H. T. HARVEY & ASSOCIATES
Ecological Consultants
50 years of field notes, exploration, and excellence

Section 2081(b) Incidental Take Permit Application for Longfin Smelt for Activities Associated with 2025 Chevron Eureka Terminal Repairs In Humboldt Bay, California

Project # 3606-07

Prepared for:

Chevron
3400 Christie Street
Eureka, CA 95501

and

Pacific Affiliates
205 I Street, Suite B
Eureka, CA 95501

Prepared by:

H. T. Harvey & Associates

April 2025

Executive Summary

The information in this document serves as formal application for an Incidental Take Permit (ITP) under Section 2081(b) of the California Endangered Species Act (CESA) for a proposed project to be located in Humboldt Bay, California. The proposed project ('the Project') consists of improvements to the Chevron Eureka Terminal (Terminal), located in Eureka, California, on the eastern shoreline of the Entrance Bay region of Humboldt Bay and bordering the North Bay Channel. Mudflats north and south of the Terminal's trestle support native eelgrass (*Zostera marina*). CESA-threatened longfin smelt (LFS) larvae may potentially be impacted by Project activities and are thus included in this ITP.

This ITP application begins with background information on Humboldt Bay and the specific project sites. Descriptions of project components are included, in addition to background information on LFS. The level of detail provided directly supports the impact assessment. The impact assessment includes estimating take and the amount of mitigation area required to compensate for the loss of LFS based on the best available science. The activities involved in habitat restoration are reviewed, and the area of mitigation provided by the restoration is compared to estimates needed to compensate for estimated take from the Project.

Based on our assessment of the Project components, new LFS habitat will be created through pile removal, partially mitigating for estimated Project take. Especially when considering the expected footprint and short duration of Project impacts, it is evident that prior pile removal in 2016 and 2017 provides enough habitat to support more LFS than is estimated to be taken via Project activities in 2025. The issuance of the requested ITP will thus not jeopardize the continued existence of LFS in Humboldt Bay.

Table of Contents

Tables

Figures

List of Preparers

Carolyn Belak, Marine Ecologist

Sharon Kramer, Ph.D., Principal

Ellen Pimentel, M.S., Project Manager

Joy DeBruyn, Senior Technical Support

Sadie Trush, GIS Analyst

Abbreviated Terms

Key terms used throughout this document are defined here. These definitions are also incorporated contextually throughout this document.

- *The Project*—The Chevron Pier Terminal Improvements Project. Chevron is proposing to make additional repairs and upgrades to the Terminal, including replacement of piles and pile bracing, guide piles and guides, and a beam on the working platform.
- *Project Site*—Location within Humboldt Bay where aquatic-related Project activities will occur.
- *Project Area*—Region within Humboldt Bay where there may be direct and/or indirect effects on species listed under the Federal Endangered Species Act. This includes the terminal wharf structure and an additional 45 meters (150 feet) surrounding the Terminal. This distance, at which the sound pressure level resulting from proposed pile driving attenuates to a level that is equal to the ambient sound level, was calculated using a background noise level of 160 dB root mean square (RMS; ICF 2020), estimated acoustic impact zones from the present analysis, and methods outlined in Molnar et al. (2020). The Project site is located at the west end of Truesdale Street, in the city of Eureka along the east shore of Humboldt Bay, and west of Highway 101. The Project is surrounded by Humboldt Bay to the west and the city to the east.

Abbreviation	Definition
BMPs	Best Management Practices
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cm	Centimeters
dB	Decibels
ERDC	U.S. Army Engineer Research and Development Center
ESU	Evolutionarily Significant Unit
ETM	Entrainment Model
FHWG	Fisheries Hydroacoustic Working Group
ft	Feet
in	Inch
ITP	Incidental Take Permit
km	Kilometer
LFS	Longfin Smelt
m	Meters

Abbreviation	Definition
mi	Miles
mm	Millimeter
NMFS	National Marine Fisheries Service
p.	Page
ppt	Parts Per Thousand
PSU	Practical Salinity Unit
SEL	Sounds Exposure Levels
SFBE	San Francisco Bay Estuary
SONCC	Southern Oregon-Northern California Coastal
Terminal	Chevron Eureka Terminal
TL	Total Length
USFWS	U.S. Fish and Wildlife Service
YOY	Young-of-the-Year

Section 1.0 Project Applicant

This serves as formal application for an Incidental Take Permit (ITP) under Section 2081(b) of the California Endangered Species Act (CESA) for the proposed project described herein, to be located in Humboldt Bay, California. This application was prepared pursuant to Sections 702 and 2081(d) of the California Department of Fish and Game (CDFG) Code and contains the information requested therein.

Project Applicant (Lead Agency)
Chad Brandt
Chevron Products Company
3400 Christie Street
Eureka, CA 95501

Applicant Contacts
Travis Schneider
Pacific Affiliates
205 I Street, Suite B
Eureka, CA 95501
(707) 445-3001, Ext. 209

Section 2.0 Humboldt Bay

The Project is in Humboldt Bay and this section provides a background description of Humboldt Bay in its entirety. Details related to the specific locations of the Project are in Section 3.0.

Humboldt Bay is located along the northern California coast, is semi-enclosed, and spans approximately 14 miles (mi; 22.5 kilometers [km]) long and 4.5 mi (7.2 km) wide at its widest point; the surface area is 38.8 mi^2 (62.4 km^2) at mean high tide and 17.4 mi^2 (28.0 km^2) at mean low tide. The bay is made up of three subbasins: South Bay, North (Arcata) Bay, and Entrance Bay (Figure 1, Barnhart et al. 1992). Humboldt Bay has a 359 mi^2 (578 km^2) drainage area from watersheds of the Coast Range (Barnhart et al. 1992). The Elk River is the largest freshwater source, in addition to other tributaries such as Jacoby Creek and Freshwater Creek that feed into North Bay, and Salmon Creek that empties into South Bay (Schlosser and Eicher 2012).

Entrance Bay is a relatively narrow, deeper region in the middle of Humboldt Bay that leads to the ocean. From Entrance Bay, there is one deep connecting channel (North Bay or Main Channel) that joins the Entrance Bay and North (Arcata) Bay (Figure 1, Barnhart et al. 1992). The Main Channel splits at Tuluwat Island (formerly Indian Island) into the Samoa and Eureka channels that taper off into shallow channels at the furthest reaches of the intertidal flats in Arcata Bay (Schlosser and Eicher 2012). The North Bay Channel (Barnhart et al. 1992, Schlosser and Eicher 2012) (i.e., Main Channel [Swanson 2015]) runs from Entrance Channel up into the Samoa Channel and North Bay (Figure 1, Schlosser and Eicher 2012).

Humboldt Bay's north and south jetties are the terminus to both the North Spit (Samoa Peninsula) and the South Spit, respectively (Figure 1). The spits are bound by the Pacific Ocean to the West and Humboldt Bay to the east. North Spit is located along Arcata Bay (i.e., North Bay, basin north of Highway 255 Bridge), and the South Spit is located along the South Bay; both areas have maximum elevations of approximately 25 feet (ft) (7.6 meters [m]). The North and South Spits were developed during the last period of sea level rise and formed the bar-built estuary in combination with wave action (Barnhart et al. 1992).

The transition from natural to artificial shoreline within the bay primarily occurred between 1870 and 1946, and included the installation of docks and marinas, establishment of boat building and repair facilities, addition of railroad infrastructure, and conversion of wetlands to grazing lands (Barnhart et al. 1992, Laird et al. 2013). Present-day Humboldt Bay retains multiple docks and marinas for recreational, commercial, and marine services. These include the Chevron Eureka Terminal (Terminal). The bay entrance is routinely dredged to 48 ft (14.6 m) and the shipping channel where the Terminal is located is dredged to 38 ft (11.6 m).

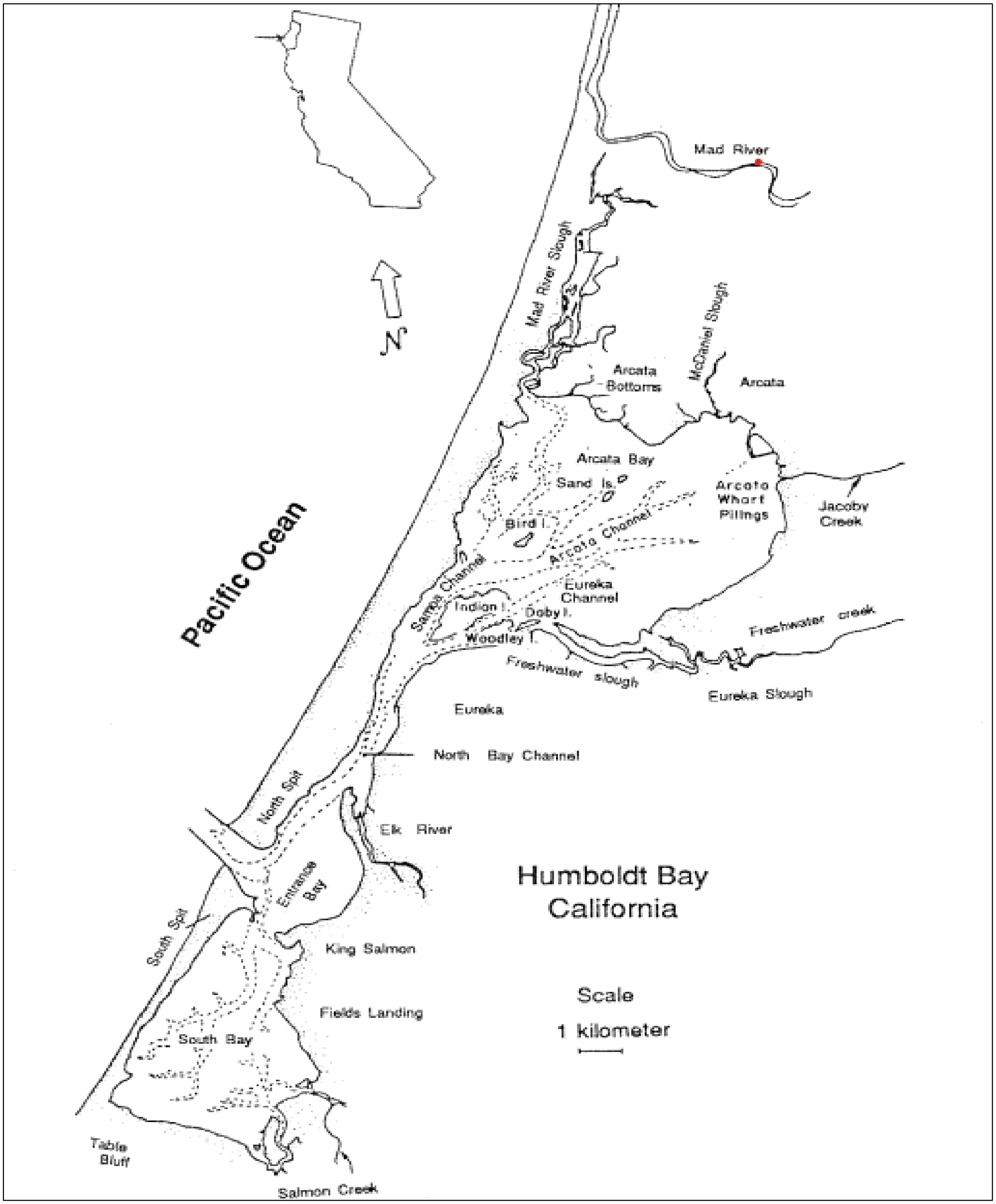

Figure 1. Humboldt Bay Overview

Notes: This map provides a general overview of key geographic features in Humboldt Bay, sourced from Barnhart et al. 1992 and modified from Costa 1982, as cited *in* Northern Hydrology and Engineering 2015. The Chevron Eureka Terminal is located approximately 366 meters north of the present mouth of Elk River. North Bay Channel (i.e., Main Channel) is the channel running between the North Spit and the city of Eureka, along which the Terminal is located.

Humboldt Bay is relatively shallow, with the majority of the bay comprised of tidal flats that are exposed during low tide (Costa 1982, as cited *in* Northern Hydrology and Engineering 2015). It supports a diversity of habitat types and spatially defined ecological communities, including eelgrass beds, invertebrate rich mudflats and subtidal habitats, salt marshes, wetlands, dunes, and seasonally flooded agricultural fields. Humboldt Bay habitats were evaluated by Schlosser and Eicher (2012), and 31% of the bay are comprised of eelgrass or patchy eelgrass, 28% of the bay comprised of subtidal habitat, followed by 21% unconsolidated sediment, and 12% macroalgae. Each community and habitat type contributes to the overall function of Humboldt Bay, provides a set of ecological services and supports a different species assemblage. The substrate, depth, and tidal/ marine influence are three (of many) characteristics that define a given community.

2.1 Project Components

In 2017, a retrofit project for the Terminal was completed to bring it into compliance with California Building Code Chapter 31F, Marine Oil Terminals and support the fuel transfer pipeway during a seismic event. In 2025, Chevron is proposing to make additional repairs and upgrades to the Terminal, including replacement of piles and pile bracing, guide piles and guides, and a beam on the working platform. The Terminal repairs will require construction activities that may affect marine resources in Humboldt Bay, California.

The respective locations where activity components are proposed are referred to herein as a '*Project site*' or '*Project area.'* Descriptions of the Project sites and activities for each component are provided in Section 3.0. The Project is expected to impact juvenile longfin smelt (*Spirinchus thaleichthys*) (LFS). Appropriate mitigation for the Project is addressed in Section 7 but is not considered one of the components of the Project itself.

Section 3.0 Project Description

In accordance with Marine Oil Terminal Engineering and Maintenance Standards, Chevron USA is proposing repairs and upgrades to the Terminal. The work will be conducted in a single phase with construction repairs scheduled for the work window between July 1 and October 15, 2025. These repairs and upgrades have potential to affect fish, designated critical habitat, and/or essential fish habitat in the Project area and methods are discussed here, as well as various best management practices (BMPs) that will be implemented. The analysis of effects is in Section 6.

3.1 Project Site

The Terminal consists of a timber trestle and wharf situated on the tidelands on Humboldt Bay, California, and bulk fuel storage facility on an adjacent upland parcel in the city of Eureka, Humboldt County (Figures 2 and 3). The Project site is located at the west end of Truesdale Street, in the city of Eureka along the east shore of Humboldt Bay, and west of Highway 101. The Project is surrounded by Humboldt Bay to the west and the city to the east. Chevron leases the tideland portion of the terminal area from the City of Eureka. The Terminal is T-shaped with an approximately 182.9-m-long trestle connected to an approximately 45.7-m-long wharf. Five mooring dolphins are connected to the wharf by timber catwalks. The overall length of the wharf and the catwalks is approximately 131.1 m. The Terminal trestle and wharf extend westward from shore through shallow waters to the margin of the North Bay Channel. The trestle is located approximately 365.8 m north of the present mouth of Elk River.

The Terminal serves fuel barges that arrive once every 10-12 days to deliver bulk fuel products. The fuel products are transferred from the barges to the bulk fuel storage facility through the unloading platform on the wharf and the fuel transfer pipeway on the trestle. Nearly all of the fuel used by the greater Eureka area is delivered via barge to the Terminal. Believed to have been originally constructed in the early 1900s, the facility has been expanded, upgraded, and repaired numerous times since. Serving fuel barges only, which provide their own hoses and pumps, the Terminal does not have any equipment, rack, towers, or loading arms on the wharf. Construction of the trestle and wharf are typical of a timber structure – wood pilings driven in rows are connection with a 12x12-inch (in) timber cap, and stringers span between piling caps and are covered with 4x12-in decking. Wood pilings are primarily creosote-treated, but a number of pressure-treated pilings have been installed over the years during repairs.

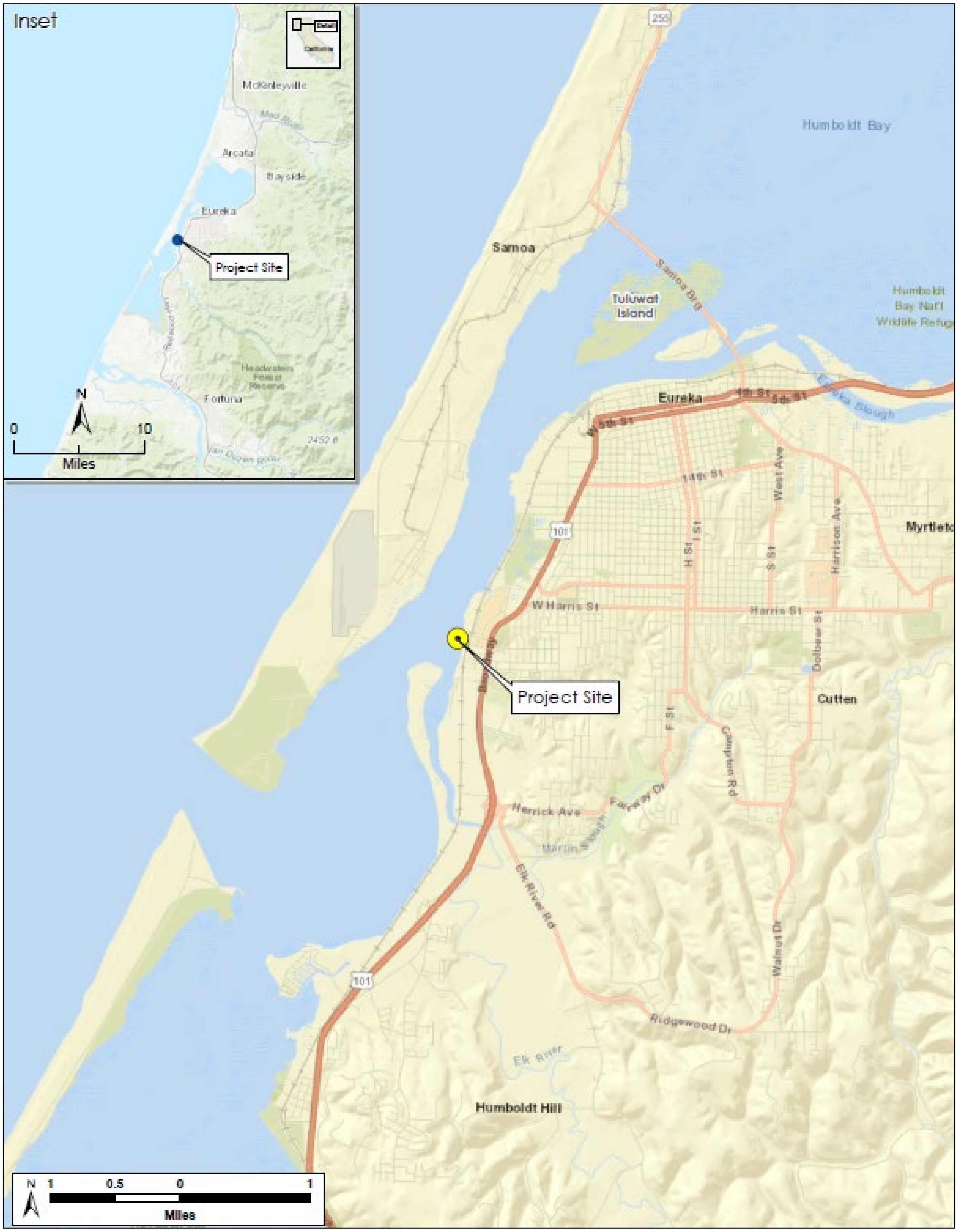

Figure 2. Chevron Eureka Terminal Project Location

Figure 3. Project Area

3.2 Terminal Repairs and Upgrades

The Project will occur in three discrete Project areas: replacement of piles and pile bracing on the dock causeway at Bents 8, 20, 21, 22, and 23; replacement of guide piles and guides at the floating dock; and replacement of the beam at the working platform (Figure 4). Work includes the removal of five timber piles at Bents 8, 20, 21, and 22 and three concrete piles at the floating dock. All piles identified in Bents 8, 20, 21, and 22 are located in eelgrass habitat (Figure 5). Timber piles will first be cut off 1 ft (0.3 m) below the mudline and will then be removed using a crane located on a floating barge; the barge will be anchored in place by setting two 28-in (0.71-m) diameter spud poles. The exact method of removal using the crane will be determined by the contractor. Timber piles (14-in [0.36-m] diameter) will be replaced with 16-in (0.41-m) diameter timber piles, fully coated with polyurea, installed to a depth of 40 ft (12.2 m). Existing concrete piles anchoring the floating dock will be removed and replaced with two 12-in (0.36-m) diameter steel guide float piles; once piles are replaced, new guide systems, bracing systems, and hardware will be installed as required to connect and reinforce the newly installed piles and the causeway. New piles located at Bents 8, 20, 21, and 22 on the causeway will be installed in eelgrass habitat, while the two steel guide float piles will be installed outside of eelgrass habitat.

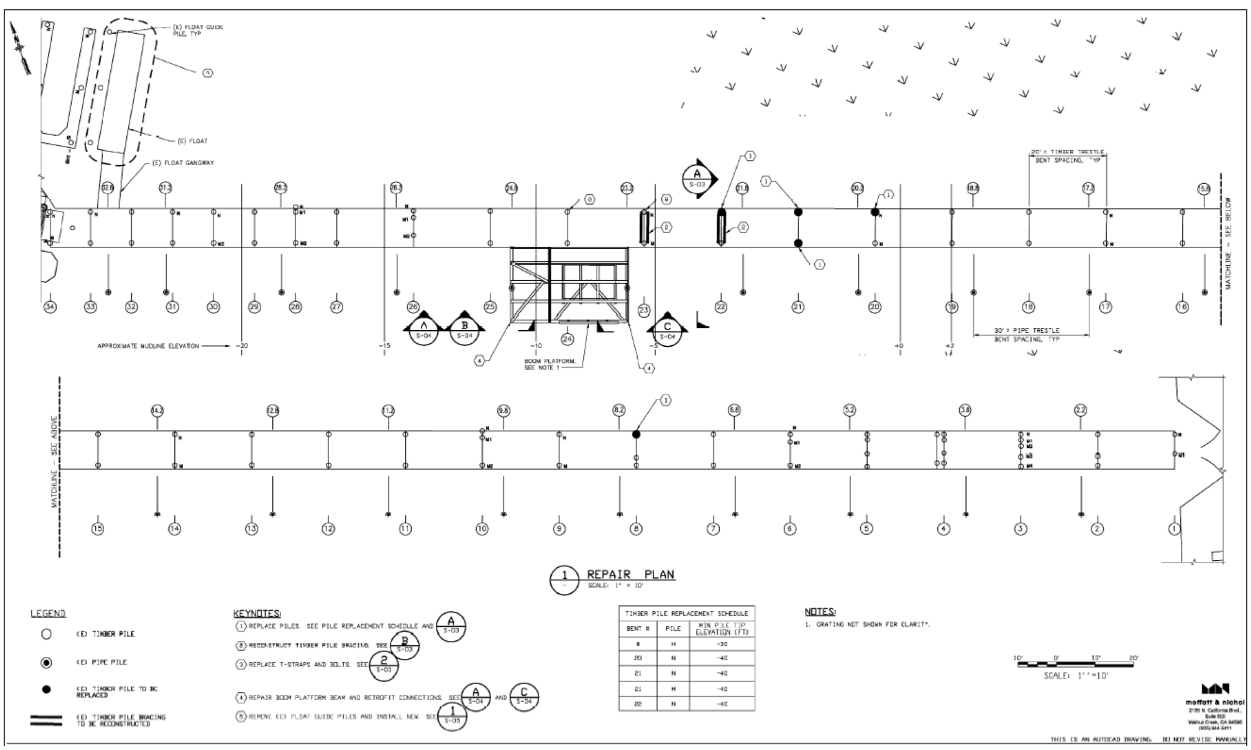

Figure 4. General Plans for 2025 Upgrades and Repairs to the Chevron Eureka Terminal

Figure 5. Location of Eelgrass in the Vicinity of the Chevron Eureka Terminal Project Site

Construction activities will be performed from a flat-bottomed barge with an approximately 4.9-ft (1.5-m) draft when loaded (e.g., the Moondoor II, a 113.8- by 78.1-ft [34.7- by 23.8-m] long barge). The barge will be powered and maneuvered into position by a push boat (e.g., the *Joseph George*). The barge will approach the trestle from the south side and will be repositioned as needed to access work locations. A crane (e.g., Kobelco CK1000-III Crawler Crane with a 120.4-ft [36.7-m] boom) will be positioned on the barge and will be used to install and remove piles and other components. Work in eelgrass habitat will be limited to times of the day when tidal heights are sufficient to allow the barge to float over the substrate.

All steel and timber piles will be driven to tip elevation or refusal using a crane and a vibratory hammer. If refusal occurs before tip elevation is reached, an impact pile-driving hammer will be used to drive the piles to the required tip elevation, completing the installation. Timber piles will be removed using a crane, with the method to be determined by the contractor. It is not known how long it will take to perform pile installation and removal procedures; however, because the work will occur only during high tides, the barge will not be in any given position long enough to affect eelgrass through shading. After they are removed, existing piles (Figure 6) will be placed on the barge in a containment area.

3.2.1 Project Timing

Following site preparation activities, in-water work is planned for a single phase with construction repairs scheduled for the work window between July 1 and October 15, 2025. The threshold exceedance will be implemented to maintain the project schedule (i.e. complete all in-water work before October 15). The pilings must be driven to their final location and surveyed by early October.

3.2.2 Mitigation and Monitoring Plan

The *Eelgrass Mitigation and Monitoring Plan for the Chevron Eureka Terminal 2025 Repairs* was developed by H. T. Harvey & Associates (2025a). It outlines the various construction activities, potential impacts, and mitigation techniques for eelgrass habitat. It additionally outlines the short-term construction impacts, long-term operations and maintenance impacts, and potential benefits, and information on mitigation project locations. Information in this monitoring plan is designed to support the BMPs.

3.3 BMPs

3.3.1 Pile Removal and Driving

The removal of piles and cross beams will be consistent with the recommendations of the *Humboldt Bay Eelgrass Comprehensive Management Plan* (Gilkerson and Merkel 2017) and is divided into two parts. The first part requires a staff member or designated representative to be present to ensure that these BMPs are adhered to. Part two of the management plan and BMPs require that:

- Neither the barge nor the tug will anchor during the project. The barge may attach to existing piles to maintain its position;
- During the barge method, piles will be removed at a tide of sufficient elevation to float the barge and tugboat adjacent to the piles being removed without scarring the mudflats or injuring eelgrass;
- Grounding of the barge will not be permitted;
- A floating containment boom will surround each pile being removed to collect any debris. To collect debris that floats below the surface but does not sink to the bottom, weighted plastic mesh (similar to orange construction fencing) will be attached to the boom and extended across the area surrounding the pile. If debris sinks to the bottom, then it will be removed by a diver;
- All equipment will be checked before use to minimize risk of petroleum product releasing to the bay. A spill response kit, including oil absorbent pads will be onsite to collect any petroleum product that is accidentally released;

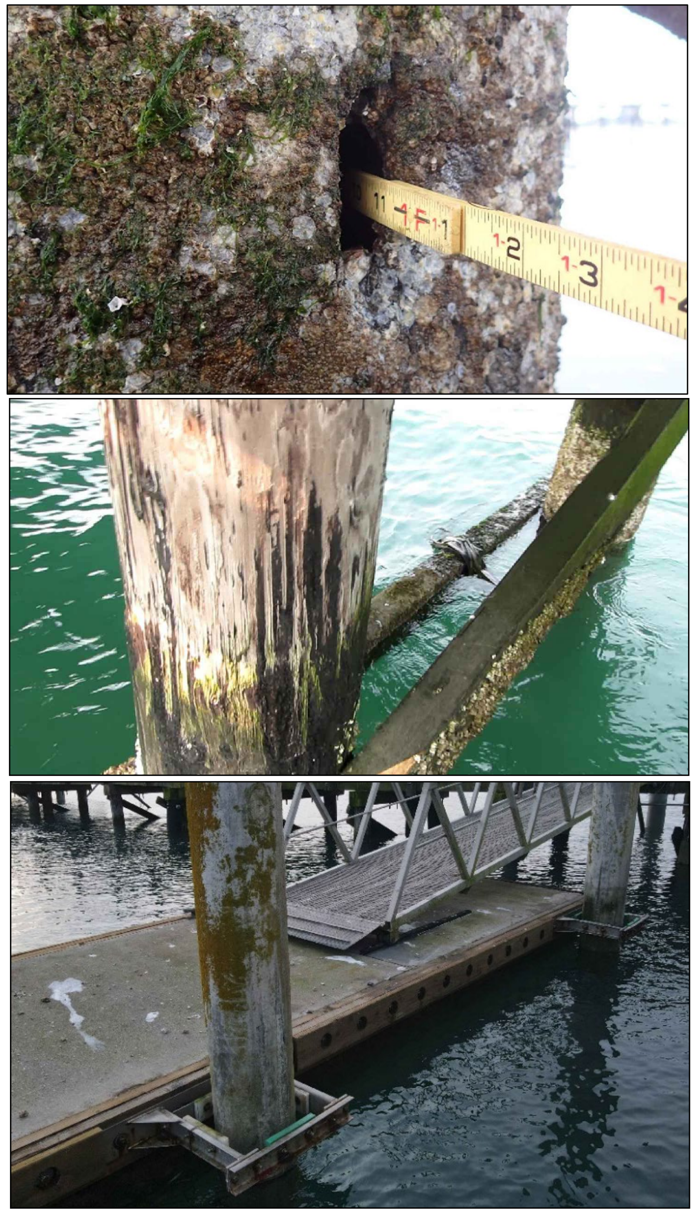

Figure 6. Existing Piles and Support Structures at the Chevron Eureka Terminal
Notes: Images from Chevron Eureka 2025 Maintenance Repairs. The Image on the top is the existing pile M at Bent 21. The middle image is the existing cross beam at Bent 23 that will be replaced. The bottom image is an existing concrete float guide pile.

- The crane and tug operators will be experienced with vibratory pile removal;
- The crane operator will break the soil/pile bond prior to pulling to limit pile breakage and sediment adhesion;
- All work should be confined to within the floating containment boom;

- Piles will be removed slowly to limit sediment disturbance;
- Piles will not be hosed off, scraped, or otherwise cleaned once they are removed from the sediment;
- Piles will be placed in a containment area on the barge to capture sediment attached to the piles;
- The containment area will be lined with plastic sheeting to not allow sediment or residual water to reenter the bay;
- Sawdust or woody debris generated from pilings that are cut 1 ft (0.3 m) below the mudline using a saw are to be retrieved and placed in the containment area;
- Holes left in the sediment by the pilings will not be filled. They are expected to naturally fill;
- Piles and debris will be removed from the barge carefully and moved to designated site for disposal preparation. Prior to disposal, the piles and debris will be stored on a paved surface, covered with tarps, and surrounded be an erosion boom, straw waddle, or hay bale perimeter;
- All removed piles or portions of piles will be disposed of at an authorized facility. No piles or portions of piles will be re-used in Humboldt Bay or along shoreline areas; and
- Land operations will not be conducted in wetlands in proximity to the staging site.

In addition to the BMPs described above, the following conservation and protection measures would minimize the risk of Project-related impacts to threatened and endangered species and their proposed and designated critical habitat:

- A biological monitor or team will be present onsite during work hours when (and if) impact hammer pile driving occurs, during work in the eelgrass area, to staff the hydroacoustic monitoring equipment, and record marine mammal use with the Project area. The monitor(s) will be responsible for ensuring that all pile driving work is conducted according to permit terms and conditions. In addition, contractor will consult with the biological monitor to ensure that any changes to means and methods are in compliance with permit conditions relating to the protection of estuarine resources;
- A bubble curtain will be placed around each piling during in-water pile driving activities that use an impact hammer to reduce noise levels to less than would results in injury or mortality of fish species. The bubble curtain will reduce the noise levels by up to 15 decibels (dB);
- Cushion pads will also be used if an impact hammer is required to finish driving any pilings that refuses during vibratory pile driving. The cushion pads should reduce noise levels, potentially by 4 to 5 dB;
- All impact pile driving activities will incorporate a "soft start" approach whereby the pilings are lightly tapped before the full hammer strength is applied. The first few taps of the hammer on the piling should deter fish away from the pilings before full impact hammer strength is applied, reducing the potential for fish to be present and exposed to potential injury during full hammer strikes;

- Hydroacoustic monitoring will be conducted at 10 m from all pile driving activities if an impact hammer is used to set the pilings. Impact hammer pile driving will cease for at least 12 hours if the cumulative sound exposure levels reach 186.5 dB at 10 m regardless of the number of strikes;
- Permanent and temporal impacts on eelgrass will be mitigated. The amount of mitigation will be determined from pre-construction and post-construction eelgrass survey data and prescribed mitigation ratios. Impacts and potential mitigation activities are addressed in a separate document (H. T. Harvey & Associates 2025a);
- A debris containment structure (i.e., floating boom) will be installed in Humboldt Bay outside of the pile driving area to ensure that any floating debris that enters the water will be contained for later collection and disposal; and
- A full complement of oil spill clean-up equipment will be on site and available for immediate deployment should there be an accidental discharge of fuel, lubricant, or hydraulic oils. Chevron will implement their Facility Response Plan, activate the Incident Command System, refer to the Coast Guard Dock Operation Manual, and enact Spill Prevention, Control, and Countermeasures.

Section 4.0 Species for Which Incidental Take Authorization is Requested

The Project Applicant is seeking authorization under Section 2081(b) of CESA for incidental take of threatened longfin smelt (LFS) because LFS likely occur within the Project area. Since there is reasonable potential for take of LFS larvae, they will be covered under the ITP. Coho salmon (*Oncorhynchus kisutch*) are the only other species that were considered for coverage, but coverage is not warranted under the ITP because operational work windows and pile driving noise mitigations are expected to avoid take (Section 4.4.4).

4.1 CEQA Lead Agency

Vanessa Blodgett
Contract Harbor District Planner
districtplanner@humboldtbay.org
707.825.8260

4.2 Consultation History

The California Department of Fish and Wildlife (CDFW) is the agency responsible for complying with the California Environmental Quality Act (CEQA) as it considers issuing an ITP under CEQA. In accordance with Title 14 of the California Code of Regulations, Section 783.3, the Harbor District Planner prepared a Mitigated Negative Declaration for Chevron and Pacific Affiliates to identify the significant effects of the Project on the environment, to identify alternatives to the Project, and to indicate the manner in which those significant effects can be mitigated or avoided. The Mitigated Negative Declaration (SCH# XXX) determined that the potentially significant impacts to LFS can be mitigated to a less than significant impact.

4.3 Longfin smelt (LFS)

LFS are anadromous, planktivorous forage fish present in estuarine and coastal waters from San Francisco Bay Estuary (SFBE) to the Aleutian Islands in Alaska. They are small fish with a predominantly two-year life cycle averaging 9-12 centimeters (cm) in length, although some live a third year and reach maximum length of about 14-15 cm (CDFG 2009, USFWS 2022). Adults and juveniles can be found in estuaries, primarily in the middle of the water column or at the bottom during the day, and become more associated with surface waters at night to follow prey (CDFG 2009).

LFS were listed as threatened under CESA in 2009 (CDFG 2009, Garwood 2017, CNDDB 2023). The San Francisco Bay and Sacramento-San Joaquin Delta (both of which are considered part of the SFBE) is the southernmost spawning location for LFS. It also supports the largest population in California. This population is genetically distinct (USFWS 2012) and was listed as threatened under the Federal Endangered Species Act on July 30, 2024 (USFWS 2024a). There are a select few freshwater populations, including the land-locked population in Lake Washington (CDFG 2009). Most available information on LFS is from studies in the SFBE or Lake Washington (Appendix Q *in* GHD 2021).

Based on a review of published articles, technical reports, specimen collections and field observations from 1889 through 2016, LFS populations span 15 watersheds and were collected in small and large estuaries with a wide range of flow regimes and habitat complexities (Garwood 2017). They are present in locations such as Humboldt Bay, in addition to regions with minimal estuarine habitats where water is dominated by freshwater flows, suggesting there are local adaptations and life-history patterns to support a broad use of estuary types (Garwood 2017, Brennan et al. 2022, Yanagitsuru et al. 2022).

4.3.1 Life History

LFS have an anadromous life history, where adults migrate from coastal marine and embayment habitats in the late fall to streams and estuaries to spawn (Lewis et al. 2019, Yanagitsuru et al. 2022). Based on the incubation period of newly hatched larvae captured in surveys, they primarily spawn from January through March (CDFG 2009). In the SFBE, the nearest genetically distinct population (Saglam et al. 2021), they typically spawn between January and April, but spawning may be as early as November and as late as June (USFWS 2012, Lewis et al. 2019). There is typically a two-year life cycle, while some individuals may spawn as one to three year olds, and most fish die after spawning but a few (mostly females) may live another year (USFWS 2012, Lewis 2021). Females lay adhesive eggs on sandy or grassy substrate that hatch after approximately 40 days (CDFG 2009). Larvae can be moved downstream to estuaries by high flows, but predominately spend considerable time in fresh water; it takes almost three months to reach the juvenile stage (USFWS 2012). The spatial distribution of juveniles shows a distinct seaward migration as water temperatures warm in the late spring and early summer (Rosenfield and Baxter 2007).

Their life history (and abundance and distribution) remains poorly understood, especially because of variations between subpopulations. Several new studies have altered or modified the existing understanding of their life cycle (Garwood 2017, Lewis 2021). For example, recent findings suggest their life cycle is likely more complex than simple anadromy (i.e., spawning in freshwater followed by a direct migration to sea) because optimal spawning and rearing may occur in a broader region than previously recognized, including more moderately brackish estuarine habitats and in restored wetlands (Grimaldo et al. 2017, Lewis et al. 2020, Yanagitsuru et al. 2022). Laboratory studies suggest that LFS are obligate freshwater-estuarine spawners unlikely to use marine-dominated habitats for reproduction (Yanagitsuru et al. 2022).

Larvae, especially in their early stages, are surface oriented and most abundant in upper layers of the water column. Once the swim bladder reaches inflation, larvae can move vertically in the water column, and older larvae and juveniles inhabit the middle and bottom strata of the water column (page [p.] 191 *in* Baxter 1999). These differences in how LFS use the water column throughout their life history are evident from catch abundances from plankton tows and mid-water and otter trawls. By May, most young-of-the-year LFS begin to reach 40 mm in length. Across the estuary, juvenile LFS have been collected most frequently from deep water channel habitats (≥7 m depth; Rosenfield and Baxter 2007), a similar habitat found at the end of the Chevron Eureka Terminal. CDFW Bay Study data indicate catches of juvenile and adult LFS follow this same trend, and catches of LFS at deep channel habitats also exhibit strong seasonality, with the majority taken in December, January and February (IEP 2022). Similarly, peaks in abundances of larval and juvenile LFS in Humboldt Bay channels and tributaries occurred in January, although catches were observed year-round (Eldridge and Bryan 1972, Garwood 2017).

4.3.2 Habitat Requirements

As previously mentioned, a large portion of LFS research has focused on the SFBE population. This includes studies on their preferred habitat (e.g., temperature, salinity, and foraging preferences). Because the SFBE population is near to Humboldt Bay, and LFS between the SFBE and Humboldt Bay share appreciable amounts of ancestry based on genetic analysis (Saglam et al. 2021), results from the numerous studies on the SFBE LFS population can, within reason, be applied to the Humboldt Bay population. In the SFBE, the southernmost part of their distribution, adults and juveniles have been found in waters of less than 22°C, and likely spend time in the coastal ocean during warmer periods to escape peak temperatures within the estuary during the summer (p. 194 *in* USFWS 2022). They are not known to return to most of the estuary until temperatures drop below 22°C in the fall.

Their spawning habitat, rearing habitat, and the presence of larvae is highly seasonal and linked to temperature (Lewis 2021). Laboratory and field studies on the SFBE population found that hatching success, size, growth and survivability depend on water temperatures being near or less than 15°C (USFWS 2022). Temperatures between 9 and 12°C have been experimentally identified as appropriate culturing temperatures for LFS embryos and larvae from the SFBE (Yanagitsuru et al. 2021). Larval abundance is strongly correlated to temperature, with peaks in abundance between temperatures of 8°C and 12°C (Grimaldo et al. 2017, Hobbs et al. 2010). The embryonic through early juvenile life stages are when SFBE LFS are believed to be most vulnerable to warming temperatures because they do not possess the ability to migrate to the cooler waters of central San Francisco Bay and the coastal ocean due to limited motility and increases in potential predation (USFWS 2024b). Grimaldo et al. (2017) also conducted field sampling throughout SFBE to explore larval densities across habitats. Of the 10 predictor variables considered, water temperature, salinity, and chlorophyll-a were key factors, and density was negatively correlated with temperature and positively related to chlorophyll-a (Figure 6 *in* Grimaldo et al. 2017). Even though their spawning typically occurs in water temperatures up to 13°C, lower temperatures are more ideal (USFWS 2022). Young juvenile LFS show a preference for temperatures below 20ºC (USFWS 2024b).

Across all life stages, LFS can tolerate salinities ranging from nearly pure salt water to completely fresh water, though larvae are rarely present in salinities greater than 8 parts per thousand (ppt) and most juveniles and adults prefer salinities of 15 to 30 ppt. For reference, salinities just north of the mouth of the Elk River and adjacent to the Project site ranged from 33.6 to 34.3 practical salinity units (PSU; roughly equivalent to ppt) between July 1 and October 15, 2025 (CeNCOOS 2025). Larval abundance and presence in rearing habitats are strongly correlated with salinity (Grimaldo et al. 2017, Lewis 2021, Yanagitsuru et al. 2022, Brennan et al. 2022).

Larval abundance in the SFBE peaks between of 2-6 PSU (as summarized by Yanagitsuru et al. 2022). Grimaldo et al. (2017) highlighted how the relationship between larval density and salinity in SFBE was non-linear, with peaks between 3 and 4 PSU, although data suggests that larvae can hatch and rear between ~2 and 12 PSU. In SFBE, the majority of LFS larvae are affiliated with the estuary's major low-salinity zones and are unlikely to be found in marine-influenced waters. However, juveniles (>20 mm in length) have been detected at one time or another throughout the estuary (USFWS 2024b); by their first summer, juvenile longfin smelt inhabit salinities up to and including marine water (Baxter et al. 1999, Rosefield and Baxter 2007, IEP 2022).

SFBE longfin smelt exhibit high prey-specificity. As larval and juvenile longfin smelt rear and feed in low-salinity habitats, they appear to only focus on two taxa – the copepod *Eurytemora affinis* and mysids (USFWS 2024a). Biomass of preferred copepod prey is significantly greater in southern SFBE ponds and sloughs than southern SFBE open bay habitats, suggesting that feeding incidence is higher in brackish estuaries (Barros et al. 2022). Pre-spawning adults have also shown a strong dietary preference for mysids, while relying on copepods and amphipods when mysids are scarce.

4.3.3 Use of Humboldt Bay

Humboldt Bay likely supports the most abundant population of LFS outside of SFBE (CDFG 2009). Historic records detailing the presence of LFS in Humboldt Bay, including field surveys from the late 1960s and early 1980s, have documented their presence (Eldridge and Bryan 1972, Chamberlain and Barnhart 1993). Results of these studies are detailed in Section 8. While they confirm LFS presence in certain locations within Humboldt Bay, these studies were not specifically designed to identify their distribution nor quantify abundance. More recent, targeted efforts have increased the knowledge base of LFS inside Humboldt Bay and its tributaries, confirming their existing presence (Cole 2004, Garwood 2017, Brennan et al. 2022, Tenera 2023).

General information on their existing presence in Humboldt Bay can be inferred from recent studies, although none were systematically designed to describe their distribution over their life cycle. For example, in extensive fish surveys conducted by Cole (2004), a total of 11 LFS with an average length of 126 mm were collected at four different sites. These 11 LFS contributed to <0.01% of the total number of individual fish captured in Humboldt Bay (Table 3 and 7 *in* Cole 2004). All LFS were collected via trawling in what was considered estuarine, subtidal, unconsolidated bottom, sand, and subtidal habitats.

LFS were historically very common in Humboldt Bay but have experienced a significant decrease in population since the 1970s (CDFG 2009). The reasons for the decline in Humboldt are unknown. A status review of LFS was conducted by CDFW prior to the species' listing under CESA. CDFG (2009) reported:

> "Beginning in 1960 and continuing through fall 1969, HSU professors and students sometimes collected longfin smelt with otter trawls inside and outside Humboldt Bay. Outside Humboldt Bay, sampling occurred along the Samoa Peninsula from just north of the bay entrance and for several miles north along the coast.

Small numbers of adult and juvenile longfin smelt were captured in recent years inside Humboldt Bay proper and in tributary sloughs (Cole 2004; Pinnix et al. 2005; Mike Wallace, CDFG Fisheries Biologist, personal communication 2007).

Small-but-consistent catches of a few dozed longfin smelt occurred during annual collections around a dredge disposal site about two miles offshore of Humboldt Bay (Tim Mulligan, Humboldt State University, 2008, reported to J. Milliken, USFWS)."

Recent efforts targeting LFS have increased the knowledge base of their use inside Humboldt Bay and its tributaries. With the primary objective to conduct surveys documenting LFS larval presence and habitat preference in coastal estuaries north of SFBE during the spawning season, Brennan et al. (2022) completed sampling tows at 16 estuarine sites with salinities between 2 and 12 ppt, from Tomales Bay north to the Smith River along the Oregon border. Sampling was conducted between January and April of 2019, and January to March and May of 2020. Larval smelt in Humboldt Bay specifically were limited to Eureka Slough, which is roughly 3.9 mi (6.3 km) upstream of the Project site (Figures 1and 2; Figure 2 *in* Brennan et al. 2022). Overall, salinity, turbidity, and year were the most critical factors determining the presence of larval LFS, and shallow, tidal wetlands in large estuaries and characteristics associated with increased freshwater outflows (low salinity, high turbidity) were positively associated with larval presence (Brennan et al. 2022). Catch probabilities increased with increased turbidity and decreased salinity (Figure 5 *in* Brennan et al. 2022), which aligns with results from LFS surveys in SFBE (Yanagitsuru et al. 2022). Note that Brennan et al. (2022) designed their surveys to assess locations where presence was expected.

Specialized surveys conducted between January and December 2022 also confirm the presence of larval LFS in Humboldt Bay (Tenera 2023); however, this study was not intended to identify their distribution nor abundance. Rather, Tenera (2023) designed the survey to estimate take from the Humboldt Bay Harbor District's Humboldt Bay Master Water Intakes Project. The overall approach was to collect data on the concentrations of fish larvae at the two intake locations and at six locations in the surrounding source water within Humboldt Bay, including Entrance Bay and the North Bay Channel adjacent to the Chevron Terminal (Figure 1; Figure 3-1 *in* Tenera 2023). Sampling methods were similar to those developed by the California Cooperative Oceanic and Fisheries Investigation in their larval fish studies (Smith and Richardson 1977), and subsequently have been used in other intake assessments in California (e.g., Tenera 2005). LFS were not collected in high abundance during the sampling efforts; a total of 11 larvae were collected via plankton net tows across all sampling sites (Tenera 2023). All catches of LFS larvae occurred between January and February 2022, with an average notochord length of 8.45 mm and an overall range of 7.19 to 12.87 mm. Salinity at the stations was approximately 30 PSU and close to 33 PSU during the January and February surveys, conditions near that of seawater. The presence of longfin smelt larvae was not documented in the bay in the summer/early fall months, when the Project work window is proposed.

4.3.4 ITP Issuance Request

We are requesting for LFS to be covered under this ITP because there is reasonable potential for take of this species through pile removal and pile driving activities associated with the Project.

4.4 Coho Salmon

Coho salmon are a widespread Pacific salmonid distributed across northern temperate latitudes (Moyle et al. 2008). They occupy most river basins in Northern California and spawn in streams from California to Alaska. Coho salmon from the Southern Oregon-Northern California Coastal (SONCC) Evolutionary Significant Unit (ESU) include naturally spawned coho salmon originating between Cape Blanco, Oregon and Punta Gorda, California, and spawning between Elk River, Oregon south through Mattole River, California (NMFS 2005a, 2014, 2016a). Thus, the ESU encompasses Humboldt Bay and its watersheds and overlaps with the Project area. The SONCC coho salmon ESU also includes those from the Cole Rivers Hatchery, Trinity River Hatchery, and Iron Gate Hatchery. There are several different functionally independent populations of SONCC coho salmon, and the Humboldt Bay population is one of the largest remaining populations (NMFS 2005b, Moyle et al. 2008, NMFS 2014).

The SONCC coho salmon ESU is federally and state threatened (NMFS 2005a). The life cycle for SONCC coho salmon can be divided into five essential habitat types: 1) juvenile summer and winter rearing areas, 2) migration corridors for juveniles, 3) areas for growth and development, 4) migration corridors for adults, and 5) spawning areas (NMFS 1999). Within these areas, essential features for critical habitat include locations with adequate substrate, water quality, quantity, temperature and velocity, cover/shelter, food, riparian vegetation, space, and safe passage conditions (NMFS 1999). Critical habitat was designated in 1999 to encompass reaches of all rivers between the Mattole River in California through the Elk River in Oregon (NMFS 1999), including the water, substrate, and adjacent riparian zones of estuaries and river reaches, thus overlapping with the Project area.

4.4.1 Life History

Coho salmon typically exhibit a 3-year life history (NMFS 2014), split between freshwater and saltwater phases. There are two basic life history strategies for juvenile coho salmon in Humboldt Bay tributaries (Wallace and Allen 2007). The first strategy includes those that rear in the upper estuary (near salt marsh habitat) for the summer and migrate back upstream to over-winter, and the second strategy includes those that rear in the lower estuary (e.g., intertidal habitat of Humboldt Bay) before migrating to the ocean.

Adults typically begin their freshwater spawning migration from October to late December, spawn primarily between November through January, and then die within 10-14 days following spawning (NMFS 2014). Adult females lay eggs in redds (gravel pits excavated by females) and the eggs incubate for 1.5 to 4 months prior to hatching as alevins (a larval life stage where there is still dependency on food in the yolk sack) (NMFS 2014). Alevins emerge from redds and following yolk sac absorption, become fry (juveniles). Juveniles rear in freshwater for up to 15 months. Their downstream migration as smolts typically begins between April and May and continues into June (NMFS 2014). The exact timing depends on the size of the fish, flow conditions, water temperature, dissolved oxygen, and food availability.

Once juveniles reach the estuary, they spend variable amounts of time completing their juvenile-to-smolt transformation. Growth rates in estuaries are generally higher than in freshwater habitats, and depending on the opportunity and capacity, will spend a few days to a few weeks in the estuary (Miller and Sadro 2003, Clements et al. 2012, Pinnix et al. 2013, Jones et al. 2014, all as cited *in* NMFS 2014). The migrating smolts enter the ocean in spring to late summer (NMFS 2014). Adult SONCC coho salmon generally spend two growing seasons (years) at sea prior to returning to their native stream to spawn (NMFS 2014). The upstream migration to spawning areas typically occurs from October to March, with peaks between November and January, but the exact timing depends mostly on stream flow (CDFG 2004).

4.4.2 Use of Humboldt Bay

SONCC coho salmon may be present year-round in fresh water tidal creeks and sloughs, deep and shallow tidal channels, and creeks and rivers in and around Humboldt Harbor and Bay. SONCC coho salmon migrate through Humboldt Bay twice throughout their life cycle: once on their migration to sea as smolts and once on their spawning migration upstream as adults. Coho salmon smolts are found in Humboldt Bay between April through the first week of July, but primarily move through the bay in May and June (Table 1, Pinnix et al. 2013) to feed throughout the north Pacific. Juveniles (85-240 millimeters [mm] fork length) use the brackish portion of the Bay as a nursery (Pinnix et al. 2013), and in the summer, the adults may make brief movements into Humboldt Bay entrance with incoming tides to feed on schools of forage fish. Juvenile SONCC coho salmon have been collected in deep channel, tidal channel, and subtidal habitats in Humboldt Bay, including the Samoa Channel (Cole 2004, NMFS 2016b). Adults are expected to begin entering freshwater tributaries to spawn in mid-October. The coming paragraphs describe the migration and habitat use of juvenile SONCC coho salmon after they leave their natal Humboldt Bay tributaries, move downstream into estuarine habitats, then through Humboldt Bay to the Pacific Ocean.

Table 1. Southern Oregon-Northern California Coastal Coho Salmon Life History Timing

	J	F	M	A	M	J	J	A	S	O	N	D
Adult migration into Humboldt Bay	dark grey	light grey								light grey	dark grey	dark grey
Upstream migration and spawning	light grey	light grey									dark grey	dark grey
Juvenile freshwater rearing	light grey	light grey	light grey	light grey	light grey	light grey	light grey	light grey	light grey	light grey	light grey	light grey
Downstream migration			light grey	dark grey	dark grey	dark grey	light grey					
Humboldt Bay outmigrants				light grey	dark grey	dark grey	light grey					

Note: Peak timing indicated by dark grey.
Source: Pinnix et al. (2013)

Coho salmon are likely to be present in the Project area when adults are returning to spawn and when smolts are outmigrating to the Pacific Ocean. Extensive fish surveys conducted in most of the habitat types in Humboldt Bay from September 2000 through November 2001 used a variety of gear types, including minnow traps, pole seines (sampling shallow water mostly intertidal habitats near jetties, and in mud flats), beach seines (sampling intertidal and subtidal habitats from shore), and epibenthic otter and beam trawls (sampling deeper water/channels near the bottom; Cole 2004). A total of 67 fish species from 25 families were collected in Humboldt Bay using all methods: the ten most abundant species accounted for 94.75% of the total catch; the three most abundant made up over 55% (threespine stickleback [*Gasterosteus aculeatus*], shiner surfperch [*Cymatogaster aggregata*], and topsmelt [*Atherinops affinis*]) (Cole 2004). Only five juvenile coho salmon were captured, contributing to <0.1% of the total number of individual fish captured (Cole 2004). Two juvenile coho salmon were captured in estuarine, subtidal, unconsolidated and sand bottom habitat measuring 98 and 105 mm total length (TL), one in estuarine, intertidal, unconsolidated and mud shore habitat measuring 127 mm TL, and two in estuarine, intertidal habitat with emergent and persistent vegetation measuring 93 and 99 mm TL (Cole 2004). Notably, none were captured in eelgrass habitat (Cole 2004).

More detailed information on residence time and habitat use of coho salmon within Humboldt Bay proper stems from acoustic telemetry studies specifically designed to monitor the movement of outmigrating smolts from freshwater habitats, through the estuary, into Humboldt Bay and the ocean (Pinnix et al. 2013). A total of 32 and 48 smolts were captured and acoustically tagged at the head of Freshwater Slough in 2007 and 2008, and monitored via fixed receiver networks and mobile tracking. The acoustically tagged juvenile coho salmon smolts leaving freshwater and estuarine habitats were found to occur in Humboldt Bay itself for 15-22 days prior to entering the Pacific Ocean (Pinnix 2008, Pinnix et al. 2013). They were rarely detected near structures such as pilings or docks inside Humboldt Bay, but preferred the deeper channels of Central Humboldt Bay, adjacent to the Project area (Pinnix 2008, Pinnix et al. 2013). Although coho salmon have been documented by receivers near the Project area, juveniles outmigrating to the sea are only present in Humboldt Bay for a short time period (Pinnix et al. 2013).

4.4.3 Threats

The most recent status review identified several key emergent or ongoing habitat concerns that threaten the recovery of SONCC coho salmon (NMFS 2024). These include insufficient tidal prisms continuing to limit sediment movement, reducing available habitat and connectivity between tidal, brackish, and freshwater habitats, and disrupting the formation, function, and persistence of salmon habitat. Significant declines of eelgrass have also been observed as a result of eelgrass wasting disease, disrupting ecosystem processes and reducing the quality and quantity of estuarine and migratory habitat elements (NMFS 2024). Insufficient stream flow and a lack of water for rearing juveniles during the summer remains a major habitat concern inhibiting the recovery of SONCC ESU, and groundwater use has significantly increased as water users rely more on groundwater pumping now that new state regulations further limit diversions directly from streams, resulting in a further reduction of flow (NMFS 2024). The threat posed by stormwater runoff from roadways is now greater than initially understood, because it contains 6PPD, a degradation product of tires that has recently been shown to cause salmon mortality at concentrations of less than one part per billion (Tian et al. 2021).

Lastly, increased frequency of drought since 2015 has resulted in 1) reduced quantity and quality of rearing habitat; 2) increased stress and disease due to chronic high temperatures; 3) reduced reproductive success due to increased redd scour in vulnerable areas; and 4) disruption of smolt outmigration as a result of disconnected flow and temperature barriers (NMFS 2024).

The most recent recovery plan for SONCC coho salmon identified key stresses and threats that are specific to the Humboldt Bay tributary population. The key limiting stressors include impaired estuary and mainstem function, and lack of floodplain and channel structure. Strong floodplain structure exists in locations where the river retains areas off the main channel (e.g., ponds and oxbows), which provide critical refuge during high winter flows. Sufficient channel structure exists where there are sufficient pools and instream structure (e.g., complex wood jams). The key limiting threat (for all populations of the coho SONCC ESU, in addition to the Humboldt Bay tributary population) is channelization, where stream channels are straightened and simplified, thus reducing off-channel habitat (NMFS 2014).

4.4.4 ITP Issuance Request

Take of coho salmon is not expected at the Terminal. Coverage for coho salmon is not being requested under this ITP because of the Project timing: SONCC coho salmon smolts were not observed in Humboldt Bay past the first week of July. Using the Pinnix et al. (2013) 15-22 days residence time, it is unlikely that coho smolts would be in the Project area during the work window of July 1 to October 15.

Section 5.0 Project Activities Resulting in Take

The potential take of LFS could result from the pile driving and removal activities.

Section 6.0 Impact Analysis and Potential for the Project to Take State-Listed Species

Project activities with the potential to take LFS will occur within the Project area. Effects on LFS could occur from noise and suspended sediment produced by pile driving and removal of contaminated pilings.

6.1 Pile Driving Noise Generation

The noise generated during driving the pilings into the sediment of Humboldt Bay has the potential to result in the injury or mortality of listed fish species that may be close to the work area.

The Fisheries Hydroacoustic Working Group (FHWG) has developed agreed-upon injury threshold criteria for listed fish species (FHWG 2008). The FHWG identified sounds pressure levels of 206 dB-peak at 10 m as being injurious to fish. Accumulated sounds exposure levels (SEL) at 10 m of 187 dB for fishes that are greater than 2 grams (g), and 183 dB for fishes below that weight, are considered to cause temporary shifts in hearing, resulting in temporarily decreased fitness (i.e., reduced foraging success, reduced ability to detect and avoid predators) (FHWG 2008). LFS weighing less than 2 g may be present in the Project area during construction (CDFW 2016).

It must be noted that recent research summarized in Popper et al. (2014) suggests that cumulative SEL thresholds for injury may be well above 200 dB. However, until there is broad agreement on the use of higher thresholds, those in FHWG (2008) should be used. It is very important to recognize that these criteria were developed for impact pile driving only. They should not be used to assess sounds from vibratory pile driving because the injury thresholds for impact driving are likely to be much lower than the injury thresholds for non-impulsive, continuous sounds produced by vibratory drivers. Until injury thresholds are developed for vibratory pile driving, this ITP will rely on the comparison of noise information developed for a number of projects that included both impact and vibration hammers.

Impact pile driving is the most commonly used pile driving method. Impact pile drivers are piston-type drivers that use various means to lift a piston (ignition, hydraulics, or steam) to a desired height and drop the piston (via gravity) against the head of the piling in order to drive it into the substrate. In general, an impact hammer driving 14-in steel pipe and timber pilings can be expected to generate peak dB of approximately 199 and 184 dB, respectively, at a distance of 10 m from the piling (Molnar et al. 2020). The single-strike SELs during impact driving of 14-in steel pipe and timber pilings have been documented as 169 and 145 dB, respectively, at a distance of 10 m from the piling. However, site conditions in the Project area may result in noise levels that are different from those reported by Molnar et al. (2020). Table 2 shows monitoring results for a number of pile driving projects conducted in the western U.S.

Vibratory pile driving, in contrast to impact hammer driving, uses oscillatory hammers that vibrate the piling, causing the sediment surrounding the piling to liquefy and allow penetration. The vibratory hammer produces sound energy that is spread out over time and is generally 10 to 20 dB lower than impact pile driving (Molnar et al. 2020). Peak sound pressure levels for vibratory hammers can exceed 180 dB; however, the sound from these hammers rises relatively slowly. Although peak sound levels can be substantially less than those produced by impact hammers, the total energy imparted can be comparable to impact driving because the vibratory hammer operates continuously and requires more time to install the piling (Molnar et al. 2020). Peak and cumulative SEL noise levels are not likely to exceed injury threshold levels if a vibratory hammer is used to place the pilings.

Table 2. Various Project-Measured Maximum Sound Pressure Levels at 10 m from Piling, Unattenuated

Project Location	Pile Type	Diameter	Water Depth	Hammer Type	Peak SPL (dB re 1 μPa)	SEL (dB re 1 μPa²s)
Richmond, CA – San Francisco Bay	Steel pipe	14-in	3–15 m	Diesel impact	199	169
San Rafael, CA – San Francisco Bay	Steel pipe	14-in	>15 m	Diesel impact	198*	170*
San Francisco, CA – Pier 39	Timber	14-in	5 m	Drop	184	145
Benicia, CA – Port of Benicia	Timber	~14-16 in†	10.7 m	Impact	180	148
Oakley, CA – Sand Mound Slough	Steel pipe	16-in	3 m	Drop	182	158
Eureka, CA – Humboldt Bay	CISS Steel pipe	36-in	10 m	Diesel impact	210	183

Notes: lb = pounds; m = meter; in = inches; CISS = castin-steel-shell. Humboldt Bay project included due to location.

* Sound levels measured at a distance of 22 m

† No data given on pile size; diameter estimated from reference photo (pg. I-108 in Molnar et al. 2020)

Source: Molnar et al. (2020)

The most common impact minimization measure used to minimize noise effects on fish from impact pile driving is the installation and operation of a bubble curtain around the piling. The air within the bubble curtain “absorbs” some of the noise generated from pile driving, which reduces the potential impact area. It can be expected that up to 15 dB attenuation can be achieved using a bubble curtain during a slack tide (Molnar et al. 2020). A rapidly incoming or outgoing tide reduces bubble curtain efficacy, since bubbles get carried away from the piling (Molnar et al. 2020). Therefore, this project will use a “stacked” series of bubble extruder rings to surround the piling with bubbles. In addition, to improve the effectiveness of the bubble curtain, the contractor will attempt to finish driving a piling with an impact hammer in the period that extends from an hour before to an hour after slack tide, which would avoid rapid tidal velocities. The contractor is aware that tidal action will make the bubble curtain less effective, which could result in exceeding noise thresholds and shutting down impact pile driving.

During impact pile driving, cushion blocks can be placed between the top of the piling and the hammer. The cushions are typically 1 to 3 in thick and made with wood, nylon, or a polymer material. The cushions are used to absorb and dissipate heat and can protect the top of the piling from damage. The Washington State Department of Transportation conducted a study to evaluate the effectiveness of each of the material types in reducing underwater sound generation (Washington State Department of Transportation 2006; as cited *in* Caltrans 2009) during the driving of 12-in diameter steel pipe pilings. The study results indicated that a wood piling cushion reduced sound levels from 11 to 26 dB. Polymer and nylon piling cushions reduced sound levels from 7 to 8 dB and 4 to 5 dB, respectively.

As stated in Section 3, vibratory pile driving will be used to the greatest extent possible during the Terminal improvements. However, there is the potential that during vibratory pile driving resistant subsurface sediment layers could be encountered, which would result in the piling refusing to go deeper. During this unlikely scenario, the contractor would be required to utilize an impact hammer to finish setting the piling. Sound levels generated by impact hammer pile driving have the potential to reach the FHWG (2008) threshold levels and injure listed fish species in the Project area.

An analysis was conducted of potential noise impacts of impact hammer pile driving on listed fish species in the Project area. The analysis for the 14-in and 16-in piles were based on unattenuated sound data provided by NMFS (2016b). Due to a lack of available data, source levels for impact driving of 14-in timber piles at Pier 39 in San Francisco, CA, were used as a proxy for source levels of 16-in timber piles (Molnar et al. 2020). The 14-in and 16-in data were then run through the NMFS (2022) pile driving noise calculation model to determine the distance from the piling where the onset of injury might occur. A second model run was conducted with the same peak and SEL dB data, but adjusted with an attenuation level of 5 dB to account for sound attenuation gained through use of a bubble curtain (-5 dB; Molnar et al. 2020). Although placement of a nylon cushion block between the hammer and piling is planned, no specific sound level reduction credit was applied, following guidance by Molnar et al. (2020). It was assumed that it would take 100 hammer strikes to finish setting a single pile, and one pile would be driven per day. As can be seen from Table 3 and Figure 7, attenuation of sound levels using a bubble curtain result in a significant decrease in the area where a fish may be subject to injury from pile driving sound levels. In predicting injury thresholds, NMFS considers the concept of "effective quiet," at which point the received SEL from an individual pile strike is below a certain level and the accumulated energy from multiple strikes would not contribute to injury regardless of how many pile strikes occur (Molner et al. 2020). Effective quiet is assumed to be 150 dB; as the single strike SEL for 16-in timber piles is estimated at 145 dB, it is therefore assumed that driving 16-in timber piles will not accumulate to cause injury. According to the model, the 183 dB threshold for fish <2 g would be met at 11.7 m for the 14-in steel guide pilings with attenuation.

Under a worst-case scenario, if a significant amount of impact pile driving is necessary due to early refusal, additional strikes with the impact hammer may be needed to reach the desired tip elevation or engineering piling setting criteria in order to complete all in-water work (pile driving and removal) by October 15, 2025. Table 4illustrates the estimated distance to injury thresholds based on the NMFS (2022) pile driving noise calculator with an additional 325 strikes (425 total) on 14-in and 16-in pilings (one pile per day). According to the model, the 183 dB threshold for fish <2 g would be met at 30.6 m for the 14-in pilings with attenuation. However, this worst-case scenario is unlikely to occur, given the short-term nature of the Project relative to the proposed work window.

Table 3. Modeled Distance to Injury for Unattenuated and Attenuated Impact Pile Driving Using 100 Strikes with an Impact Hammer

Piling Type	Attenuated with Bubble Curtain (Y/N)	Strike Peak (dB) at 10 m	Strike SEL (dB) at 10 m	Cumulative SEL (dB) at 10 m	Distance (m) to Onset of Physical Injury		
					Peak (206 dB)	Cumulative SEL dB	
						Fish ≥ 2 g (187 dB)	Fish < 2 g (183 dB)
16-in timber	N	184	145	165*	0.3	0.3	0.6
16-in timber	Y	179	140	160*	0.2	0.2	0.3
14-in pipe	N	199	169	189	3.4	13.6	25.1
14-in pipe	Y	194	164	184	1.6	6.3	11.7

Note: Actual measured sounds levels are expected to vary by an unknown degree from those estimated in the National Marine Fisheries Service calculator. dB = decibels; SEL = sound exposure level; m = meters; g = grams.

* See description above of "effective quiet" (150 dB): as single strike SEL for 16-in timber piles is estimated at 145 dB, it is assumed that these pile strikes will not accumulate to cause injury.

Table 4. Modeled Distance to Injury for Unattenuated and Attenuated Impact Pile Driving Using 425 Strikes on 16-in and 14-in Steel Pilings

Piling Type	Attenuated with Bubble Curtain (Y/N)	Strike Peak (dB) at 10 m	Strike SEL (dB) at 10 m	Cumulative SEL (dB) at 10 m	Distance (m) to Onset of Physical Injury		
					Peak (206 dB)	Cumulative SEL dB	
						Fish ≥ 2 g (187 dB)	Fish < 2 g (183 dB)
16-in timber	N	184	145	171*	0.3	0.9	1.7
16-in timber	Y	179	140	166*	0.2	0.4	0.8
14-in pipe	N	199	169	195	3.4	35.7	65.9
14-in pipe	Y	194	164	190	1.6	16.6	30.6

Note: Actual measured sounds levels are expected to vary by an unknown degree from those estimated in the National Marine Fisheries Service calculator. dB = decibels; SEL = sound exposure level; m = meters; g = grams.

* See description above of "effective quiet" (150 dB): as single strike SEL for 16-in timber piles is estimated at 145 dB, it is assumed that these pile strikes will not accumulate to cause injury.

Use of a vibratory hammer, bubble curtains (if an impact hammer is employed), cushion blocks, and soft strikes will minimize adverse effects on LFS. In addition, hydroacoustic monitoring will occur any time that an impact hammer is used. Impact hammer operations will be shut down if the cumulative SEL at 10 m from the piling exceeds 187 dB regardless of the number of hammer strikes.

Figure 7. Injury Zones for Fish Weighing < 2g, 14-Inch Pilings

The vast majority of available information regarding pile driving noise impacts is related to use of impact or vibratory hammers on steel or concrete pilings. No information was found that assessed noise levels for vibratory hammers removing wooden pilings. However, it is expected that use of a vibratory hammer to remove pilings would have lower sound levels and take a shorter period of time than driving in the pilings.

6.2 Potential for Take: Take Assessment

6.2.1 Estimates of LFS Take

Sound levels produced by the placement and removal of pilings with a vibratory hammer will not rise to the threshold levels of concern by FHWG (2008), and certainly not levels that would kill LFS. Therefore, the sound levels produced by placing or removing pilings with a vibratory hammer will not result in take of LFS.

Sound levels produced by impact hammer driving of 14-in steel pilings will rise to the threshold levels of concern by FHWG (2008) and could result in take of juvenile and adult LFS. The take of larval LFS is not expected, as spawning and larval grow out occurs between January and March (CDFG 2009, Garwood 2017), well outside of the Project work window (July 1 – October 15).

Mitigation measures, including the use of bubble curtains and cushion blocks, will be employed to reduce sound levels to minimize injuries to LFS. Estimates of sound levels and threshold distances in the present analysis are likely to be conservative, as certain mitigation measures (i.e. cushion blocks) were not accounted for in calculations but will likely provide additional attenuation benefits. In addition, sound monitoring will occur if impact pile driving is conducted. The sound monitor will have the authority to stop any pile driving if the accumulated SEL exceeds 187 dB at 10 m from the piling. Use of a "soft start" for impact pile driving will be employed to encourage any fish to leave the area.

The estimated acoustic impact area can be used as a surrogate for the number of fish that are likely to be within the impact area (Molnar et al. 2020). The two 14-in guide float piles to be driven will produce sound levels that will meet the 183 dB threshold for fish <2 g at 11.7 m with attenuation (Table 3). This results in an impact area of 107.5 m^2 for each pile, with the total estimated acoustic impact area calculated as 2 (piles) times 107.5 m^2 = 215 m^2.

There are very scant LFS data from Humboldt Bay available to use to estimate the amount of Project-related take during in-water work activities. One study from Cole (2004) targeted fish using otter trawls and beam trawls across various habitats in Humboldt Bay between September 2000 and November 2001. A total of 41 trawls were conducted. Although no density data was reported, a total of 54,888 fish were captured, of which 11 (0.02%) were LFS, with an average TL of 126 mm. All LFS were found in habitat type E1UB2L, where E = estuarine, 1 = subtidal, UB = unconsolidated bottom, 2 = sand, and L = subtidal, which may be similar to the habitat at the Chevron Pier.

A two-year study was conducted by Pinnix et al. (2005) in Arcata Bay (North Humboldt Bay) between August 2003 and August 2005 to test fish sampling gear types, document baseline fish community composition, and assess community structure and catch rates over eelgrass, mudflats, and oyster farms. The study collected fish using beach seines, purse seines, fyke nets, cast nets, shrimp trawls, and minnow traps. The 2005 final report analyzed 376 trawl samples (3 sets per sample = 1072 individual trawl sets) and 45 fyke nets conducted from August 2003 to August 2005; due to boat problems and inclement weather, trawling in November 2003 and March 2004 was infrequent, and no sampling was conducted from November 2004 to February 2005 and June to July 2005. A total of 22,278 fish were captured across all gear types, of which 12 (0.05%) were adult LFS. No larval or juvenile smelt were captured, although the mesh size of the nets may have allowed for these smaller fish to escape capture.

In the SFBE, the long-term CDFW Bay Study sampled juvenile LFS using otter trawls between the Central Bay, San Pablo Bay, and Suisun Bay (U.S. Army Engineer Research and Development Center [ERDC] 2013). Data from Central Bay was used to inform the present analysis, as the Central Bay stations are located near the mouth of the estuary, similar to the Chevron Pier location in Humboldt Bay. The mean Catch-Per-Unit-Effort for LFS in Central Bay (Richmond Harbor) for 2002-2011 was 38.2 (fish/m^2 X 10,000), or 0.00382 fish/m^2 (Table 2-6 *in* ERDC 2013). Using this density data as a best available estimate for Humboldt Bay LFS densities, it is expected that impact hammer pile driving will result in the take of 0.8, or rounded up to 1 LFS within the 215 m^2 acoustic impact area.

CDFG (2009) reported that LFS were historically very common in Humboldt Bay, but have experienced a significant decrease in population since the 1970s. Therefore, it appears that a limited number of LFS may be in the vicinity of the marine terminal during Project operations and only a subset of those would be exposed to noise-related effects associated with impact hammer pile driving. With incorporation of the above mitigation measures, it is expected that impact hammer pile driving could result in the take of up to one LFS.

Section 7.0 Minimization and Mitigation Measures

7.1 Minimization Measures

The BMPs described in Section 3.3 are expected to minimize take of LFS at the Terminal. Minimization measures will be employed to reduce sound levels to minimize injuries to LFS, including the use of cushion blocks and bubble curtains, which should result in an approximate 15 dB reduction in sound levels. Estimates of sound levels and threshold distances in the present analysis are likely to be conservative, as certain mitigation measures (i.e. cushion blocks) were not accounted for in calculations but will likely provide additional attenuation benefits. In addition, sound monitoring will occur if impact pile driving is conducted. The sound monitor will have the authority to stop any pile driving if the accumulated SEL 10 m from the pile exceeds 187 dB. Use of a "soft start" for impact pile driving will be employed to encourage any fish to leave the area. With the incorporation of these minimization measures, it is expected that impact hammer pile driving will result in the potential take of one LFS.

7.2 Estimates of Mitigation Requirements

With incorporation of the minimization measures described in Section 6, the take of up to one LFS is expected to occur due to implementation of the Project. To mitigate the take of up to one LFS during the 2016 Terminal seismic retrofit, 42.4 ft^2 (3.94 m^2) of habitat was restored (Stillwater Sciences 2016b). CDFW (ITP No. 2018-2016-034-01) determined that this restoration of compensatory habitat, along with minimization, monitoring, and reporting requirements, minimized and fully mitigated the impacts of the take caused by the 2016 project. Given the reduced footprint and short-term nature of the present project, the mitigation of 42.4 ft^2 (3.94 m^2) should once again adequately cover the take of one LFS.

To mitigate permanent losses to eelgrass habitat, Chevron will remove 1.52 m^2 of piles at another location in Humboldt Bay (within Eureka city limits) as out-of-kind mitigation (H. T. Harvey & Associates 2025a). To cover potential LFS take, this mitigation project will include an additional 3.94 m^2 (at a 1:1 ratio) of piles. Monitoring will be conducted prior to pile removal at the mitigation site to confirm the size of the piles to be removed, and after the piles have been removed to confirm that the appropriate total area has been removed.

Additionally, mitigation for LFS take in 2016 included removal of five creosote-treated pilings and one timber dolphin (Stillwater Sciences 2016b). The five pilings covered 1.06 ft^2 (0.10 m^2) each (5.3 ft^2 [0.49 m^2] total) and the timber dolphin was approximately 100 ft^2 (9.29 m^2), of which the removal of 37.1 ft^2 (3.45 m^2) was used as LFS mitigation. The remainder of the dolphin area (100 – 37.1 = 62.9 ft^2) was banked for future mitigation. The credit remaining (62.9 ft^2, or 5.84 m^2) is more than enough to cover compensatory mitigation for the take of up to one LFS.

Section 8.0 Jeopardy Analysis: ITP Issuance Analysis

This section focuses on identifying the Project impacts on the continued existence of the state-listed species per ITP issuance. Abundance trends, population size, and factors and threats affecting LFS abundance are discussed, followed by the final ITP issuance analysis on whether the proposed Project will jeopardize the continued existence of the species.

8.1 Population Trends

LFS stocks in California are well below historic population levels; however, abundance trends outside of SFBE are not well reported. Exact population trends are challenging to quantify because there has been no comprehensive historic studies that evaluate distribution and abundance, and current studies are limited in their spatial and temporal scope. By qualitatively evaluating available information, it appears as though there have been significant declines. In the Humboldt Bay Watershed from the 1960s through early 1980s, LFS were common within and outside Humboldt Bay, and likely spawned in tributary watersheds (p. 5 *in* CDFG 2009).

Larval fish surveys were conducted in Humboldt Bay in 1969, as part of a series of studies investigating marine resources within Humboldt Bay and to determine the seasonal and areal distribution of larval fishes (Eldridge and Bryan 1972). A total of 118 plankton tows collecting larval and juvenile fishes were completed between January and December 1969. Sampling was conducted at five stations, including one station located in North Bay Channel near the Terminal. A total of 27 different species of larval and juvenile fishes from 17 families were identified (p. 4 *in* Eldridge and Bryan 1972). There were peaks in seasonal abundance in January and February, and April and May (with relatively few fish caught June through December), and the number of larvae increased with increased distance from the mouth (p. 5 and 6 *in* Eldridge and Bryan 1972). In terms of larval abundance, LFS, bay goby, pacific herring, pacific staghorn sculpin, and arrow gobies made up 95% of all larvae captured (i.e., LFS larvae were in the top 5 most abundant species of larvae) suggesting they were relatively abundant; however, bay goby and Pacific herring together made up 82% of the catch. LFS larvae and juveniles were collected throughout the year, with catches peaking in January, and ranged from 4 to 51 mm (Table 1 *in* Eldridge and Bryan 1972). A total of 525 and 186 larvae were caught in the oblique (water column) and bottom tows, respectively. No juveniles were collected in the oblique tow, and two were collected in the bottom tows.

There are also historical records of LFS in Humboldt Bay from field surveys in North Bay from July 1981 through October 1982 (Chamberlain and Barnhart 1993). These field surveys were designed to determine whether marsh restoration efforts provided adequate mitigation for the construction of Woodley Island Marina, and similar to Eldridge and Bryan (1972), were not intended to quantify abundance nor distribution. Monthly surveys using several different collection methods were conducted at channels adjacent to and within two marshes (Freshwater and Eureka Slough) and adjacent to Woodley Island Marina (Eureka Channel; Figures 1 and 2). A total of 27 juvenile and 4 adult LFS were caught at these three sites contributing to <1% of total catches (Table 1 and 2 *in* Chamberlain and Barnhart 1993). Larval LFS made up 1% of ichthyoplankton surveys in Freshwater Slough, and were not collected in Eureka Slough nor Eureka Channel (Table 3 *in* Chamberlain and Barnhart 1993).

Small numbers of adult and juvenile LFS have been captured in recent years, and previous ITP applications have reported that there has been a significant decline since the 1970s (Stillwater Sciences 2016a). Since neither historic nor recent studies looked specifically at the distribution and population within Humboldt Bay, and without long-term monitoring, exact abundance trends cannot be determined. That said, LFS larvae were once in the top five species contributing to 95% of larvae collected in Humboldt Bay (Eldridge and Bryan 1972). Recently, studies have found a decline in their contribution to catch efforts, suggesting they may be present in lower numbers than they have in past surveys. Information from field studies in SFBE have found that spawning and rearing occurs in brackish estuarine habitats and restored wetlands, and laboratory experiments suggest that LFS are obligate freshwater-estuarine spawners (Grimaldo et al. 2017, Lewis et al. 2020, Yanagitsuru et al. 2022). Brennan et al. (2022) surveyed bays north of SFBE and found LFS larvae consistently in Eureka Slough over the two-year survey effort. Therefore, it is possible that adult and larval LFS are in regions of Humboldt Bay and its tributaries that have not previously been a focus of surveying. Additionally, the loss of 90% of the intertidal coastal marsh habitats that LFS spawn and initially rear in is likely a bottleneck to their populations recovering in California, particularly in the Eel River and Humboldt Bay (Garwood 2017).

8.2 Population Threats

Within SFBE, the three indices used by CDFW to monitor relative abundance have been declining since the 1980s (Figure 4 *in* CDFG 2009). The threats identified as being critical for the SFBE may also apply to the Humboldt Bay population given that the SFBE population is genetically most similar to those in Humboldt Bay (Saglam et al. 2021). For example, the amount and duration of freshwater input from rivers and tributaries flowing through the estuary determines where there are temperature and salinity conditions suitable for LFS (USFWS 2024b). Those in the SFBE (as with Humboldt Bay's population) need appropriate freshwater or low saline water and appropriate water temperature to spawn, hatch and rear, and adequate food resources. Thus, the magnitude, timing, and frequency of freshwater flow both at a seasonal and annual scale are requirements for successful spawning and rearing (USFWS 2024b). Freshwater flows must be strong enough to prevent waters from becoming too warm and/or saline but cannot be too strong whereby the eggs are incapable of sticking to substrate.

Sedimentation from land use is another potential threat (USFWS 2012). Since LFS spawn in tributaries, it is possible that the increase in fine sediment from tributaries in the Humboldt Bay watersheds and nearby rivers has adversely impacted their preferred spawning habitat, as fine sediment interferes with adhesion of eggs to substrate (Stillwater Sciences 2016a). Existing threats may also result from predation, entrainment from larger diversion facilities (this is likely more problematic in SFBE than it is inside Humboldt Bay), and contaminant loads.

8.3 Reasonably Foreseeable Impacts from Other Projects

There are a number of reasonably foreseeable projects within the Humboldt Bay area that could potentially result in impacts on LFS. The following list indicates these projects, and the activity that may impact LFS.

- Maintenance dredging at Woodley Island Marina and Fields Landing Boat Yard;
- U.S. Army Corps of Engineers dredging of the Humboldt Bay shipping channels to maintain adequate depth for ships and barges using hopper-type dredges. These activities may entrain LFS;
- Future dredging of the interior Fisherman's Channel to support unimpeded navigation at low tide. These activities may entrain LFS;
- Initial and maintenance dredging (and pile driving) by the Harbor District near Redwood Marine Terminal I to develop two wharfs and a wet storage area. These efforts are part of the District's port redevelopment project, to provide facilities that can support the development of the offshore wind. The dredging activities may entrain LFS, and pile driving may have acoustic impacts;
- Development of the Humboldt Bay Seawater Intakes. Increased withdrawal from the bay, to support tenants such as Nordic Aquafarms, may result in entrainment of LFS;
- City of Eureka's dredging of the Eureka waterfront, boat basin, and dock; and
- Caltrans pile driving at Eureka Slough Bridge.

A more complete list of potential projects involving dredging can be found in Section 2.2.1 (Dredging Sites) in the Programmatic Environmental Impact Review Humboldt Bay Sediment Management Plan (ICF 2020).

8.4 Species Impact Assessment

The issuance of the requested ITP would not jeopardize the continued existence of the species, considering:

- It is estimated that installation of five timber causeway piles and two guide piles will take a maximum of seven 10-hour working days, assuming one pile is driven per day;
- Larval LFS are not expected to be in the Project area, given the extent of the proposed work window (July 1 – October 15) and their preference for low salinity, brackish habitats;
- The distance to injury will extend 11.7 m from the 14-in guide piles with attenuation for fish <2 g in weight. This acoustic impact area only barely extends into the adjacent North Bay Channel, where juvenile and adult LFS may be present; and
- Using "soft start" methods, juvenile and adult LFS will likely move out of the area during pile driving activities. Any disruption of normal behavioral patterns will not result in take, due to wide expanses of suitable habitat adjacent to the Project area.

Nonetheless, although it is not anticipated, the take of one LFS is requested. Previous and proposed mitigation will restore enough habitat to support more LFS than what will be taken via pile driving at the Terminal.

Section 9.0 Monitoring Plan for Compensatory Mitigation

Please see Attachment 1 for the acoustic monitoring (H. T. Harvey & Associates 2025b) that will be implemented during impact hammer pile driving.

As stated in Section 3.3, a biological monitor or team will be present onsite during work hours when impact hammer pile driving, work is conducted in eelgrass areas, to monitor marine mammal activity, and to staff the hydroacoustic monitoring equipment. The monitor(s) will be responsible for ensuring that all in-water work is conducted according to permit terms and conditions. In addition, the contractor will consult with the biological monitor to ensure that any changes to means and methods are in compliance with permit conditions relating to the protection of estuarine resources.

Section 10.0 Funding Source for Compensatory Mitigation

The mitigation funding source is Chevron. Full funding has already been applied to mitigation of impacts on LFS as described above, through previous creosote-treated dolphin pile removal conducted in 2016 and 2017, and additional funds will be secured for 2025 pile removal at an additional mitigation site within Humboldt Bay (H. T. Harvey & Associates 2025a).

Section 11.0 Certification

I certify that the information submitted in this application is complete and accurate to the best of my knowledge and belief. I understand that any false statement herein may subject me to suspension or revocation of this permit and to civil and criminal penalties under the laws of the State of California.

By: ______________________________ Date: ______________________________

Name: ______________________________

Title: ______________________________

Section 12.0 References

Barnhart, R. A., M. J. Boyd, and J. E. Pequegnat. 1992. The Ecology of Humboldt Bay, California: An Estuarine Profile. January. Biological Report 1. U.S. Fish and Wildlife Service, Washington, D.C.

Baxter, R. D. 1999. Report on the 1980-1995 Fish, Shrimp, and Crab Sampling in the San Francisco Estuary, California. 63. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Technical Report. Sacramento, California.

Brennan, C. A., J. L. Hassrick, A. Kalmbach, D. M. Cox, M. Sabal, R. Zeno, L. F. Grimaldo, and S. Acuña. 2022. Estuarine recruitment of longfin smelt (*Spirinchus thaleichthys*) north of the San Francisco estuary. San Francisco Estuary and Watershed Science 20(3):1–15.

[CDFG] California Department of Fish and Game. 2004. Recovery Strategy for California Coho salmon. February 2004. Report to the California Fish and Game Commission.

[CDFG] California Department of Fish and Game. 2009. A Status Review of the Longfin Smelt (*Spirinchus thaleichthys*) in California. January 23. Report to the Fish and Game Commission.

[CDFW] California Department of Fish and Wildlife. 2016. California Endangered Species Act Incidental Take Permit No. 2081-2016-034-01 for the Chevron Eureka Terminal Seismic Retrofit.

[Caltrans] California Department of Transportation. 2009. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish. February.

California Natural Diversity Database. 2023. State and Federally Listed Endangered and Threatened Animals of California. January. Prepared by the California Department of Fish and Wildlife, Sacramento, California.

[CeNCOOS] Central and Northern California Ocean Observing System. 2025. California Ocean Observing Systems Data Portal – Humboldt Bay Pier (NDBC: HBXC1). https://data.caloos.org/#map. Accessed April 2025.

Chamberlain, R. H., and R. A. Barnhart. 1993. Early use by fish of a mitigation salt marsh, Humboldt Bay, California. Estuaries 16(4):769–783.

Cole, M. E. 2004. Distribution of fish species in Humboldt Bay, Humboldt County, California, USA: A GIS Perspective. Thesis. Humboldt State University, Arcata, California.

Eldridge, M. B., and C. Bryan. 1972. Larval Fish Survey of Humboldt Bay, California. December. NOAA Technical Report NMFS SSRF-665. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Seattle, Washington.

[FHWG] Fisheries Hydroacoustic Working Group. 2008. June 12, 2008 Memorandum – Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. NOAA Fisheries, U.S. Fish and Wildlife Service, California/Washington/Oregon Departments of Transportation, California Department of Fish and Game, U.S. Federal Highway Administration.

Garwood, R. S. 2017. Historic and contemporary distribution of longfin smelt (*Spirinchus thaleichthys*) along the California coast. California Fish and Game 103(3):96–117.

GHD. 2021. Draft Environmental Impact Report Samoa Peninsula Land-based Aquaculture Project. Draft Environmental Impact Report. December 17. SCH # 11205607. Prepared for Humboldt Bay Harbor Recreation and Conservation District, Eureka, California.

Gilkerson, W. A., and K. W. Merkel. 2017. Humboldt Bay Eelgrass Comprehensive Management Plan. Prepared for Humboldt Bay Harbor, Recreation and Conservation District, Eureka, California.

Grimaldo, L. F., F. Feyrer, J. Burns, and D. Maniscalco. 2017. Sampling uncharted waters: Examining rearing habitat of larval longfin smelt (*Spirinchus thaleichthys*) in the Upper San Francisco Estuary. Estuaries and Coasts 40:1771–1784.

Hobbs, J., L. S. Lewis, N. Ikemiyagi, T. Sommer, and R. D. Baxter. 2010. The use of otolith strontium isotopes ($^{87}Sr/^{86}Sr$) to identify nursery habitat for a threatened estuarine fish. Environmental Biology of Fishes 89:557–567.

H. T. Harvey & Associates. 2025a. Draft Eelgrass Mitigation and Monitoring Plan for the Chevron Eureka Terminal 2025 Repairs. Prepared for Pacific Affiliates. April.

H. T. Harvey & Associates. 2025b. Chevron Eureka Terminal 2025 Repairs – Draft Underwater Noise and Marine Mammal Monitoring Plan. Prepared for Pacific Affiliates. April.

ICF. 2020. Draft Program Environmental Impact Report for Humboldt Bay Sediment Management. November. 00638.17. Los Angeles, California. Prepared for Humboldt Bay Harbor, Recreation, and Conservation District.

[IEP] Interagency Ecological Program for the San Francisco Estuary. 2022. Electronic data accessed from iep.ca.gov/Data/IEP-Survey-Data. Central Valley Bay – Delta Branch, California Department of Fish and Wildlife, Stockton, California.

Laird, A., B. Powell, and J. Anderson. 2013. Humboldt Bay Shoreline Inventory, Mapping, and Sea Level Rise Vulnerability Assessment. January. Trinity Associates, Arcata, California. Prepared for State Coastal Conservancy, Oakland, California.

Lewis, L. S., A. Barros, M. Willmes, C. Denney, C. Parker, M. Bisson, J. Hobbs, et al. 2019. Interdisciplinary Studies on Longfin Smelt in the San Francisco Estuary. 2018-2019 Annual Report Contract # 4600011196. October. California Department of Water and Resources, IEP Longfin Smelt Technical Team, Davis, California.

Lewis, L. S., M. Willmes, A. Barros, P. K. Crain, and J. A. Hobbs. 2020. Newly discovered spawning and recruitment of threatened longfin smelt in restored and underexplored tidal wetlands. Ecology 101(1):1–3.

Lewis, L. S. 2021. Longfin Smelt: USFWS Population Assessment Session 1. August 27. Davis, California. Conference Presentation.

Molnar, M., D. Buehler, R. Oestman, J. Reyff, K. Pommerenck, and B. Mitchell. 2020. Technical Guidance for the Assessment of Hydroacoustic Effects of Pile Driving on Fish. October. CTHWANP-RT-20-365.01.04. Sacrament, California. Prepared by the California Department of Transportation, Division of Environmental Analysis.

Moyle, P. B., J. A. Israel, and S. E. Purdy. 2008. Salmon, Steelhead, and Trout in California. Status of Emblematic Fauna. Center for Watershed Sciences, University of California, Davis.

[NMFS] National Marine Fisheries Service. 1999. Designated critical habitat; central California coast and southern Oregon/northern California coasts Coho salmon. Federal Register 64(86):24049–24062.

[NMFS] National Marine Fisheries Service. 2005a. Endangered and threatened species: Final listing determinations for 16 ESUs of west coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs. Federal Register 70(123):37160–37204.

[NMFS] National Marine Fisheries Service. 2005b. Endangered and threatened species; Designation of critical habitat for seven evolutionarily significant units of Pacific salmon and steelhead in California. Federal Register 70(170):52488–52624.

[NMFS] National Marine Fisheries Service. 2014. Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region, Arcata, California.

[NMFS] National Marine Fisheries Service. 2016a. 2016 5-Year Review: Summary & Evaluation of Southern Oregon/Northern California Coast Coho Salmon. National Marine Fisheries Service, West Coast Region, Arcata, California.

[NMFS] National Marine Fisheries Service. 2016b. Endangered Species Act Section 7(a)(2)Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Humboldt Harbor and Bay Operations and Maintenance (O&M) Dredging in Humboldt Bay, Humboldt County, California. Biological Opinion. April 18. WCR-2015-3779. Prepared for Aaron Allen, U.S. Department of the Army, San Francisco, California.

[NMFS] National Marine Fisheries Service. 2022. Pile driving noise calculations. Developed by NOAA Fisheries Southwest and Northwest regions.

[NMFS] National Marine Fisheries Service. 2024. 2024 5-Year Review: Summary & Evaluation of Southern Oregon/Northern California Coast Coho Salmon. National Marine Fisheries Service, West Coast Region, Arcata, California.

Northern Hydrology and Engineering. 2015. Humboldt Bay: Sea Level Rise, Hydrodynamic Modeling, and Inundation Vulnerability Mapping. Final Report. April 2018. McKinleyville, California. Prepared for State Coastal Conservancy, Coastal Ecosystems Institute of Northern California.

Pinnix, W. D., T. A. Shaw, K. C. Acker, and N. J. Hetrick. 2005. Fish Communities in Eelgrass, Oyster Culture, and Mudflat Habitats of North Humboldt Bay, California Final Report. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Technical Report Number TR2005-02, Arcata, California.

Pinnix, W. D. 2008. Green Sturgeon Monitoring - Humboldt Bay Acoustic Telemetry. February 15. Arcata, California. Presentation.

Pinnix, W. D., P. A. Nelson, G. Stutzer, and K. A. Wright. 2013. Residence time and habitat use of coho salmon in Humboldt Bay, California: An acoustic telemetry study. Environmental Biology of Fishes 96:315–323.

Popper, A. N., A. D. Hawkins, R. R. Fay, D. A. Mann, S. Bartol, T. J. Carlson, and W. N. Tavolga. 2014. Sound Exposure Guidelines *in* ASA S3/SCI. 4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SCI and registered with ANSI. p. 33-51.

Rosenfield, J. A., and R. D. Baxter. 2007. Population Dynamics and Distribution Patterns of Longfin Smelt in the San Francisco Estuary. Transactions of the American Fisheries Society. 136:1577–1592.

Saglam, I. K., J. Hobbs, R. D. Baxter, L. S. Lewis, A. Benjamin, and A. Finger. 2021. Genome-wide analysis reveals regional patterns of drift, structure, and gene flow in longfin smelt (*Spirinchus thaleichthys*) in the northeastern Pacific. Canadian Journal of Fisheries and Aquatic Sciences 78:1793–1804.

Schlosser, S., and A. Eicher. 2012. The Humboldt Bay and Eel River Estuary Benthic Habitat Project. August. California Sea Grant Publication T-075. California Sea Grant College Program, La Jolla. Final report to the California State Coastal Conservancy, Agreement No. 06-085.

Smith, P. E., and S. L. Richardson. 1977. Standard techniques for pelagic fish egg and larva surveys. FAO Fisheries Technical Paper. December. 175.

Stillwater Sciences. 2016a. California Endangered Species Act Incidental Take Permit Application for the Chevron Eureka Terminal Seismic Retrofit. Arcata, California. Prepared for Chevron and Pacific Affiliates.

Stillwater Sciences. 2016b. California Endangered Species Act Incidental Take Permit Application for the Fisherman's Channel Dredging Project. Arcata, California. Prepared for Humboldt Bay Harbor, Recreation, and Conservation District and California Department of Fish and Wildlife.

Swanson, C. R. 2015. Annual and seasonal dissolved inorganic nutrient budgets for Humboldt Bay with implications for wastewater dischargers. Thesis. Humboldt State University, Arcata, California.

Tenera. 2005. 316(b) Entrainment characterization report for Potrero Power Plant Unit 3. LF05-200.1. Mirant Potrero, LLC.

Tenera. 2023. Intake Assessment of the Potential Effects on Ichthyoplankton and other Meroplankton Due to Entrainment at Proposed Samoa Peninsula Water Intakes. May 1, 2023. ESLO2023-001.2. San Luis Obispo, California.

Tian, Z., H. Zhao, K. T. Peter, M. Gonzalez, J. Wetzel, C. Wu, X. Hu, J. Prat, E. Mudrock, and R. Hettinger. 2021. A ubiquitous tire rubber–derived chemical induces acute mortality in coho salmon. Science 371(6525): 185-189. https://hero.epa.gov/hero/index.cfm/reference/details/reference_id/9106923

[ERDC] U.S. Army Engineer Research and Development Center. 2013. Entrainment of Smelt in San Francisco Bay by Hydraulic Dredges: Rates, Effects, and Mitigation. October 24. Prepared for the U.S. Army Engineer San Francisco District.

[USFWS] U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the San Francisco Bay-Delta population of the longfin smelt as endangered or threatened. Federal Register 77(63):19756–19797.

[USFWS] U.S. Fish and Wildlife Service. 2022. Endangered and threatened wildlife and plants; Endangered species status for the San Francisco Bay-Delta distinct population segment of the longfin smelt. Federal Register 87(194):60957–60975.

[USFWS] U.S. Fish and Wildlife Service. 2024a. Endangered and threatened wildlife and plants; endangered species status for the San Francisco Bay-Delta Distinct Population Segment of the Longfin Smelt. July 30. Sacramento, California. Federal Register 89 (146):61029-61049.

[USFWS] U.S. Fish and Wildlife Service. 2024b. Species Status Assessment for the San Francisco Bay-Delta Distinct Population Segment of the Longfin Smelt. Version 2.0. U.S. Fish and Wildlife Service San Francisco Bay-Delta Fish and Wildlife Office, Sacramento, California. 105 pp.

Wallace, M. 2006. Juvenile Salmonid Use of Freshwater Slough and Tidal Portion of Freshwater Creek, Humboldt Bay, California: 2003 Annual Report. Inland Fisheries Administrative Report No. 2006-04. California Department of Fish and Game.

Wallace, M., and S. Allen. 2007. Juvenile Salmonid Use of the Tidal Portions of Selected Tributaries to Humboldt Bay, California. June. Final Report for Contract No. P0410504. California Department of Fish and Game, Pacific States Marine Fisheries Commission.

Wallace, M., S. Ricker, J. Garwood, A. Grimodig, and S. Allen. 2015. Importance of the stream-estuary ecotone to juvenile coho salmon (*Oncorhynchus kisutch*) in Humboldt Bay, California. California Department of Fish and Game 101(4):241–266.

Wallace, M., E. Ojerholm, A. Scheiff, and S. Allen. 2018. Juvenile Salmonid Use and Restoration Assessment of the Tidal Portions of Selected Tributaries to Humboldt Bay, California, 2015–2017. January. Fisheries Restoration Grant Program Final Report for Grant P1310520.

Yanagitsuru, Y. R., M. A. Main, L. S. Lewis, J. A. Hobbs, T. C. Hung, R. E. Connon, and N. A. Fangue. 2021. Effects of temperature on hatching and growth performance of embryos and yolk-sac larvae of a threatened estuarine fish: longfin smelt (*Spirinchus thaleichthys*). Aquaculture 537(736502).

Yanagitsuru, Y. R., I. Y. Daza, L. S. Lewis, J. A. Hobbs, T. C. Hung, R. E. Connon, and N. A. Fangue. 2022. Growth, osmoregulation and ionoregulation of longfin smelt (*Spirinchus thaleichthys*) yolk-sac larvae at different salinities. Conservation Physiology 10(1).