and medium- to large-sized tanker vessels. Essentially, large vessels move around the port in series, one after another, never simultaneously. Additionally, vessels with a draft up to 38 feet typically may enter and depart Dutch Harbor at any stage of tide without delay. Vessels with a draft at or exceeding 38 feet are likely to experience delays due to the stage of the tide. Further constraints include weather, such as times of high wind or heavy seas. A vessel's maneuvering capabilities within the system come into play as well. During times of high wind and/or seas, vessels are required to wait either at dock or the pilot buoy.

4.1.3 Underkeel Clearance (UKC)

According to the Alaska Marine Pilots Port Parameters, published December 2015, vessels with a draft up to 38 feet may generally enter and depart Dutch Harbor at any stage of the tide. Minus tides or extreme swell conditions often cause delays. Vessels with a draft exceeding 38 feet are likely to experience delays due to the stage of the tide and/or swell conditions. Given that the bar at the harbor entrance is at a depth of -42 feet, this would indicate that the minimum UKC over the bar was 4 feet.

Once vessels are moored at the dock, the UKC requirement can be much lower. As previously mentioned, there are only two places in Dutch Harbor where vessels are constrained by draft: the bar and the dock. The rest of the harbor is 75-100 feet deep. So, as long as ships are not resting on the bottom at the dock, they are free to get underway into deeper water. In the without-project condition, the bar is the limiting factor for draft at -42 feet. Therefore, the UKC of any vessel won't exceed 38 feet (42 minus 4-foot min UKC) unless there's extenuating circumstances and a flood tide. However, as the bar is deepened in the with-project condition, the draft constraint moves to the individual docks as the limiting factor. If the vessels simply must be underway at that point, the minimum UKC is no longer 4 feet above the bar—it is now ~1 foot above the respective dock. This assumption was confirmed after discussions with the pilots. Below is a table displaying how the minimum UKC will change in the 58-foot alternative as an example.

Table 10 *UKC Requirements for Deep Draft Docks*

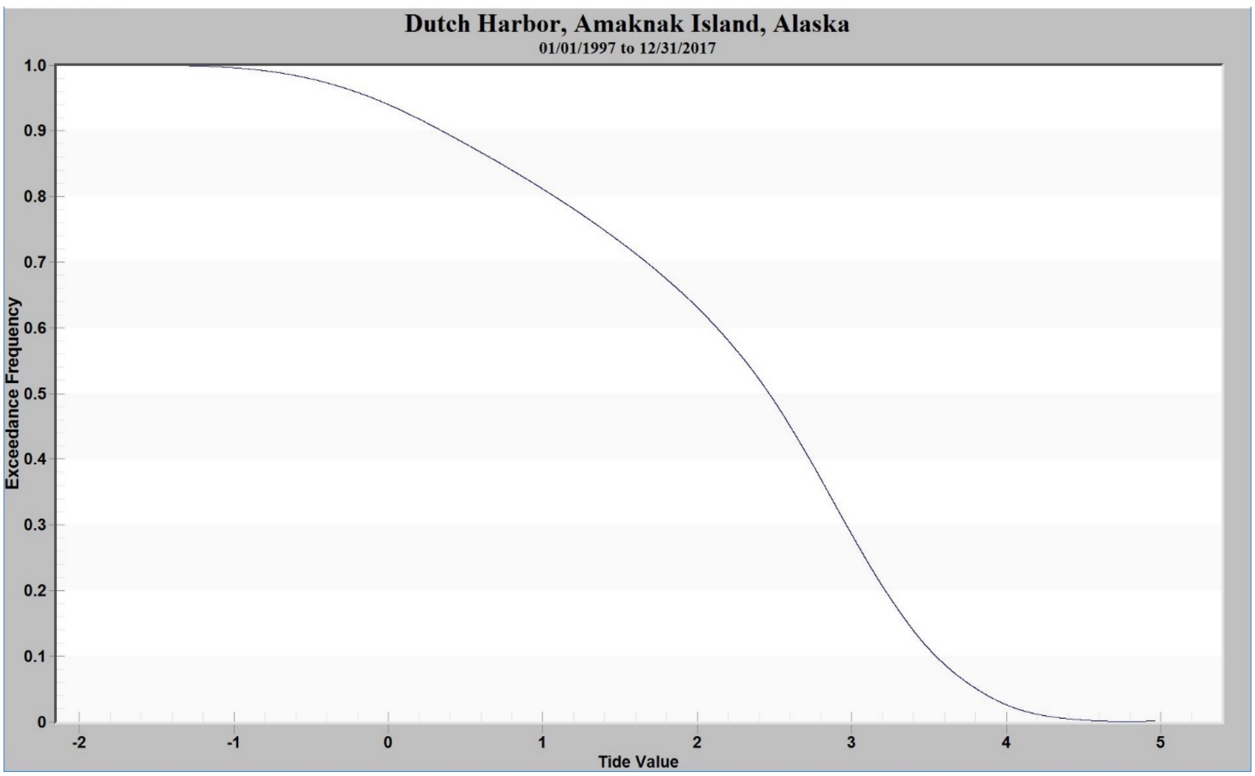
Dock	FWOP Depth	FWOP Depth w/ UKC	FWP Depth (58ft)	FWP Depth w/ UKC (58ft)
APL	45	38	45	44
UMC	40	38	45	44
Delta Western	30	29	30	29

4.1.4 Tidal Range

Tides are used often in order to transport cargo to the docks of Unalaska – Dutch Harbor. As mentioned in the previous section, a minimum UKC of 4 feet is maintained, unless extenuating circumstances and a flood tide are present. An analysis of the arrival data provided by the pilots show that approximately 47 container vessels crossed over the bar at a depth greater than 38 feet from 2013-2016; or approximately 1 a month. Of those 47 vessels, 36 of them had arrival drafts between 38-39 feet. So, exceedance of the minimum UKC may be frequent, but not sizeable. Also, as mentioned in the previous section, as the bar is deepened, the UKC requirement will decrease as the docks become the limiting factors. This would most likely lead to a shift from using the tide to cross the bar to using the tide to leave the dock at a heavier draft.

High tides average approximately 2.1 to 4.7 feet above MLLW, while low tides typically fall from -0.9 feet to 3.7 feet below MLLW. The Tide Tool included in the HarborSym model was incorporated for the analysis described later in this report. The IWR Tide Tool makes use of standard astronomical tidal prediction techniques and databases of tidal stations. The Tide Tool generates tidal height and current information for primary and secondary tidal stations as well as statistics on tidal availability, for example the cumulative distribution function of tidal availability at a location, shown in the figure below for Dutch Harbor.

Figure 15 *Tidal Exceedance Function for Dutch Harbor 1997-2017*



A geographical interface making use of Bing™ allows for simple identification of tidal stations, and supports creation of secondary tidal stations for use in HarborSym. The two tide stations for Dutch Harbor are shown in the figure below.

__Figure 16__ Dutch Harbor Tide Stations from IWR Tide Tool

4.1.5 Existing Vessel Fleet Composition

The existing fleet for the analysis was developed by evaluating a combination of empirical data for a 5-year period (2010-2015). Vessel movement data was collected from the Waterborne Commerce Statistics Center for 2010-2015 for the port. The City of Unalaska also provided pilots' records for 2013-2016, and Automated Identification System (AIS) vessel movement data was collected from IHS's Maritime database, SeaWeb, for 2015.

As mentioned in the previous sections, the principle commodities are fish, petroleum products, and manufactured equipment. Based on the data collected, only four types of vessels carried those commodities: liquid barges, refrigerated cargo ships, bulk carriers, and container ships. Since the purpose of this study is to evaluate the effects of a deepened channel, only those types of vessels that would benefit from a deepened channel were included in the base fleet. If we were modeling to reduce overall harbor congestion, more types of vessels would be included. A deeper channel allows containers and bulkers to gain efficiencies with their larger vessels. This would replace calls from smaller ships and barges. The refrigerated cargo fleet is currently not deep enough to benefit, so were not included. During peak seasons, they operate at anchor outside the bar as well.

The compilation of data, combined with the above methodology, allowed the benefiting fleet to be reduced to five vessel types. The following table displays the total number of vessel calls in

2015 by vessel type that called on Dutch Harbor. According to the data collected, domestic vessels called weekly at the port and foreign vessels called about five times a month, on average.

Table 11 *Calls by Vessel Type to Dutch Harbor in 2015*

Vessel Type	Number of Calls
Liquid Barge	40
Chemical/Products Tanker	3
Products Tanker	7
Crude Oil Tanker	2
Container Ship	122
Total	174

Those five vessel types were then broken down into eight vessel classes, based on their size (length or beam) or capacity (DWT). The following table displays the total number of vessel calls (not transits) in 2015 by vessel class that were developed for the base fleet.

Table 12 *Calls by Vessel Class to Dutch Harbor in 2015*

Vessel Class	LOA(ft)	Beam(ft)	DWT	Draft(ft)	Number of Calls
Barge	329	78	15,853	24.3	40
Chemical/Products Tanker					
- MR2 Class Tanker	591-601	105.6	47,975-51,527	41.9-43.5	3
Products Tanker					
- MR2 Class Tanker	590-596	105.6	45,761-48,700	39.8-41.4	4
- Panamax Class Tanker	750	105.8	74,996	46.5	3
Crude Oil Tanker					
- Aframax	820	143.7	114,749	49.0	2
Container Ship					
- Regional Feeder	575-720	78.0-95.0	20,668-25,651	33.9-35.8	55
- Feedermax	617-729	93.5-99.7	27,130-39,266	34.4-39.4	18
- Panamax	856-965	105.8	50,201-68,411	41.3-44.7	9
- Baby Post Panamax	852-906	122.4-131.2	58,197-66,696	41.0-45.9	33
- Post-Panamax	909	131.9	67,987	46.0	7
Total					174

There were 149 unique vessels that called on the port from 2010-2015. Their design drafts ranged from 12.0 to 58.8 feet. Of that 149, 56 had greater design drafts than the current allowable depth of 38 feet at the bar (42 feet minus 4 feet UKC), or 38 percent of the traffic.

4.2 Without Project Condition

4.2.1 Dockside Changes

As mentioned in previous sections, the City of Unalaska is planning to expand the size of its UMC Dock. No other companies have plans to make changes to their docks. Below is a summary table of the anticipated changes to the Deep Draft Docks at Dutch Harbor in the Future Without-Project Condition.

Table 13 *Future Without-Project Condition Dock Dimensions*

Dock Name	Length (ft)	Depth (ft)	Notes
APL	1,050	45	No expansion planned
UMC	3,000	40	Berth will not be dredged
Delta Western	600	30	No expansion planned

4.2.2 Commerce

As discussed in previous sections, the analysis will focus on the principle commodities of food and farm products (fish or seafood), manufactured equipment, and petroleum products. This can be further simplified into two methods of shipping: bulk commodities and containerized commodities. This is reflected in the vessel classes outlined above being exclusively bulk or container ships.

In order to measure the economic benefits of the proposed alternatives, a future condition for the port must be forecasted as a basis for comparison. The first forecast will be for the predicted levels of commodities moving through the port over the 50-year period of analysis. The following paragraphs will show the estimated annual tonnage transported through the port for the initial 20 years of the analysis. In the analysis, after the 20-year period, the tonnage was left constant in order to remain conservative and avoid over estimating tonnage at the harbor. If the project is justified with 20 years of commodity growth, by maintaining constant tonnage for the remainder of the period of analysis, risk and uncertainty can be minimized when determining whether the project is economically justified.

The first commodity forecast was with respect to commodities transported by bulk vessels. In previous sections, petroleum products were identified as the primary bulk commodity, so a petroleum forecast was used. The Department of Energy's estimated growth rates[5] for imports and exports were used for petroleum related cargo. Figures 12 and 13 display the trends for imports and exports over the next 50 years.

Figure 17 *Imported Petroleum Product Forecast vs. Historical Tonnage in Metric Tons*

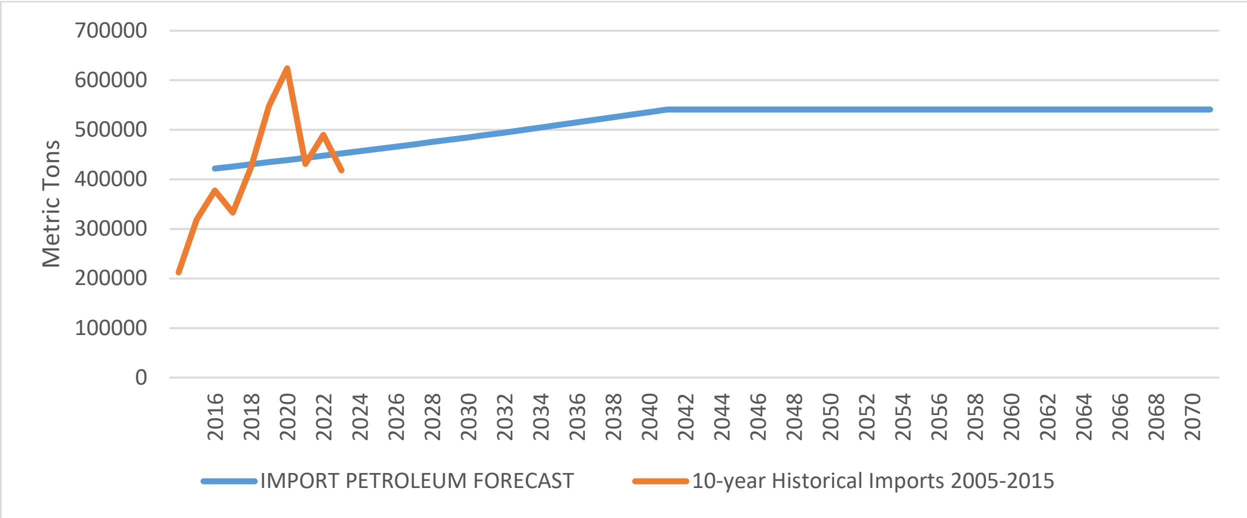
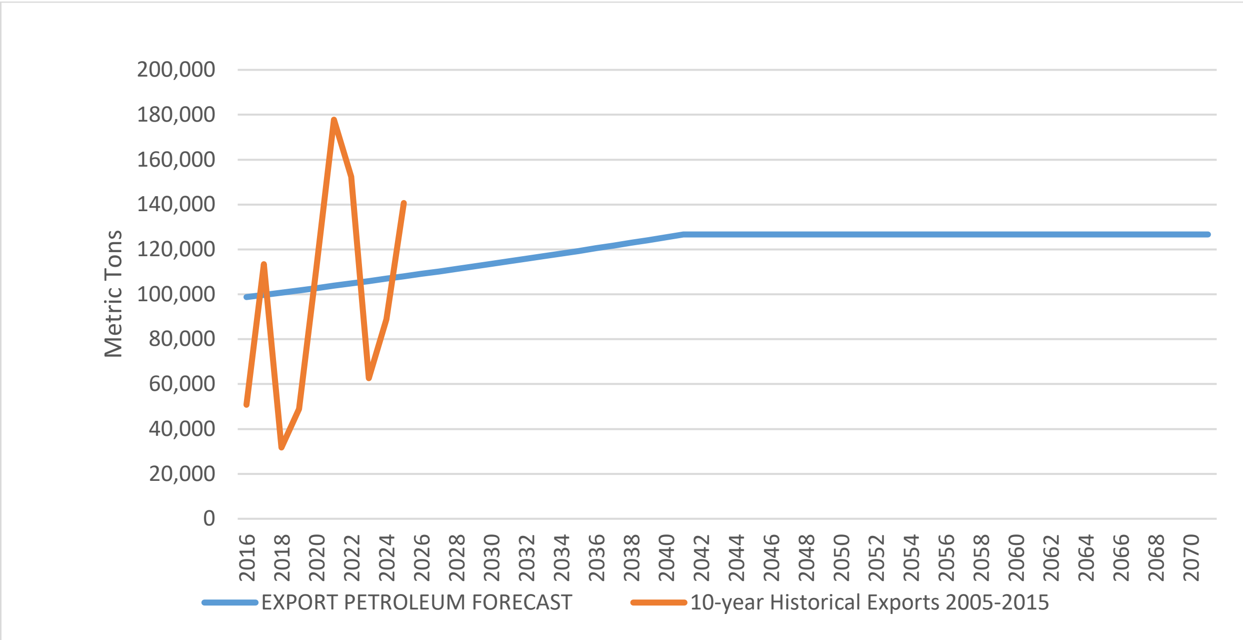


Figure 18 *Exported Petroleum Product Forecast vs. Historical Tonnage in Metric Tons*



[5] Annual Energy Outlook 2017, EIA, www.eia.gov/aeo

The second commodity forecast was completed for the containerized movements over the period of analysis. Recall previously that fish catch and containerized cargo movements were 90 percent correlated, and every aspect of the economy revolves around the fishing industry. Containerized cargo is primarily fish exports and manufactured imports. Because the groundfish catch in the BSAI drives those commodity levels in the port, this forecast will depend on that annual catch. As previously established, this annual catch is limited by law; therefore, the anticipated levels of containerized commodities are not anticipated to grow. The law that affects the catch levels is driven by the recommendations of the NPFMC based on research and study of the fishery. These regulations are not anticipated to change in the future either. Also, due to Unalaska Island's isolated geography, hinterland impacts are not anticipated to drive changes in the economy or throughput of the harbor. Going forward, the 2015 levels of all containerized commodities will be held constant.

4.2.3 Vessel Fleet and Calls

The next step is to anticipate how the base fleet of benefiting vessels will change over the period of analysis. The fleets of bulk and container ships that call on Unalaska – Dutch Harbor are unique to the industries that drive trade movements there. A handful of bulk and container companies provide shipping services to the port for very specific purposes. An example of this is Maersk's Transpacific Alaska service that runs from northern Asia to Unalaska – Dutch Harbor and back. It is the only service in their portfolio that is dedicated solely to the Alaska import and export markets and connects Alaska to the seafood markets of Hakata, Japan and Dalian, China. This allows critical movement of manufactured imports and seafood exports to arrive and depart regularly. However, when Maersk joined MSC to form the 2M ALLIANCE, their Alaska service was not included and kept as its own separate business unit. The specialization of fleets and the regularity of their services, like Maersk's, suggests a rather self-contained market for shipping to and from the port that would not be largely influenced by trends in fleets around the world. So, even though world fleets of tankers and container ships are shifting to larger size vessels, the fleet calling on Dutch Harbor will likely remain the same.

Given a constant fleet size and makeup over the period of analysis, there is still room for shipping to gain efficiencies without a project in place. Since shipping firms are assumed to be profit-maximizing entities, looking to reduce costs whenever possible, they would take the fixed amount of forecasted commodities and shift them to the larger vessels already in the existing fleet and away from smaller existing vessels. An example of this would be petroleum products. Currently, much of the levels of imported petroleum arrives by shallow-draft, ocean-going barges. In the future, shippers could reduce trips and take advantage of foreign economies of scale by using more of the existing calling fleet of larger, bulk tankers. From the container aspect, the current commodity share on Feedermax and Panamax vessels could be shifted to the existing Post-Panamax fleet to reduce trips and costs. The exception to this would be Matson Shipping's fleet of small Regional Feeder container ships. This company deals exclusively in weekly domestic shipments to the Alaskan mainland and continental U.S. This critical lifeline to the Aleutian Islands does not have much capacity to gain efficiency since their fleet is limited to one class of vessel and is on a set rotation.

Historical vessel calls were also examined to see what extent light-loading practices were being observed. This was done by showing how often vessels arrived and departed Dutch Harbor at a draft less than their maximum draft. Arrival draft data from Waterborne Commerce Statistics Center (WCSC) was collected for Dutch Harbor from 2010-2016 by vessel class. This can be compared to the vessel class's design drafts that were listed in Table 10 to show the magnitude of light-loading for each class. The table below shows the WCSC data and the comparison to design drafts.

Table 14 *Summary Data, Dutch Harbor Calls 2010-2016*

Vessel Class	**Average Design Draft**	**Average Arrival Draft**	**% Difference**	**Average Tonnage per call (short tons)**
MR2 Tanker	31.4	28.4	-9.5%	16,494
MR2 Products Tanker	33.8	28.9	-14.5%	24,252
PMX Products Tanker	40.8	32.1	-21.3%	36,866
Aframax Tanker	44.6	27.0	-39.5%	54,746
Regional Feeder	34.8	26.3	-24.4%	3,003
Feedermax	37.9	29.3	-22.7%	5,777
Panamax	41	34	-17%	8,642
Baby Post Panamax	45.1	35.0	-22.4%	5,495
Post Panamax	43	36.0	-16.3%	4,760

Next, a load factor analysis was conducted for each vessel class and each commodity that they moved through the port. This analyzes how fully loaded each vessel was when it imported or exported a certain commodity. Because of this, the load factor analysis of the current fleet can be used to inform vessel behavior into the future. This analysis was based on the historical vessel information and commodity movements gathered from WCSC. Specific vessel capacity data was gathered from various online databases that house vessel specifications, such as IHS Maritime and the USCG Port State Information Exchange. Once initial loading percentages were estimated, loading practices were tested in the HarborSym planning tool to validate that percentages were reflective of actual operations. This was done by testing if the existing vessel fleet could sufficiently move the historic commodity level given the estimated load factors. If the fleet could not, factors were adjusted until they were able to move all the historical volumes.

This process acts as a calibration of sorts for the HarborSym model to make sure it can accurately portray existing conditions before attempting future condition simulations.

Below are the results of the load factor analysis for the port of Unalaska. For each class, a minimum, maximum, and average (or most likely) loading percentage (factor) was calculated.

Table 15 Load Factors by Commodity and Vessel Class

Fuel Imports

MIN		**MOST LIKELY**		**MAX**	
MR2 Tanker	31%	MR2 Tanker	66%	MR2 Tanker	102%
Aframax Tanker	52%	Aframax Tanker	52%	Aframax Tanker	52%
MR2 Products Tanker	34%	MR2 Products Tanker	59%	MR2 Products Tanker	94%
Panamax Tanker	45%	Panamax Tanker	54%	Panamax Tanker	94%
Liquid Barge	1%	Liquid Barge	23%	Liquid Barge	100%
Panamax Container	0.05%	Panamax Container	0.05%	Panamax Container	0.05%
Baby PPX Container	0.03%	Baby PPX Container	0.31%	Baby PPX Container	0.57%

Cargo Imports

MIN		**MOST LIKELY**		**MAX**	
Regional Feeder Container	8%	Regional Feeder Container	8%	Regional Feeder Container	8%
Feedermax Container	0%	Feedermax Container	0%	Feedermax Container	0%
Panamax Container	1%	Panamax Container	1%	Panamax Container	1%
Baby PPX Container	1%	Baby PPX Container	1%	Baby PPX Container	1%
Post-Panamax Container	1%	Post-Panamax Container	1%	Post-Panamax Container	1%

Cargo Exports

MIN		**MOST LIKELY**		**MAX**	
Regional Feeder Container	63%	Regional Feeder Container	63%	Regional Feeder Container	63%
Feedermax Container	37%	Feedermax Container	37%	Feedermax Container	37%
Panamax Container	42%	Panamax Container	42%	Panamax Container	42%
Baby PPX Container	23%	Baby PPX Container	23%	Baby PPX Container	23%
Post-Panamax Container	18%	Post-Panamax Container	18%	Post-Panamax Container	18%

Given these considerations surrounding the changes in the future vessel fleet, port traffic was simulated at three points in time during the period of analysis, using the HarborSym planning tool. Traffic was simulated based on the amount of forecasted tonnage moving through the port, and the forecasted available vessel fleet. The first forecast point was the base year, or the first year that a completed project might yield benefits, 2022. The second year, was 2032, and the third was 2042. The table below shows how the numbers of calls change for certain vessel classes over the period of study.

Table 16 Forecasted vs. Existing Annual Vessel Calls to Unalaska – Dutch Harbor by Class and Year

Vessel Class	2015	2022	2032	2042
Aframax	2	2	2	2
Tanker-MR2	7	7	7	8
Tanker-Panamax	3	1	1	1
Regional Feeder	55	82	82	82
Feedermax	18	4	4	4
Panamax	9	17	6	6
Baby Post Panamax	33	33	41	41
Post-Panamax	7	1	2	2
Barge	40	9	10	11
Total	174	156	156	157

The shift to larger vessels to reduce costs is reflected in the increased number of Post-Panamax calls in 2032 and 2042 and the reduction in Feedermax and Panamax calls.

The estimated future vessel fleet and number of vessel calls was run through the HarborSym deepening model to calculate the transiting times and costs for the period of analysis for each of the increments evaluated (2022, 2032, 2042). Once the transiting times were calculated, the model calculated average vessel transit (voyage) costs based on the most recent set of USACE Deep-Draft vessel operating costs (DDVOCs).[6] The average vessel transit (voyage) costs in the without project condition, for the base year, year 10, and year 20 of the period of analysis, are displayed in the following table. These are outputs of the HarborSym model for the without project condition. Most average vessel transit costs decreased over the period of analysis. This is due to increasing efficiencies over the study period discussed previously. Model outputs for the with-project condition, along with additional details about the model itself, are provided in the with-project section of this report.

Table 13 Total Transportation Cost by Year in Without Project Condition

	2022	2032	2042
Total Without-Project Transportation Cost	$72,375,811	$61,022,814	$65,778,345

[6] Economic Guidance Memorandum, 17-04, DDNVOCs FY2016 Price Levels, Supplemental Guidance.

4.3 With Project Condition

The following section describes the anticipated condition at Unalaska – Dutch Harbor assuming that a project has been constructed. The anticipated changes in the operating procedures at the port are the basis for the economic analysis.

4.3.1 Assumptions

4.3.1.1 Dockside Changes

As discussed in previous sections, the City of Unalaska is planning to expand its UMC Dock by spring 2019. Additionally, if the USACE project is approved, they also plan to dredge the UMC berth simultaneously to a uniform depth of 45 feet MLLW to match APL's dock and accommodate larger vessels. Designs are already finalized for the dredging project and construction would be completed at the same time as the proposed entrance channel dredging. Completion of the berth dredging prior to the bar being deepened would not be economically justified since the bar would still limit vessel drafts needing to use the UMC. Below is a table showing the relevant dock dimensions in the Future With-Project condition.

Table 17 *Future With-Project Condition Dock Dimensions*

Dock Name	Length (ft)	Depth (ft)	Notes
APL	1,050	45	No expansion planned
UMC	3,000	45	
Delta Western	600	30	No expansion planned

Both bulk and container vessels will experience a time savings "with" project in the form of the reduction in transit time delays. Another source of savings will be the elimination of voyages over the year by loading the existing fleet deeper with a deeper channel in place. The ability to load deeper allows the existing fleet to move the same volume of cargo in fewer trips. The more efficient use of Post-Panamax class container vessels will allow the large amount of containerized fish to be moved from Dutch Harbor in fewer trips. This will result in cost savings to the shippers and benefit the Nation. Other costs and practices, such as land side costs, would not change as a result of the project and are assumed to remain constant.

The period of analysis is 50 years, beginning with the base year of 2022, the project effective date, to 2072. The FY 2019 Federal discount rate of 2.875 percent is used to discount benefits and costs. The report uses methodology from Engineering Regulation 1105-2-100, transportation savings accruing to deep draft vessels.

4.3.2 Project Alternatives

For the Iliuliuk Bay Navigation Improvement project, a total of five different alternatives are being evaluated in this analysis along with the existing/without project condition. These alternatives call for channel depths of 46, 48, 52, 56, and 58 feet. At the beginning of the analysis, only 50-, 56-, 58-, and 66-foot alternatives were evaluated based on inputs from Engineering and Planning. However, upon the recommendations of the vertical team, depths at 46, 48 and 52 feet were added. The relative closeness of the benefits of the 52- and 56-foot alternatives precluded the need for analyzing benefits at 54 feet. Preliminary results also showed that no additional NED benefits occurred at the 66-foot alternative, so it was dropped from further consideration and cost estimating due to much higher cost expectations. All alternatives had channel dimensions of 600 feet long and 600 feet wide. Discussions with the Alaska Marine Pilots indicated that a project would not change their traffic management practices. So, one vessel movement at a time was not assumed to change in any alternative. Of the three deep draft docks that were modeled, the dimensions and capacities of only one changed from the current condition. The City Dock at the Unalaska Marine Center increased its depth from 40 feet MLLW to 45 feet in accordance with their planned expansion project.

4.3.3 Project Benefits

In the port of Dutch Harbor, navigation benefits will be generated with the reduction in costs from more efficient use of existing vessels and reductions in transit time. By allowing the vessels to arrive and depart closer to their maximum draft, large container vessels can minimize the number of voyages to Asia to deliver fish each year. Reducing the number of trans-Pacific voyages will be a significant cost savings to the shippers. Also, reducing the amount of delays waiting for conditions to improve at the bar will make existing voyages faster and more efficient, incurring fewer operating costs over the year as well. These benefits will be estimated using the HarborSym planning model.

IWR developed HarborSym as a planning level, general purpose model to analyze the economic impacts of various waterway modifications within a harbor. HarborSym is a Monte Carlo simulation model of vessel movements at a port for use in economic analyses. While many harbor simulation models focus on landside operations, such as detailed terminal management, HarborSym instead concentrates on specific vessel movements and transit rules on the waterway. HarborSym represents a port as a tree-structured network of reaches, docks, anchorages, and turning areas. Vessel movements are simulated along the reaches, moving from the bar to one or more docks, and then exiting the port. Features of the model include intra-harbor vessel movements, tidal influence, the ability to model complex shipments, incorporation of turning areas and anchorages, and within-simulation visualization. One limitation of the model is that weather (wind or fog) is not a factor. The driving parameter for the HarborSym model is a vessel call at the port. A HarborSym analysis revolves around the factors that characterize or affect vessel movement within the harbor.

Inputs

The data required to run HarborSym are separated into six categories:

- Simulation Parameters. Parameters include start date, the duration of the iteration, the number of iterations, the level of detail of the result output, and the wait time before rechecking rule violations when a vessel experiences a delay. These inputs were included in the model runs for this study. For this analysis, 50 iterations were run to determine the economic benefits associated with transit cost reductions.

- Specific physical and descriptive characteristics of Unalaska – Dutch Harbor. These data inputs include the specific networks of the port such as the node location and type; reach length, width, and depth, in addition to tide and current stations. This also includes information about the docks in the harbor such as length and the maximum number of vessels the dock can accommodate at any given time.

- General Information. General information used as inputs to the model include: specific vessel and commodity classes, and commodity transfer rates at each dock.

- Vessel speeds. With the assistance of the Alaska Marine Pilots and the City of Unalaska, the speeds at which vessels operate in the harbor, by vessel class both loaded and light loaded, were determined for each channel segment.

- Transit rules. Vessel transit rules for each reach reflect restrictions on passing, overtaking, and meeting in Dutch Harbor, and are used to evaluate delays in the system. Underkeel clearance requirements are also used along with tide to determine whether a vessel can enter the system.

- Vessels calls. The vessel call lists are made up of vessel calls forecast for a given year. Each call is given a movement number based on its date and time of entry into the harbor. The vessel call list for the current condition was imported into HarborSym using an Excel spreadsheet. The vessel call lists for the future without-project and future with-project conditions were simulated by HarborSym based on forecasted conditions previously discussed.

Outputs

A number of parameters are collected and stored in HarborSym after the model runs are completed. Among these parameters are the number of vessels entering/exiting the harbor, the average time a vessel class spends in the system (hours), the average transit cost of a vessel for each class, the total transit cost of the annual fleet, vessel time and location (e.g., entry, dock, turning basin, etc.) spent waiting in the system, vessel times in anchorage areas, vessel times docking and undocking, vessel times loading and unloading, commodity quantities transferred, and total commodity statistics at the port. These outputs are then used to quantify delay reduction benefits.

4.3.4 Deepening Analysis – HarborSym Results

The HarborSym model was used for the economic analysis to compare the without project condition (no channel) to the with-project alternatives (600-foot wide channel with depths of 46, 48, 50, 52, 56, and 58 feet) over a 50-year period of analysis. Benefits associated with the channel deepening for Dutch Harbor were evaluated based upon deepening the bar at the entrance to Dutch Harbor, which would allow for more efficient shipments.

Just as in the without-project condition, the future vessel fleet was forecasted by conducting a load factor analysis for each vessel class and each commodity that they moved through the port. Tankers are anticipated to increase the load factors for fuel imports with a project in place. Larger container vessels (Panamax, Baby Post Panamax, Post Panamax) are anticipated to increase the load factors for cargo exports with a project in place. This is because the additional depth will allow them to eliminate some of the calls into the port by loading deeper.

Below are the results of the load factor analysis for the port at a depth of 58 feet. For each class, a minimum, maximum, and average (or most likely) loading percentage (factor) was calculated. Changes or additions for the with-project condition are highlighted in yellow.

Table 18 *With-Project Condition Load Factors by Vessel Class*

Fuel Imports

MIN		**MOST LIKELY**		**MAX**	
MR2 Tanker	81%	MR2 Tanker	100%	MR2 Tanker	100%
Aframax Tanker	94%	Aframax Tanker	94%	Aframax Tanker	100%
MR2 Products Tanker	89%	MR2 Products Tanker	100%	MR2 Products Tanker	100%
Panamax Tanker	90%	Panamax Tanker	99%	Panamax Tanker	100%
Liquid Barge	1%	Liquid Barge	23%	Liquid Barge	100%
Panamax Container	0.05%	Panamax Container	0.05%	Panamax Container	0.05%
Baby PPX Container	0.03%	Baby PPX Container	0.31%	Baby PPX Container	0.57%

Cargo Imports

MIN		**MOST LIKELY**		**MAX**	
Regional Feeder Container	13%	Regional Feeder Container	13%	Regional Feeder Container	13%
Feedermax Container	0%	Feedermax Container	0%	Feedermax Container	0%
Panamax Container	0%	Panamax Container	0%	Panamax Container	0%
Baby PPX Container	24%	Baby PPX Container	24%	Baby PPX Container	24%
Post-Panamax Container	0%	Post-Panamax Container	0%	Post-Panamax Container	0%

Cargo Exports

MIN		**MOST LIKELY**		**MAX**	

Regional Feeder Container	63%	Regional Feeder Container	63%	Regional Feeder Container	63%
Feedermax Container	40%	Feedermax Container	40%	Feedermax Container	40%
Panamax Container	60%	Panamax Container	60%	Panamax Container	60%
Baby PPX Container	40%	Baby PPX Container	40%	Baby PPX Container	40%
Post-Panamax Container	40%	Post-Panamax Container	40%	Post-Panamax Container	40%

Once this analysis was completed for each class and each commodity, then a requisite number of vessels were calculated to move the forecasted amounts of commodities, per the commodity forecasts highlighted in the previous section. Total numbers of vessel calls were estimated over the 50-year forecast period. Similar to the commodity forecasts, after the initial 20-year period, growth was held constant for the remaining 30 years. So, the level of vessels in 2040-2070 will remain unchanged.

Table 19 Future With-Project Vessel Fleet Calling at the Port of Unalaska by Class and Year and Alternative

Vessel Calls by Vessel Class: Existing Condition			
Vessel Class	**2020**	**2030**	**2040**
Aframax	2	2	2
Tanker-MR2	7	7	8
Tanker-Panamax	1	1	1
Regional Feeder	82	82	82
Feedermax	4	4	4
Panamax	17	6	6
Baby Post Panamax	33	41	41
Post-Panamax	1	2	2
Barge	9	5	11
Total	156	150	157
Vessel Calls by Vessel Class: 46ft Channel			
Vessel Class	**2020**	**2030**	**2040**
Aframax	0	2	2
Tanker-MR2	0	7	7
Tanker-Panamax	0	1	1
Regional Feeder	75	70	70
Feedermax	4	2	2
Panamax	16	5	5
Baby Post Panamax	33	39	39
Post-Panamax	1	2	2
Barge	0	2	5
Total	128	130	133

Vessel Calls by Vessel Class: 48ft Channel			
Vessel Class	**2020**	**2030**	**2040**
Aframax	2	2	2
Tanker-MR2	6	7	8
Tanker-Panamax	1	1	1
Regional Feeder	70	69	69
Feedermax	4	1	1
Panamax	14	5	5
Baby Post Panamax	33	37	37
Post-Panamax	1	2	2
Barge	0	0	4
Total	130	125	129
Vessel Calls by Vessel Class: 50ft Channel			
Vessel Class	**2020**	**2030**	**2040**
Aframax	2	2	2
Tanker-MR2	5	7	8
Tanker-Panamax	1	1	1
Regional Feeder	70	69	69
Feedermax	4	1	1
Panamax	14	5	5
Baby Post Panamax	33	37	37
Post-Panamax	1	2	2
Barge	0	0	4
Total	129	123	129
Vessel Calls by Vessel Class: 52ft Channel			
Vessel Class	**2020**	**2030**	**2040**
Aframax	2	2	2
Tanker-MR2	4	7	8
Tanker-Panamax	1	1	1
Regional Feeder	69	69	69
Feedermax	4	1	1
Panamax	14	5	5
Baby Post Panamax	33	37	37
Post-Panamax	1	2	2
Barge	0	0	4
Total	128	123	129

Vessel Calls by Vessel Class: 56ft Channel			
Vessel Class	**2020**	**2030**	**2040**
Aframax	2	2	2
Tanker-MR2	5	7	8
Tanker-Panamax	1	1	1
Regional Feeder	69	69	69
Feedermax	4	1	1
Panamax	14	5	5
Baby Post Panamax	33	37	37
Post-Panamax	1	2	2
Barge	0	0	4
Total	128	123	129
Vessel Calls by Vessel Class: 58ft Channel			
Vessel Class	**2020**	**2030**	**2040**
Aframax	2	2	2
Tanker-MR2	4	7	8
Tanker-Panamax	1	1	1
Regional Feeder	69	69	69
Feedermax	4	1	1
Panamax	14	5	5
Baby Post Panamax	33	37	37
Post-Panamax	1	2	2
Barge	0	0	4
Total	128	123	129

The reduction in the number of Baby Post Panamax and Panamax calls is the basis for the transportation cost savings for this project.

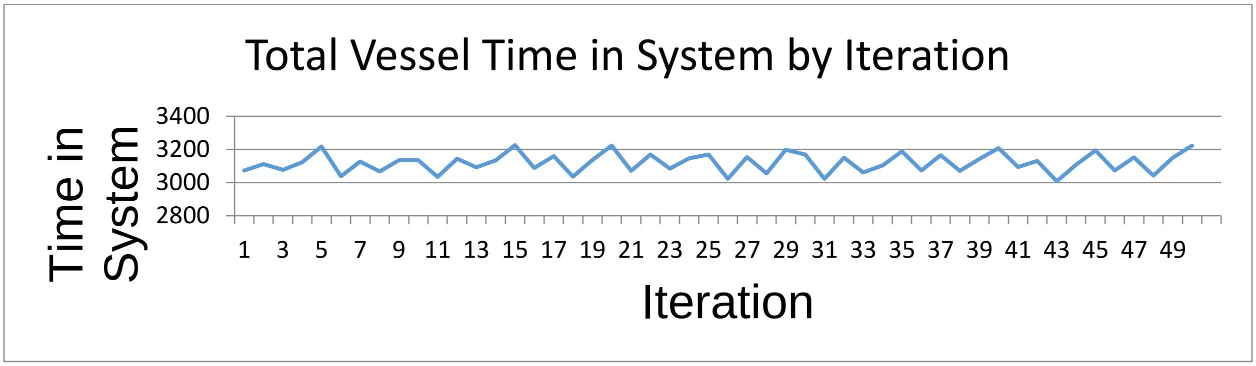
The HarborSym model was run for each of the project alternatives. Each model run consisted of 50 iterations of an entire year, beginning January 1, 12:00 a.m. In order to determine if enough iterations were run to accurately model traffic at the port, the average time that a vessel spent in the port over each year was examined for volatility. If the averages varied too much, then more iterations needed to be run. The average vessel time from the existing condition is displayed below.

Table 20 *Total Vessel Time in System in hours for all vessels calling on Unalaska – Dutch Harbor under current conditions*

	Total Vessel Time in System (hrs)

Average	3,120
Min	3,008
Max	3,226
Standard Deviation	59

Figure 19 *Total Vessel Time in System in hours for all vessels calling on Unalaska – Dutch Harbor under current conditions*



The number of iterations was determined to be adequate by achieving a standard deviation of less than two percent. Therefore, 50 iterations will be used to evaluate both the future without- and with-project conditions.

The average transportation costs for the each vessel class was determined for the without- and with-project conditions. The average vessel transportation cost reduction (benefit) in the with-project condition is displayed in the following table for each benefiting vessel class. Most vessel classes benefit from the deeper alternatives. The exception to this are the ships at the deeper ends of their respective fleet's mix (Post-Panamax Container and Aframax and Panamax Tankers). This is due to the shifting of cargo from shallower vessels to those vessels, resulting in larger loads, and subsequently longer loading and unloading times. More cargo being loaded onto deeper vessels creates more time waiting at the dock to be loaded and unloaded, but also more time waiting for ships outside the bar for berths to become available. This results in an increase in at-sea transportation costs (and a decrease in benefits) for larger vessels as the alternatives go deeper. Benefits also seem to plateau for each class at the 48-foot alternative.

Table 21 *Average Vessel Transportation Cost Reduction per Vessel Class in each With-Project Condition*

	AAEQ Transportation Cost Reduction Benefit by Vessel Class					
Vessel Class	**46ft Channel ($)**	**48ft Channel ($)**	**50ft Channel ($)**	**52ft Channel ($)**	**56ft Channel ($)**	**58ft Channel ($)**
Aframax	-$302	$361	$361	$361	$361	$361
Baby Post Panamax	$743,899	$752,432	$752,432	$752,432	$752,432	$752,432
Barge	$866,026	$978,112	$978,112	$978,112	$978,112	$978,112

Feedermax	-$452	$425	$425	$425	$425	$425
Panamax	$191,693	$191,569	$191,569	$191,569	$191,569	$191,569
Post-Panamax	-$32,092	-$30,695	-$30,695	-$30,695	-$30,695	-$30,695
Regional Feeder	$15,122	$20,999	$20,999	$20,999	$20,999	$20,999
Tanker-MR2	$235,232	$762,304	$762,304	$762,304	$762,304	$762,304
Tanker-Panamax	-$10,151	-$12,861	-$12,861	-$12,861	-$12,861	-$12,861
Note: Discount rate = 2.875%, period 50 years; totals may be affected by rounding.						

Since all other model inputs remain constant (Docking/Undocking Times, Loading Rates, etc.) benefits are calculated using the reduction in the average transportation cost for each of the benefiting vessel classes and the number of calls for each class. The total benefits are determined by evaluating the difference, by vessel class, between the transportation costs for the existing condition and each alternative along with the total number of calls for each class.

4.3.5 Total Project Benefits

Total annual project benefits were determined by calculating the average annual reduction in transportation costs for Unalaska – Dutch Harbor at FY19 price levels. The following table shows the preliminary results for average annual benefits generated by each alternative. The annualized transportation costs savings were calculated using the total reduction in vessel operating costs for each alternative evaluated, discounted to FY19 price levels using the Federal discount rate of 2.875 percent, over a 50-year period of analysis.

Table 22 *Preliminary Average Annual Equivalent Benefits by Alternative*

AAEQ Transportation Cost Reduction Benefit by Alternative ($)	
Alternative	**AAEQ Transportation Cost Reduction Benefit**
46ft Channel	$2,157,811
48ft Channel	$2,809,965
50ft Channel	$2,746,467
52ft Channel	$2,606,684
56ft Channel	$2,602,556
58ft Channel	$2,602,556

The benefits above were modeled using an underkeel clearance assumption of 4 feet beneath the keel for all vessels based on the general guidelines published by the Alaska Marine Pilots for

Dutch Harbor. Therefore, it's no surprise that benefits are maximized at 48 feet, given that the maximum draft allowed at the dock in the FWP condition would be 44 feet (plus 4 feet of UKC = 48).

During the course of the study, the UKC assumptions were revised based on additional pilot input. While calls did occur with 4 feet of UKC, this was extremely rare. It would need to be ideal conditions, which rarely occur at Dutch Harbor, combined with a flood tide to attempt to navigate the bar with only 4 feet UKC. This would indicate that a 4 foot UKC was more of an extreme minimum measurement than a reasonable assumption of normal operations, as is needed for HarborSym modeling. An updated UKC was determined by Engineering, using the ship's motion from waves (pitch, roll, and heave), squat underway, and a safety clearance. These values were estimated with equations from the Engineering Manual (EM) 1110-2-1613, "Hydraulic Design of Deep-Draft Navigation Projects," and the Permanent International Association of Navigation Congresses (PIANC) guidance for channel design. The resulting UKC was 14 feet, instead of the 4 feet used in the preliminary benefit estimates. This was approved by the pilots during Ship Simulation.

Since this UKC increase would not affect the behavior of the vessels in the HarborSym model, just the depth at which benefits begin to accrue, the levels of benefits modeled did not change. Benefits were simply shifted 10 feet deeper. Also, since the preliminary results indicated that benefits would be maximized with the 48-foot alternative, this effect would now be present at the 58-foot alternative instead. Thus, only the 56- and 58-foot alternatives were displayed for decision-making purposes going forward. The declines in benefits at deeper depths are the same as in the preliminary results.

Table 23 *Final Average Annual Equivalent Benefits by Alternative*

AAEQ Transportation Cost Reduction Benefit by Alternative ($)	
Alternative	**AAEQ Transportation Cost Reduction Benefit**
56ft Channel	$2,157,811
58ft Channel	$2,809,965

4.3.6 Project Costs

Rough Order of Magnitude (ROM) costs were developed for the initial construction costs for each alternative. The period of construction for all alternatives is 233 days, or 8 months. Project costs were developed without escalation and are at the October 2018 price level. Operations and Maintenance (O&M) is assumed to occur once over the period of analysis, 25 years after construction. This O&M cost was estimated and a present value was calculated using the FY19 federal discount rate. This present value is displayed in the table below for OMRR&R costs. The combination of these costs were used to determine the average annual cost of each project. The table below displays the costs for each channel alternative.

Table 24 Costs for all channel alternative (FY2019 dollars)

Cost Type	56ft	58ft
Dredging	$23,623,059	$26,790,034
IDC	$252,783	$286,414
Landside Ancillary (City Dock Dredging)	$2,041,560	$2,041,560
OMRR&R*	$2,075,129	$2,075,129
PED	$3,678,827	$3,678,827
Total Investment	$31,653,358	$34,871,964

*present value calculation from ROM costs at year 20

Average annual costs were developed by combining the initial construction costs with the annual Operations and Maintenance costs for each potential alternative using the FY19 Federal Discount Rate of 2.875 percent along with a period of analysis of 50 years.

Table 25 Average Annual Cost Summary Information per Alternative

Alternative	AAEQ Total Investment	AAEQ OMRR&R	Total AAEQ
56ft Channel	$1,124,057	$78,747	$1,202,805
58ft Channel	$1,244,607	$78,747	$1,323,354

4.4 Benefit Cost Ratio

The benefit-cost ratio is determined using the average annual benefits and average annual costs for each project alternative. A benefit cost ratio was calculated for both of the remaining alternatives. The table below shows the BCR for each alternative along with net benefits. The project that maximizes net benefits is the 58-foot alternative.

Table 26 Benefit Cost Ratio

Alternative	Total AAEQ Costs	Total AAEQ Benefits	Total Net Benefits	Benefit/Cost Ratio
56-foot Channel	$1,202,805	$2,157,811	$955,006	1.8
58-foot Channel	$1,323,354	$2,809,965	$1,486,611	2.1

4.4.1 Incremental Analysis

An additional way to illustrate the alternative that most reasonably maximizes net benefits is to examine how much additional benefit and costs are added with each increment of depth. The table below shows these additional incremental benefits compared with the costs of those additional increments. Alternatives deeper than 58 feet result in no more benefits; however, their cost continue to increase.

Table 27 Incremental Benefits vs. Incremental Costs

Alternative	Total AAEQ Costs	Total AAEQ Benefits	Total Net Benefits	Incremental AAEQ Benefits	Incremental AAEQ Costs
56ft Channel	$1,202,805	$2,157,811	$955,006	$0	$0
58ft Channel	$1,323,354	$2,809,965	$1,486,611	$531,605	$120,549

4.5 Risk and Sensitivity

There are risk factors that add to the uncertainty of the commodity forecasts. These risk factors stem from issues such as regulatory actions and commodity prices. The possible regulatory actions likely would result in an easing of catch regulations given the stability of the fisheries in the BSAI, resulting in an increase in total tonnage being moved through the port. As mentioned before, catch levels of shellfish and groundfish in the BSAI have been stable over the last 20 years, as shown in the figures below.

Figure 20 BSAI Shellfish Catch 1967-2013

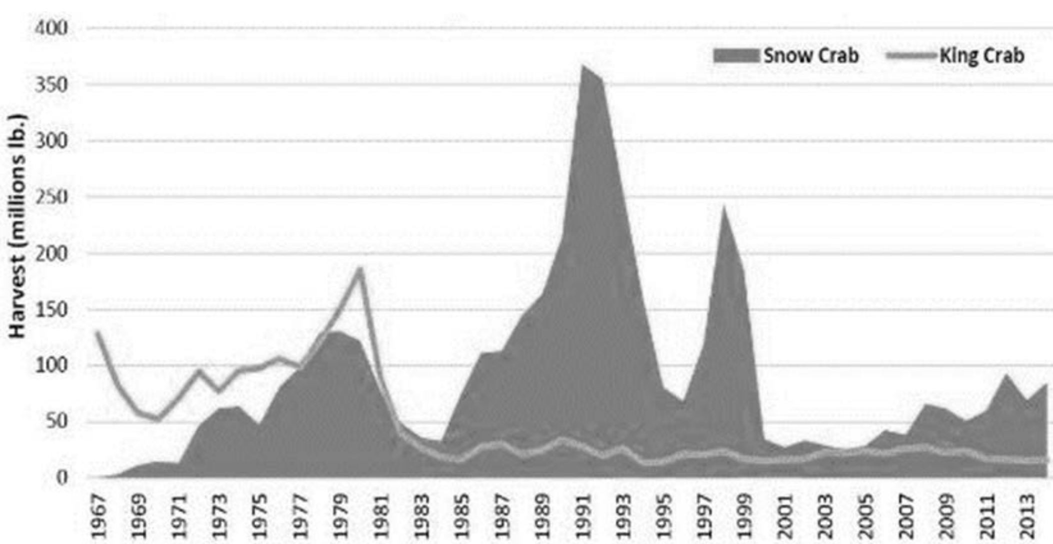
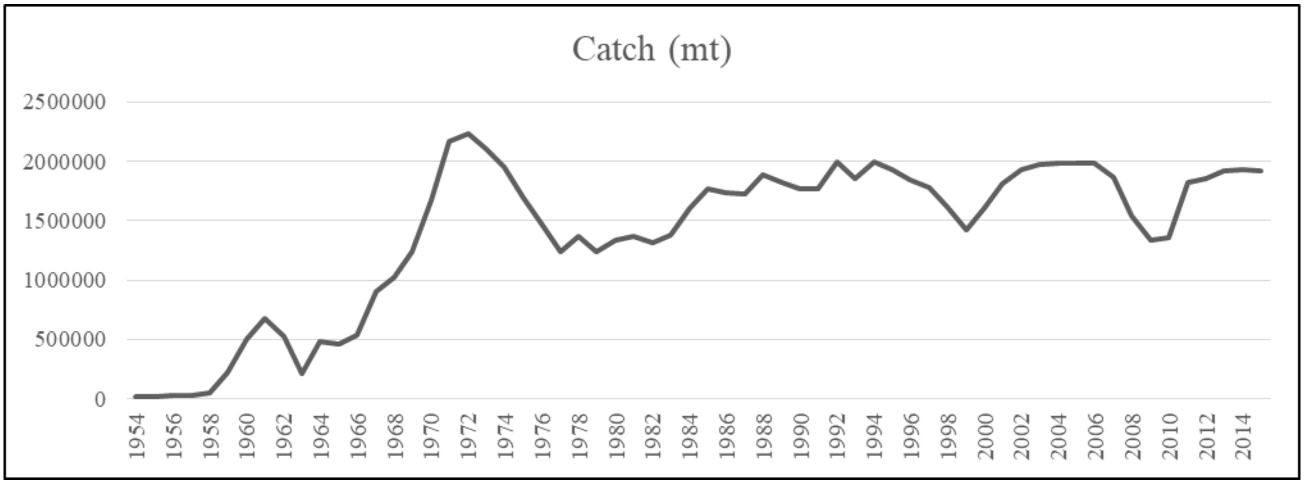


Figure 21 BSAI Groundfish Catch 1954-2014

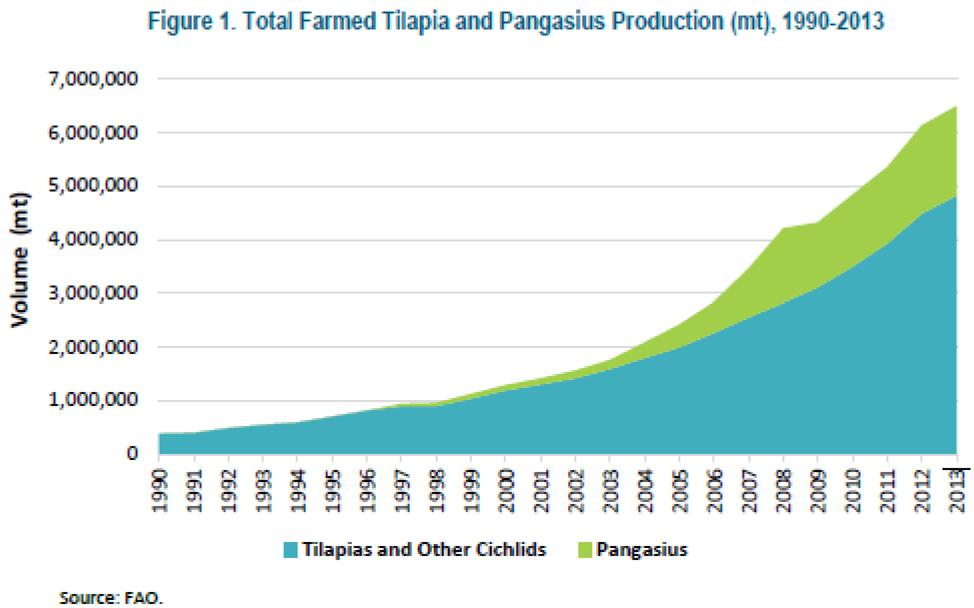


This would indicate that harvests are at an equilibrium with the ecosystems that support them and the catch limits are supported by good research. The likelihood of these limits being eased is low, and so is the likelihood of increased fish-related tonnage moving through the port.

Possible commodity price risk factors would come from impacts to export prices from growing foreign fisheries. Alaska's commercial fisheries produce larger harvests than every other U.S. state combined and 80 percent of Alaska's harvest volume came from high-volume whitefish fisheries (pollock, cod, and flatfish) in 2013. Despite the impressive scale of its high-volume whitefish fisheries, Alaska is only a fractional part of global whitefish production. As a result, Alaska's groundfish industry is a usually a price taker where the value of its cod, pollock, and flatfish are impacted by competing suppliers and competing whitefish species. Russia (cod/pollock/flatfish), China (tilapia), Norway (cod), Japan (pollock/cod), New Zealand (hoki), and Vietnam (pangasius) are the biggest competitors for Alaska's groundfish industry, in terms of high-volume whitefish species.[7] Tilapia and pangasius production in Southeast Asia is on the rise, as shown in the figure below.

[7] Alaska Groundfish and Crab Wholesale Market Profiles, NOAA/NMFS, May 2016.

Figure 22 *Total Farmed Tilapia and Pangasius Production 1990-2013*



Consumption and demand for these fish species are also on the rise in the U.S. and Europe, as shown in the figure below.

Figure 23 *Imports of Tilapia and Pangasius Products, US and Europe, 2012-2014*

Table 3. Imports of Tilapia and Pangasius Products, United States and Europe vs. Other Markets, 2012-2014

	2012	2013	2014	YOY Pct. Change
U.S. & Europe (Combined)				
Import Value ($millions)				
Tilapia – Frozen Fillets	$803.9	$845.3	$918.0	8.6%
Tilapia – Frozen Fish	54.9	82.5	92.4	12.0%
Pangasisus – Frozen Fillets	778.0	717.4	694.3	-3.2%
Import Volume (mt)				
Tilapia – Frozen Fillets	187,130	182,956	186,021	1.7%
Tilapia – Frozen Fish	29,796	41,776	40,674	-2.6%
Pangasisus – Frozen Fillets	260,126	267,260	248,078	-7.2%
Import Value/mt				
Tilapia – Frozen Fillets	$4,296	$4,620	$4,935	6.8%
Tilapia – Frozen Fish	1,841	1,975	2,271	15.0%
Pangasisus – Frozen Fillets	2,991	2,684	2,799	4.3%

Ultimately, these new species could act as a substitute or a complement to Alaskan groundfish. Expanding culinary options presents new marketing opportunities for Alaska's seafood industry. Particularly since Alaska has a reputation for quality and a strong distribution network, having been in the business of exporting fish for decades. However, it may also present challenges in existing markets in years to come as consumers gain more exposure to seafood from other cultures.[8] While marginal declines could occur due to these changes, it is unlikely that a wholesale shift away from Alaska groundfish would occur to the degree that a reduction in vessel fleet size would occur at Dutch Harbor.

Some project specific risks include underestimation of project costs in the areas of erosion control measures. These measures were estimated to mitigate possible wave-induced erosion at a beach near the project location. Detailed modeling showed no significant increases in wave action on the beach in question as a result of project modifications. However, conservative estimates for stone revetments were still added as potential costs for mitigation in case this modeling underestimated wave effects. These costs totaled $12,882,809 for each alternative. The impact of this cost increase on each alternative is shown in the table below.

Table 28 *Benefit and Cost Analysis Including Erosion Control Measures (FY19 Dollars)*

Project Costs, with erosion control	**PV Economic Costs**			**AAEQ Costs**				
Alt	**Project First Costs**	**PV Economic Cost Sub-Total**	**Total Investment**	**AAEQ Economic Cost Sub-Total**	**AEEQ Total Investment Cost**	**AAEQ Benefits**	**Net Benefits**	**Benefit-Cost Ratio**
56-foot Channel	40,209,393	42,492,913	54,724,989	$1,573,977	$1,652,724	$2,157,811	$505,087	1.3
58-foot Channel	43,352,368	45,654,361	58,625,679	$1,691,080	$1,769,827	$2,809,965	$1,040,138	1.6

Another project-specific area of uncertainty is the amount of maintenance dredging required for the project. The recommended plan assumes that maintenance dredging will only be required one time, at year 25 of the period of analysis, due to the bathymetry of the project area. However, this could change over the life of the project, so costs were re-calculated if O&M was conducted every 10 years or every 15 years over the period of analysis. The tables below show the results. This variance in O&M frequency does not affect the justification of the project.

Table 29 *Costs and BCR with O&M conducted every 10 years*

Alternative	**AAEQ Total Investment**	**AAEQ OMRR&R**	**Total AAEQ Costs**	**BCR**
56ft Channel	$1,124,057	$369,793	$1,493,851	1.7
58ft Channel	$1,244,607	$369,793	$1,614,400	1.6

[8] Alaska Groundfish and Crab Wholesale Market Profiles, NOAA/NMFS, May 2016.

Table 30 Costs and BCR with O&M conducted every 15 years

Alternative	AAEQ Total Investment	AAEQ OMRR&R	Total AAEQ Costs	BCR
56ft Channel	$1,124,057	$217,566	$1,341,624	1.9
58ft Channel	$1,244,607	$217,566	$1,462,173	1.8

4.6 Regional Economic Development Analysis

The regional economic development (RED) account measures changes in the distribution of regional economic activity that would result from each alternative plan. Evaluations of regional effects are measured using nationally consistent projection of income, employment, output and population.

4.6.1 Regional Analysis

The USACE Online Regional Economic System (RECONS) is a system designed to provide estimates of regional, state, and national contributions of Federal spending associated with Civil Works and American Recovery and Reinvestment Act (ARRA) Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-Federal expenditures sustained, enabled, or generated by USACE Recreation, Navigation, and Formally Utilized Sites Remedial Action Program (FUSRAP). Contributions are measured in terms of economic output, jobs, earnings, and/or value added. The system was used to perform the following regional analysis for the Iliuliuk Harbor Navigation Improvements Project.

4.6.2 Summary

The U.S Army Corps of Engineers (USACE) Institute for Water Resources, the Louis Berger Group, and Michigan University developed the regional economic impact modeling tool called RECONS to provide estimates of regional and national job creation and retention and other economic measures such as income, value added, and sales. This modeling tool automates calculations and generates estimates of jobs and other economic measures such as income and sales associated with USACE's ARRA spending and annual Civil Works program spending. This is done by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations. These multipliers were then imported to a database and the tool matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. The Tool will be used as a means to document the performance of direct investment spending of the USACE as directed by the ARRA. The Tool also allows the USACE to evaluate project and program expenditures associated with the annual expenditure by the USACE. The Tool has been developed in both a desktop and on-line version.

4.6.2.1 Results of Economic Impact Analysis

This RED impact analysis was evaluated using the ROM costs for the 58-foot alternative at three geographical levels: Local, State and National. The local represents the Aleutians West Borough impact area. The State level includes the State of Alaska. The National level will include the 48 contiguous United States.

The following table displays the breakdown of overall spending of the total project construction costs among the major industry sectors. The spending profile also identifies the geographical capture rate, also called Local Purchase Coefficient (LPC) in RECONS, of the cost components. The geographic capture rate is the portion of USACE spending on industries (sales) captured by industries located within the impact area. In many cases, IMPLAN's trade flows Regional Purchase Coefficients (RPCs) are utilized as a proxy to estimate where the money flows for each of the receiving industry sectors of the cost components within each of the impact areas.

Table 24 *Input Assumptions (Spending and LPCs)*

Category	Spending (%)	Spending Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Dredging Fuel	6%	$1,092,754	5%	80%	90%
Metals and Steel Materials	4%	$770,302	3%	24%	90%
Textiles, Lubricants, and Metal Valves and Parts (Dredging)	2%	$376,194	2%	7%	65%
Pipeline Dredge Equipment and Repairs	5%	$931,528	3%	35%	100%
Aggregate Materials	3%	$519,506	58%	91%	98%
Switchgear and Switchboard Apparatus Equipment	0%	$53,742	2%	8%	80%
Hopper Equipment and Repairs	2%	$340,366	0%	1%	97%
Construction of Other New Nonresidential Structures	14%	$2,436,304	29%	68%	100%
Industrial and Machinery Equipment Rental and Leasing	7%	$1,307,722	6%	82%	100%
Planning, Environmental, Engineering and Design Studies and Services	5%	$824,044	100%	100%	100%
USACE Overhead	7%	$1,182,324	0%	17%	100%
Repair and Maintenance Construction Activities	4%	$734,474	12%	82%	100%
Industrial Machinery and Equipment Repair and Maintenance	11%	$1,880,970	51%	95%	100%
USACE Wages and Benefits	13%	$2,382,562	75%	100%	100%
Private Sector Labor or Staff Augmentation	15%	$2,740,842	100%	100%	100%
All Other Food Manufacturing	2%	$340,366	3%	20%	90%
Total	**100%**	**$17,914,000**	**-**	**-**	**-**

The table below displays the geographical capture amounts for each of the three geographical impact analyses, which is that portion of spending that is captured in each impact area. It initially measures $7,458,499 at the local impact level and increases to $15,051,431 at the State level, and expands to a $28,271,945 capture at the national level. The labor income represents all forms of employment earnings. In IMPLAN's regional economic model, it is the sum of employee compensation and proprietor income. The Gross Regional Product (GRP) which is also known as value added, is equal to gross industry output (i.e., sales or gross revenues) less its intermediate inputs (i.e., the consumption of goods and services purchased from other U.S. industries or imported). The number of jobs equates to the labor income.

***Table 25** Overall Summary Economic Impacts*

Impacts	Impact Areas	Regional	State	National
Total Spending		$17,914,000	$17,914,000	$17,914,000
Direct Impact				
	Output	$7,601,665	$13,226,109	$17,512,219
	Job	151.07	179.40	218.44
	Labor Income	$5,869,986	$8,245,112	$10,073,473
	GRP	$6,309,633	$9,514,217	$11,812,929
Total Impact				
	Output	$9,491,399	$22,444,380	$46,630,614
	Job	167.04	241.74	393.88
	Labor Income	$6,437,840	$11,317,558	$19,576,057
	GRP	$7,458,499	$15,051,431	$28,271,945

The next three tables present the economic impacts by Industry Sector both for each geographical region. Impacts at the national level show a tremendous expansion most certainly due to the multiple turnovers of money that ripple throughout the national economy.

***Table 26** Economic Impact at Regional Level*

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$0	0.00	$0	$0
171	Steel product manufacturing from purchased steel	$0	0.00	$0	$0
198	Valve and fittings other than plumbing manufacturing	$0	0.00	$0	$0
201	Fabricated pipe and pipe fitting manufacturing	$0	0.00	$0	$0
26	Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	$259,205	3.33	$27,436	$37,898
268	Switchgear and switchboard apparatus manufacturing	$0	0.00	$0	$0

290	Ship building and repairing	$0	0.00	$0	$0
319	Wholesale trade businesses	$64,098	0.38	$30,199	$50,803
322	Retail Stores - Electronics and appliances	$0	0.00	$0	$0
323	Retail Stores - Building material and garden supply	$22,331	0.20	$11,996	$16,286
324	Retail Stores - Food and beverage	$2,383	0.03	$1,386	$1,842
326	Retail Stores - Gasoline stations	$29,504	0.26	$13,959	$21,572
332	Transport by air	$335	0.00	$56	$131
333	Transport by rail	$0	0.00	$0	$0
334	Transport by water	$5,983	0.01	$1,193	$2,543
335	Transport by truck	$37,481	0.30	$14,548	$18,758
337	Transport by pipeline	$0	0.00	$0	$0
36	Construction of other new nonresidential structures	$700,129	3.98	$296,574	$353,371
365	Commercial and industrial machinery and equipment rental and leasing	$73,116	0.18	$15,191	$40,362
375	Environmental and other technical consulting services	$824,044	10.28	$466,025	$468,921
386	Business support services	$0	0.00	$0	$0
39	Maintenance and repair construction of nonresidential structures	$90,865	0.55	$40,262	$51,496
417	Commercial and industrial machinery and equipment repair and maintenance	$964,427	5.43	$571,201	$717,885
439	* Employment and payroll only (federal govt, non-military)	$1,786,922	12.00	$1,639,117	$1,786,922
5001	Labor	$2,740,842	114.15	$2,740,842	$2,740,842
69	All other food manufacturing	$0	0.00	$0	$0
	Total Direct Effects	$7,601,665	151.07	$5,869,986	$6,309,633
	Secondary Effects	$1,889,734	15.97	$567,853	$1,148,866
	Total Effects	**$9,491,399**	**167.04**	**$6,437,840**	**$7,458,499**

Table 27 *Economic Impact at State Level*

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$771,921	0.09	$23,056	$105,642
171	Steel product manufacturing from purchased steel	$81,093	0.12	$27,540	$33,297
198	Valve and fittings other than plumbing manufacturing	$0	0.00	$0	$0
201	Fabricated pipe and pipe fitting manufacturing	$233,211	0.92	$48,847	$85,007
26	Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	$259,205	3.33	$27,436	$37,898
268	Switchgear and switchboard apparatus manufacturing	$0	0.00	$0	$0
290	Ship building and repairing	$1,056	0.00	$274	$328

319	Wholesale trade businesses	$177,733	1.09	$83,737	$140,870
322	Retail Stores - Electronics and appliances	$981	0.01	$423	$552
323	Retail Stores - Building material and garden supply	$96,180	0.95	$51,668	$70,144
324	Retail Stores - Food and beverage	$2,383	0.03	$1,386	$1,842
326	Retail Stores - Gasoline stations	$29,504	0.26	$13,959	$21,572
332	Transport by air	$1,042	0.00	$243	$459
333	Transport by rail	$0	0.00	$0	$0
334	Transport by water	$5,983	0.01	$1,193	$2,543
335	Transport by truck	$241,307	1.92	$110,281	$134,303
337	Transport by pipeline	$11,679	0.02	$4,552	$4,375
36	Construction of other new nonresidential structures	$1,667,350	9.48	$736,474	$867,487
365	Commercial and industrial machinery and equipment rental and leasing	$1,072,911	2.67	$265,269	$616,223
375	Environmental and other technical consulting services	$824,044	10.28	$466,025	$468,921
386	Business support services	$201,897	3.89	$117,767	$116,549
39	Maintenance and repair construction of nonresidential structures	$602,003	3.63	$282,943	$353,772
417	Commercial and industrial machinery and equipment repair and maintenance	$1,779,797	10.05	$1,054,119	$1,324,817
439	* Employment and payroll only (federal govt, non-military)	$2,380,177	16.36	$2,183,301	$2,380,177
5001	Labor	$2,740,842	114.15	$2,740,842	$2,740,842
69	All other food manufacturing	$43,811	0.14	$3,775	$6,597
	Total Direct Effects	$13,226,109	179.40	$8,245,112	$9,514,217
	Secondary Effects	$9,218,272	62.33	$3,072,446	$5,537,214
	Total Effects	**$22,444,380**	**241.74**	**$11,317,558**	**$15,051,431**

Table 28 *Economic Impact at National Level*

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$818,196	0.10	$33,036	$149,775
171	Steel product manufacturing from purchased steel	$557,986	1.13	$189,494	$229,113
198	Valve and fittings other than plumbing manufacturing	$192,910	0.58	$47,917	$93,006
201	Fabricated pipe and pipe fitting manufacturing	$735,674	2.89	$177,490	$308,977
26	Mining and quarrying sand, gravel, clay, and ceramic and refractory minerals	$259,205	3.33	$27,436	$37,898
268	Switchgear and switchboard apparatus manufacturing	$33,602	0.09	$7,957	$16,409
290	Ship building and repairing	$325,616	1.53	$110,667	$132,891
319	Wholesale trade businesses	$416,438	2.58	$196,201	$330,067

322	Retail Stores - Electronics and appliances	$1,710	0.02	$788	$1,030
323	Retail Stores - Building material and garden supply	$96,180	1.05	$51,668	$70,144
324	Retail Stores - Food and beverage	$2,383	0.03	$1,386	$1,842
326	Retail Stores - Gasoline stations	$29,504	0.26	$13,959	$21,572
332	Transport by air	$1,042	0.00	$256	$480
333	Transport by rail	$12,298	0.07	$3,926	$6,644
334	Transport by water	$5,983	0.01	$1,193	$2,543
335	Transport by truck	$268,433	2.14	$123,022	$149,680
337	Transport by pipeline	$12,016	0.02	$5,304	$5,101
36	Construction of other new nonresidential structures	$2,436,304	15.53	$1,086,201	$1,276,216
365	Commercial and industrial machinery and equipment rental and leasing	$1,305,812	4.09	$338,167	$750,368
375	Environmental and other technical consulting services	$824,044	10.28	$466,025	$468,921
386	Business support services	$1,181,951	22.77	$749,017	$741,243
39	Maintenance and repair construction of nonresidential structures	$734,265	5.31	$345,739	$431,989
417	Commercial and industrial machinery and equipment repair and maintenance	$1,880,333	13.29	$1,133,665	$1,399,652
439	* Employment and payroll only (federal govt, non-military)	$2,382,562	16.38	$2,185,489	$2,382,562
5001	Labor	$2,740,842	114.15	$2,740,842	$2,740,842
69	All other food manufacturing	$256,930	0.81	$36,627	$63,961
	Total Direct Effects	$17,512,219	218.44	$10,073,473	$11,812,929
	Secondary Effects	$29,118,395	175.44	$9,502,584	$16,459,016
	Total Effects	**$46,630,614**	**393.88**	**$19,576,057**	**$28,271,945**

The total Iliuliuk Bay Navigation Improvements Project Economic Impact for the State of Alaska geographical area, as displayed above, is composed of $22,444,380 in sales, 241 jobs, $11,317,558 in labor income, and a contribution of $15,051,431 to GRP.