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RE: Jordan Cove Energy Project Removal-Fill Application #APP0060697 Revised

Mr. Lobdell,

Per the Department of State Lands (DSL) request, the Oregon Department of Fish and Wildlife (ODFW) provides the following update on its ongoing technical review of the Jordan Cove Energy Project removal-fill application (DSL Application # APP0060697). This letter follows up on ODFW's original impact assessment provided as formal comment to DSL on February 3, 2019, as well as the multiple meetings and electronic correspondence between Jordan Cove LNG (the applicant), DSL, and ODFW that have occurred over the previous year.

In summary, there are some components of the Jordan Cove Energy Project removal-fill application that still do not meet the criteria and/or standards of ODFW statute and rule. Those components include:

- Fish Passage Authorizations (ORS 509.580 through .910 and OAR 635 Division 412)
- In-Water Blasting Permits (ORS 509.140)
- Avoidance, Minimization, and Mitigation of Impacts to Fish and Wildlife (ORS 496.012, ORS 496.171-182, OAR 635-415-0000 to -0025), particularly as it relates to:
    - In-Water Work Windows
    - Horizontal Directional Drilling
    - Estuarine impacts associated with dredging and construction of the terminal
    - Eelgrass mitigation plans
    - Kentuck mitigation plans
    - Pipeline Wetland/Waterway Mitigation.

A discussion of each of the remaining issues is provided below. This letter does not fully reiterate the potential impacts of the application's proposed actions, which were described in ODFW's original February 2019 letter. Instead, the purpose of this letter is to list the remaining, unresolved issues.

General Comment

Over the last year, the applicant has provided ODFW with a number of technical memoranda, maps, GIS data, and electronic correspondences that improve upon the original removal-fill application. At this time, it is difficult for ODFW to provide an updated comprehensive review when the most current information has only been provided in a piece-meal fashion. ODFW has requested that these various documents be integrated into a revised Compensatory Wetland Mitigation Plan, or perhaps organized into a few more specific topical plans (eelgrass mitigation, Kentuck Slough mitigation plan, stream/riparian restoration and mitigation plan, etc.) to help facilitate this review and to ensure the public and interested stakeholders are aware of this new information. It is ODFW's understanding that the applicant is actively preparing updated plans for the public record.

Specific Comments on Remaining Issues

Fish Passage

ODFW has received fish passage plan submittals for project components within the Oregon Coastal Zone Management Area (CZMA) and has met with the applicant on multiple occasions to address insufficiencies in their applications. ODFW has received sufficient information for the Kentuck and APCO Mitigation actions within the CZMA. These actions include the East Bay Drive Bridge, Golf Course Lane Culvert, Kentuck Tide Gate, Kentuck Creek Restoration and the APCO Bridge. The information we have received for these sites is adequate for our review and approval and ODFW is working on the final fish passage authorizations for these restoration actions.

However, the following CZMA fish passage plan items need to be updated and re-submitted to ODFW for final review and determinations on fish passage and compliance with the state's rules and regulations. These items include:

a. Updated Appendix 3 of the applicant's fish passage application (Horizontal Directional Drill Plans – CZMA) to understand current drilling strategies, potential impacts, and appropriate In-Water Work Windows, and
b. Updated Appendix 6 of the applicant's fish passage application (Stream Crossing Risk Assessment - CZMA) – Stream Restoration actions. This information is critical in the development of site specific stream crossing restoration plans.

These two appendices are necessary for ODFW's final review, evaluation and determination of fish passage authorizations for the project components within the CZMA authority and where the state has fish passage authority (ORS 509.585).

ODFW has not received fish passage plan information on project components situated outside of the CZMA authority. ODFW is unable to proceed forward with our review, evaluation, and fish passage authorization for these project components. These project components include:

a. the proposed new LNG Pipeline and the associated fish bearing waterway crossings subject to the state's fish passage authorities, as per ORS 509.585, and
b. the transportation road infrastructure to access, install, maintain and monitor the project where these actions will cross a fish bearing waterways subject to the state's fish passage authorities, as per ORS 509.585, and
c. associated plans for fish salvage and release.

In-Water Blasting

The applicant has stated that in-water blasting is not needed within the CZMA. Outside the CZMA, the applicant indicates that in-water blasting may be necessary in certain areas for construction of the pipeline. Below is an excerpt from the applicant's May 9, 2019 response to comments on the removal-fill application:

> ODFW states that the Applicants should only submit in-water blasting permit applications after obtaining access to site locations and collecting necessary site-specific information to complete applications. No in-water blasting will occur within the coastal zone. Not all waterbodies outside of the coastal zone that may require blasting have been reviewed on-site, and access may not be obtained until nearer the time of construction. More importantly, road access to conduct geotechnical investigations is not available at most of the stream crossings; therefore, it is physically and environmentally impractical to recommend geotechnical investigations to determine if blasting is the only practical method to cross streams. Therefore, PCGP will provide a programmatic approach in the In-Water Blasting Plan that will detail the BMPs that will be implemented to minimize potential effects to aquatic species in the event blasting is necessary during dry open cut stream crossings due to mechanical excavation methods being unable to achieve required pipeline design depths. To the extent in-water blasting will be required outside of the coastal zone, PCGP will coordinate with ODFW during development of the In-Water Blasting Plan in the fourth quarter of 2019.

At this time, the applicant has not coordinated with ODFW on an In-Water Blasting Plan.

In-Water Work Windows

In Coos Bay:
The established in-water work window (IWWW) for Coos Bay is October 1 through February 15. However, during the City of Coos Bay Comprehensive Plan Amendment application process (187-18-000153 and 187-19-000035), ODFW received concerns from the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw (CTCLUSI) and from members of the public that the IWWW was not adequately addressing early spawning events by pacific herring (*Clupea pallasii*).

ODFW evaluated these concerns. Pacific herring is an Oregon Nearshore Conservation Strategy Species (ODFW 2016). Populations of Pacific herring contribute to the overall health of the estuary and support local fishery resources. They are an important prey base for salmon, halibut, various groundfish, as well as birds and marine mammals. These fish support substantial commercial fisheries and popular recreational fisheries in Oregon estuaries and the nearshore Pacific Ocean.

In Oregon, the herring spawning season typically occurs from mid-February to mid-March, and they deposit their transparent adhesive egg masses in shallow water and estuaries on eelgrass, seaweed, and other benthic structures. Following spawning, the eggs hatch after about 2 weeks, and the small transparent larvae develop in the water column for a period of about 3 months until they complete metamorphosis and take on the final shape and form of adults. Dredging during herring spawn could increase sediment loads to levels that inhibit egg and larvae development.

While ODFW does not specifically monitor herring spawn dates in Coos Bay, ODFW has been monitoring herring spawn dates in Yaquina Bay for the last 35 years (ODFW 2017). In Yaquina Bay, the average spawn initiation date is February 21, and the earliest documented spawn is February 9 (see the Spawn Survey table provided at the bottom of this letter, which is summary data from the ODFW Marine Resources Program). However, a really important precursor to the actual spawn event happens when herring begin schooling up, or ‘staging’ in the bay. Staging typically occurs two weeks prior to the spawn event and is an essential behavior in the ecology of herring, as it determines where the spawn will occur. In Yaquina Bay, ODFW hydroacoustic surveys have documented herring staging beginning on average on February 3, with the first documented date of January 24 (see the Acoustic Survey table at the bottom of this letter, which is summary data provided by the ODFW Marine Resources Program). Noise disruption from construction activity during the staging phase of the herring spawn could cause spatial redistribution of herring into sub-optimal habitats or inhibit use of Coos Bay (Wilson and Dill 2002, Schwarz and Greer 1984, Blaxter et al. 1981, ODFW 2016, ODFW 2019).

ODFW will modify its standard IWWW's when site-specific conditions warrant a change. During the City of Coos Bay land use application process and after evaluating the herring issue, ODFW recommended the IWWW be truncated to February 1. Truncating the end of the In-Water Work Window from February 15 to February 1 would decrease the impact of noise disruption when herring are staging, and reduce the potential for dredge impacts and siltation to the herring spawn/egg masses. The applicant expressed concern that truncation to this earlier end date would create logistical hardships and likely force construction into three winter work seasons instead of just two. While the City of Coos Bay ultimately did not accept this recommendation, ODFW would still recommend that DSL consider this issue in its removal-fill decision.

To best address the risk to early herring spawn events, while accommodating the project logistics, ODFW recommends on-site, real-time monitoring for herring spawn during the applicant's in-water work in Coos Bay, beginning in mid-January. In the event herring staging and/or spawning is detected in the vicinity of the project's active work, ODFW recommends cessation and truncation of the IWWW. If herring spawn is not detected, ODFW believes in-water work could proceed up to the normal IWWW end date (Feb 15).

Horizontal Directional Drilling

ODFW continues to have concerns for aquatic habitat function associated with horizontal directional drilling (HDD) risks. The primary risks for aquatic habitats associated with HDD are considered to be: 1) frac-out and subsequent drilling fluid "mud" delivery to the water column; 2) drill bore site soil rutting/denigration and mobilization through precipitation to the waterway; 3) drill bore site impacts to pasture wetlands and stream-adjacent habitats.

ODFW's experience with other pipeline HDD projects in southwestern Oregon has shown that frac-outs can and do occur, as was the case on the 2003 Coos County Gas Pipeline HDD which had multiple frac-outs that spilled harmful chemicals and drilling mud into fish-bearing streams.

HDD frac-outs are difficult to predict, but can have significant impacts to local fish and wildlife populations depending on the time of year in which they occur. HDD risks to stream habitat function are primarily linked to the potential for frac-out, upland disturbance of soils with subsequent delivery of sediment to streams, and spills of fuels/hydraulic fluids. Release of drilling fluid ("mud") into waterways can result in heavy sediment plumes that potentially can result in embedment of spawning gravels, direct short-term reduction in the ability of fishes to pursue food items due to poor visibility, and direct impacts to gill filaments.

To address this risk, ODFW recommends that monetary bonds be retained at all the HDD sites on this project to cover mitigation costs associated with a frac-out event and the resulting fish/wildlife losses and habitat damages. The ODFW Fish and Wildlife Habitat Mitigation Policy states "the Department may recommend or require the posting of a bond, or other financial instrument acceptable to the Department, to cover the cost of mitigation actions based on the nature, extent, and duration of the impact and/or the risk of the mitigation plan not achieving mitigation goals" (OAR 635-415-0020(6)).

HDD in Coos Bay:
In a meeting between the applicant and ODFW on January 3, 2020, the applicant noted that they will be revising the Coos Bay HDD plan to include: 1) that there will not be a need for dredging of equipment access channels to the drill bore site; 2) that the language will be adjusted in the HDD plan for the dual HDD with tie-in option. This revised written plan is necessary for ODFW to determine if the plan will sufficiently address concerns.

In the applicant's HDD plans, ODFW notes a limited number of geotech borings along the two-mile HDD line under Coos Bay. ODFW remains concerned that the frac-out risk may not have been adequately analyzed. This concern needs to be resolved prior to ODFW having sufficient information to determine if the proposed crossing strategy is considered a "reliable" method under OAR 635-415.

ODFW and the applicant are currently in discussions concerning the IWWW timing for the Coos Bay HDD. ODFW recommends the standard October 1 to February 15 IWWW for drilling. In addition, ODFW has strongly encouraged the applicant to construct the preparatory bore site pads during drier months and to include access construction with rock base to prevent site rutting and sediment transport during wetter months. ODFW needs resolution of Coos Bay HDD construction timing prior to full assessment of the ability to meet the standards of the ODFW Fish and Wildlife Habitat Mitigation Policy. (*Note: ODFW recommends the standard IWWW for drilling simply to minimize the impacts of a potential frac-out. This differs from the recommended truncation for dredging and terminal construction in the herring discussion above, because that would be actual direct and indirect impacts associated with dredging and construction*).

Rogue River HDD Crossing:
ODFW is highly concerned with the potential for frac-out risk at the Rogue River HDD site. The project engineering/design plans identify the pipeline crossing for the Rogue River is at milepost 122.6. The geotech survey indicates the pipe will be 56ft below the surface of the lowest thalweg location of the Rogue River, which may provide substantive overburden protection. However, a release of drilling fluid through the riverine and streambank portions of the 4,200+ft HDD would deliver drilling fluids directly to active Rogue River flow.

This reach of the Rogue River is just downstream from Trail Creek, and provides critical spawning habitat for endemic Rogue Basin spring Chinook *(Oncorhynchus tshawytscha).* Construction of William Jess Dam/Lost Creek Reservoir reduced the amount of spawning habitat available for spring Chinook salmon on the Rogue River. Spring Chinook spawning habitat is now limited to approximately 30 miles of the river just downstream of a barrier dam at Cole Rivers Fish Hatchery. Spring fed Big Butte Creek is the only tributary of the Rogue that is used by spawning spring Chinook on an annual basis. Because of dam construction, habitat volume is considered a limiting factor for the population in the Rogue Spring Chinook Salmon Conservation Plan (ODFW 2007).

Surveys conducted by ODFW during 2016-2018 found that, unlike some other rivers on the west coast, the Rogue spring Chinook population maintains a strong component of fish that are homozygous for the allele(s) that determine spring migration. Introgression with fall chinook genetic material is limited. Therefore, despite the limited habitat volume described above, the

Rogue River maintains a genetically healthy population of spring Chinook. This knowledge has further increased the need to protect the ecological function of habitat that remains for this important population. A mistake here could have profound consequences.

HDD risks to stream habitat function are primarily linked to the potential for frac-out, upland disturbance of soils with subsequent delivery of sediment to streams, and spills of fuels/hydraulic fluids. Various versions of PCGP design plans have reported that HDD at this location can be done with low risk. ODFW acknowledges reading that assessment from the applicant, but considers the recently submitted contingency plan (implemented if a frac-out were to take place) to be inadequate to address the risk of frac-out for spring Chinook in the Rogue River.

Coos, Umpqua, Rogue, and Klamath Rivers HDD Work Timing:
In addition to the monetary bonding recommended above to cover fish/wildlife population or habitat mitigation costs in the event of a frac-out, ODFW recommends the following.

- *Coos HDD:* The applicant has proposed performing the Coos River HDD during the October 1 to February 15th In-Water Work window (BA, Appendix M pdf pg 3). The PCGP proposed crossing at Lillian Creek of the Coos River is 2.3 miles downstream from the location where the prescribed ODFW In-Water Work window is July 1 to September 15th. Risks associated with the HDD at this site are 1) Frac-out and subsequent drilling fluid "mud" delivery to the water column; 2) Drill bore site soil rutting/denigration and mobilization through precipitation to the waterway; 3) Drill bore site impacts to pasture wetlands, ODFW HabCat-4 or 5.

  ODFW considers the risks associated with equipment/drill bore soil disturbance during wet weather as the greater habitat function risk for this site and recommends the July 1 to September 15th In-Water Work window period for this HDD.

- *Umpqua #1 Direct Pipe:* The applicant has proposed the South Umpqua River Direct Pipe installation for July 1 to August 31st, (BA, Appendix M pdf pg 25), which is the standard In-Water Work window for this reach of river. Risks associated with the HDD at this site are 1) Frac-out (although ODFW acknowledges much lower risk with Direct Pipe methods) and subsequent drilling slurry delivery to the water column; 2) Drill bore site soil rutting/denigration and mobilization through precipitation ODFW concurs with use of this window for the Umpqua Direct Pipe.

- *Rogue HDD:* The applicant has proposed the Rogue HDD for June 15th to August 31st, (BA, Appendix M pdf pg 40), which is the standard ODFW In-Water Work window for this location. Risks associated with the HDD at this site are 1) Frac-out and subsequent drilling fluid "mud" delivery to the water column; 2) Drill bore site soil rutting/denigration and mobilization through precipitation to the waterway. ODFW concurs with use of the proposed In-Water Window for the Rogue HDD crossing.

- *Klamath River HDD:* The applicant is proposing to implement this HDD during the July 1 to January 31st period (BA, Appendix M pdf pg 55). Risks associated with the HDD at this site are 1) Frac-out and subsequent drilling fluid "mud" delivery to the water column; 2) Drill bore site soil rutting/denigration and mobilization through precipitation to waterway. ODFW concurs with use of the proposed In-Water Window for the HDD crossing.

Avoidance, Minimization, and Mitigation of Fish and Wildlife Impacts

This section outlines the remaining resource issues associated with the removal-fill application for which the applicant has not fully demonstrated its ability to avoid, minimize, and mitigate its impacts to fish and wildlife and their habitats in accordance with the state's Wildlife Policy, the Food Fish Management Policy, and the ODFW Fish and Wildlife Habitat Mitigation Policy.

Impacts to the Coos Bay Estuary:

<u>Dredging Impacts to the Coos Estuary Tidal Basin</u>:
The JCEP will include dredging and removal of unconsolidated sediment from the intertidal and subtidal zones of the Coos estuary, and the removal of sediment will have substantial impacts to aquatic habitats and species. Direct impacts to estuarine habitats associated with removal of sediment from the navigation channel (NRI Areas 1-4), construction of the vessel slip, access channel, temporary material barge berth, the material offloading facility, and rock pile apron are expected to be long-lasting and substantial. In particular, the estuarine portion of the Jordan Cove LNG Facilities would include direct impacts to about 37 ac of estuarine habitat, including 2 ac of eelgrass habitat, 13 ac of intertidal unvegetated habitat, 4 ac of shallow subtidal habitat, and 18 ac of deep subtidal habitat. The JCEP also includes extensive dredging and excavation of four submerged areas of the sub-tidal zone in Coos Bay (total 40 ac) along the Federal Navigational Channel and vessel access route to improve navigation reliability for the LNG carriers.

Unconsolidated soft-sediment habitat is widespread in the Coos estuary tidal basin where it occurs extensively throughout the intertidal zone and sub-tidal zone along the bottoms, sides, and margins of primary and secondary tidal channels (Cortright *et al*., 1987; Rumrill, 2003). Soft-sediment habitats provide a series of diverse, productive, and dynamic ecological functions in the estuary, including provision of habitat and forage areas for invertebrates, fish, birds, and marine mammals, as well as serving as an important source of detritus. Soft-sediments also play an important role in the microbial and biogeochemical transformations of organic materials and nutrient cycling, and they typically serve as a sink or reservoir for the deposition of water-borne particles. Diverse communities of motile, epifaunal, and infaunal invertebrates inhabit the soft-sediments, and the communities of crabs, shrimp, amphipods, polychaete worms, copepods, hydroids, anemones, clams, and other invertebrates are specifically adapted to survive, feed, grow, and reproduce themselves in the unconsolidated sediments (Simenstad 1983; Emmett *et al*., 2000). Microbial activity and deposition of organic matter associated with fine-grained sediments together support a complex food web that includes multiple resident (infaunal, epifaunal, motile) and transitory (seasonal, migratory) species.

Mixed communities of shellfish, such as Dungeness crab, red rock crab, bay shrimp, gaper clams, butter clams, littleneck clams, softshell clams, cockles, and many other species are year-round residents of the intertidal and sub-tidal areas of the Coos estuary. Some of these shellfish are motile (*i.e.*, crabs and shrimp) and periodically move to different locations or migrate through the intertidal and sub-tidal zones, while others are stationary (*i.e.*, bivalves) and remain largely in place over the duration of their adult lives. The mixed communities of living bivalves and the beds of their non-living shells (*e.g.*, shell rubble or shell hash) are particularly important because they function to stabilize unconsolidated sediments and provide heterogeneous habitat for numerous species of adult and juvenile fishes, crabs, shrimp, amphipods, worms, and other estuarine organisms. Moreover, filter-feeding by dense populations of living clams can sometimes play an important role in the removal of phytoplankton and smaller particulate materials, thereby decreasing turbidity and increasing light penetration through the estuarine water column. Consequently, maintenance of suitable soft-sediment habitat is essential for survival of the moderately long-lived (life-span 10-15 years or longer) gaper, butter, and cockle clams, particularly in the sub-tidal zone. When soft-sediment habitat is chronically disturbed and altered by dredging of the subtidal zone, there may be a permanent loss and impact to benthic invertebrate populations and a decline in the biodiversity of benthic communities. Loss of some or all of these sub-tidal populations of bay clams has implications for both the ecological functioning of sub-tidal habitats and the ability of the bay clams to serve as broodstock to support the recreational and commercial shellfish fisheries in Coos Bay (D'Andrea 2012).

It is expected that dredging and removal of the soft-sediments will likely have substantial and immediate local impacts on the sub-tidal populations of benthic invertebrates and shellfish, such as gaper clams, butter clams, and cockles. This may include the physical removal of the clams and their surrounding sediments, as well as a disruption of the mixed ecological communities of shellfish, mobile and infaunal invertebrates, and fish that make use of the sub-tidal habitats. The application states that dredging would directly remove benthic organisms (e.g., worms, clams, benthic shrimp, starfish, and vegetation) from the bay bottom within the access channel and navigation channel modifications. Mobile organisms such as crabs, many shrimp, and fish could move away from the region during the process, although some will be entrained during dredging so that direct mortally or injury could occur.

JCEP acknowledges that dredging, removal, and disturbance of the soft-sediment habitats will directly remove benthic organisms from the bay bottom, and estimate that recovery would occur in about one year for benthic resources particularly in the area of navigation channel modifications. The JCEP estimate of the rapid rate of community recovery is problematic, however, because the technical references cited to support the JCEP estimate are drawn from earlier investigations of dredging impacts that generally used a group small-bodied, rapidly-growing invertebrates (including amphipods, polychaete worms, small bivalves, etc. that have life-spans on the scale of months to a few years) as the focal species to provide metrics for the estimates of species and habitat recovery. These small opportunistic species are not representative of the large-bodied, long-lived bay clams that typically exhibit episodic recruitment and have life-spans on the scale of 10-20 years in the Oregon estuaries. Moreover, large-scale dredging modifications that include subsequent maintenance dredging every 5-10 years may not provide the opportunity for bay clams and other shellfish to recruit successfully and fully re-colonize after the repeated disturbance events. It is also likely that benthic food resources may also be impaired or lost for other estuarine species (*i.e.*, forage fish, salmonids, crab) as a result of dredging actions. Consequently, dredging activities that significantly disturb and/or remove the mixed communities of long-lived bay clams from soft-sediment habitat in the sub-tidal zones of Coos Bay are expected to have longer-term impacts that extend well beyond a time period of many years.

The JCEP also includes dredging of four submerged areas (NRI Areas 1-4; removing about 700,000 cubic yards of material) that are located adjacent to the existing federally-authorized Coos Bay Navigation Channel. In particular, the JCEP will include dredging of four submerged areas that directly abut the current boundary of the Navigation Channel between RM 2 to RM 7. These dredging activities will modify and alter the physical morphology of the Navigation Channel by widening four turns to allow for more efficient transit of LNG carriers.

It is likely that dredging of the four submerged areas (NRI Areas 1-4) will have indirect impacts to side slopes and soft sediment habitats located adjacent and in close proximity to the dredged areas. For example, the JCEP will include significant dredging and removal of unconsolidated sediment from NRI Area 2 (RM 4.5), NRI Area 3 (RM 6), and NRI Area 4 (RM 7), coupled with erosion of sediment from the adjacent subtidal and intertidal areas. Technical review by the U.S. Army Corps of Engineers indicates that the banks of the dredged areas are intended to be stable, and that side slope equilibration may occur over about a 6-year period. Loss of sediment from these immediately adjacent areas, however, will likely be substantial (*i.e.*, loss of 1-2 ft (30-60 cm) in depth over the first 3 years). Loss of the upper 30-60 cm of sediment from the side slopes located adjacent to the NRI dredged areas during the equilibration process is certainly not insignificant, and may result in further impacts and loss of eelgrass, infaunal invertebrates, and degradation of the habitat for shellfish and fish. Loss of the upper 30-60 cm of sediment from the side slope of NRI Area 4 is particularly alarming, because this side slope is located in the immediate vicinity of the important eelgrass donor bed and eelgrass reference bed identified as essential components of the proposed JCEP eelgrass mitigation activities. Potential loss or disturbance of the eelgrass donor bed and eelgrass reference area in the vicinity of NRI Area 4 puts the proposed JCEP eelgrass mitigation plan in jeopardy. The JCEP Eelgrass Mitigation Plan does not adequately address the potential for loss of sediment adjacent to NRI Areas 2-4, and does not give adequate consideration to loss or disturbance of the important eelgrass donor bed and reference bed located adjacent to NRI Area 4.

<u>Construction of the Marine Terminal – Indirect Effects to Eelgrass Beds</u>:
The JCEP project includes dredging and construction of a new access channel to connect the JCEP LNG Terminal to the Federal Navigation Channel at about RM 7.3. The access channel will be about 700 feet in length, and about 2,200 feet wide at confluence with the Navigation Channel, and about 780 feet wide at the Terminal. The access channel would be approximately 45 feet deep, and would cover about 22 acres below the highest measured tide elevation of 10.3 feet (NAVD88). The proposed JCEP dredging activities will permanently destroy about 2 ac of established native eelgrass located in the intertidal and shallow subtidal zones of the Project area. Dredging in the intertidal and shallow subtidal zones within the JCEP area is expected to have significant deleterious effects on native eelgrass habitats and the species found therein.

In addition to the direct removal of eelgrass at the JCEP dredging sites, it is likely that dredging operations carried out to implement the JCEP may also result in indirect impacts to adjacent eelgrass beds located in the vicinity of the JCEP area. For example, nearby eelgrass beds will likely experience periods of increased turbidity, sedimentation, and attenuated light levels resulting from dredging during construction and during subsequent periods of maintenance dredging. In this regard, the indirect effects of the JCEP to adjacent eelgrass beds have not been adequately addressed by the JCEP Comprehensive Wetland Mitigation Plan.

<u>Eelgrass Mitigation Plan</u>:
In order to offset the loss of 2 ac of eelgrass the JCEP includes a proposed eelgrass mitigation plan that relies on the “best case scenario” for full success by creating 6 ac of eelgrass (3:1 ratio) within a 9 ac site in the intertidal zone near the impact area. ODFW has noted several potential problematic issues associated with the proposed JCEP eelgrass mitigation plan that have not been fully considered and addressed by the applicant.

In particular, ODFW is concerned that the excavated JCEP mitigation basin may refill with sediment, and that the rate of sedimentation may not be conducive to survival, growth, and propagation of the planted eelgrass plants. For example, Mills and Fonseca (2003) conducted a series of field experiments to determine the susceptibility of eelgrass (*Zostera marina*) to burial by estuarine sediments. Results from the study demonstrate that eelgrass plants experience an increased likelihood of mortality and decreased productivity under burial conditions, and that the threshold level of burial tolerance for *Z. marina* is extremely low. Burial of eelgrass to depths as low as 25% of the aboveground plant height (4 cm) substantially increase mortality of eelgrass, causing death of >75% of the plants. Moreover, the probability of eelgrass mortality reached 100% for burial depths of 50% (8 cm) to 75% (12 cm) of plant height, depending on the types of sediment (e.g., sand, silt, combined) in which the plants were buried. These empirical observations indicate that eelgrass can only tolerate rapid sedimentation events that cover less than half of its photosynthetic surfaces, and that small levels of rapid sedimentation are detrimental to survival of *Z. marina*.

Earlier research (Thom et al. 2018) has shown that eelgrass beds are typically limited by the availability of proper substrata, light, heat stress, and desiccation. Survival of the transplanted eelgrass within the excavated JCEP eelgrass mitigation site will be dependent upon several ecological factors, including characteristics of the excavated sediment, sedimentation rate, erosion, light availability, nutrient availability, grazing upon seeds, seedlings, and blades, and a suite of inherent physical factors (*i.e.,* current velocities, wind fetch, slope, depth, seawater temperature, air temperature, humidity, desiccation, etc.). The proposed mitigation actions for eelgrass should be designed to retain the full array of ecosystem services provided by eelgrass beds in the JCEP area, and to achieve no-net loss of eelgrass over the entire lifespan of the JCEP operation in Coos Bay. In this regard, the planned mitigation activities should follow established in-kind, in-proximity standards established by the state of Oregon, and require long-term monitoring and remedial replanting of eelgrass as needed to compensate for losses that may occur over the entire lifespan of the Project.

The applicant proposes to remove existing eelgrass in the Project area and to offset the loss of eelgrass habitat by excavation of an eelgrass mitigation area coupled with replanting of eelgrass taken from a nearby donor bed. The applicant proposes to monitor the effectiveness of the replanting effort for a period of only five years. It is important to note that failure of eelgrass replanting efforts is common in the Pacific northwest region (Thom et al., 2008), and that five years is an insufficiently short time period to adequately evaluate long-term mitigation success.

The applicant does not demonstrate that serious consideration has been given to avoidance of impacts to eelgrass beds. In a December 11, 2019 meeting with DSL, ODFW, and the US Army Corps of Engineers, the applicant reviewed a draft alternatives analysis that considered alternative sites for eelgrass transplant. ODFW has raised additional alternatives to the applicant since that meeting. However, a more thorough alternatives analysis has not been provided nor has the Compensatory Wetland Mitigation Plan been updated to include the December 2019 analysis. ODFW recommends a more detailed analysis of eelgrass mitigation sites that characterize the location, species composition, and abundance of the eelgrass and other submerged aquatic vegetation at the alternative sites, and provide a more detailed rationale for rejection of the alternative sites and acceptance of the proposed site. The existing JCEP Mitigation Plan is incomplete because it does not provide a full description of the steps that were taken to avoid adverse impacts to existing eelgrass beds in Coos Bay.

Earlier attempts to mitigate for the damage or loss of eelgrass beds have met with limited success in Pacific Northwest estuaries. For example, Thom et al. (2008) conducted a review of 14 eelgrass mitigation and transplant projects. They concluded that it is sometimes possible to restore eelgrass under favorable site conditions and when the reason for the initial loss of eelgrass is understood and corrected. The authors also noted, however, that eelgrass restoration science is hampered by knowledge gaps, which reduce restoration success. The underlying mechanisms for recent eelgrass loss in the Pacific Northwest region are not obvious, which suggests that the scientific understanding of eelgrass biology and ecosystem conditions is currently inadequate to fully support environmental management actions (Thom et al. 2008). Local complexities in hydrologic flow regimes are known to affect potential for success in eelgrass restoration efforts. These local complexities include considerations of the following:

- Habitat conditions created through excavation or filling are often ephemeral and subject to subsequent deposition/erosion that results in movement of conditions outside of the range of preferred variability for eelgrass.
- Flow regimes including severity of wave action and current speed contribute to the potential success of a site for eelgrass establishment and growth. Sites that are created through excavation or fill are an artificial modification of conditions that have formed through the geomorphological features that drive flow regimes. Factors such as water depth reflect deposition/erosion rates from water transported sediments. Excavation or filling to a specific elevation is attempting to alter the natural elevation conditions in relation to hydrologic conditions for many sites that might serve as potential mitigation. Consequently, the potential for success is limited for projects that modify water depth/elevation of the substrates for creating conditions appropriate for eelgrass mitigation unless the site chosen has substrate elevation that has been artificially created from previous disturbance or the conditions are dominated by factors other than hydrology.
- Use of eelgrass sites immediately adjacent to or within the mitigation area for obtaining plants/shoots results in impacts to these locations, potentially weakening the vigor of eelgrass at these locations, which is counter to goals.
- Excavation of locations adjacent to existing eelgrass beds can result in hydrologic changes such as erosion of surrounding substrates resulting in impacts to currently productive stands.
- The monitoring plan should be amended to include more robust methods such as diver or low tide visual count surveys with established known planting densities at time-0 and subsequent measurable surveys with quantifiable methods.
- Due to the potential for minimal success the eelgrass mitigation ratio is likely insufficient to offset impacts at the JCEP project impact location.

For all of the reasons listed in the discussion above, ODFW recommends the eelgrass mitigation strategies be re-evaluated to favor avoidance.

<u>Unresolved Issues related to Sedimentation, Hydrodynamic Connection of the Eelgrass Mitigation Site, Adaptive Management Plan, and Proposed Mitigation Ratio</u>:
The applicant has generated several new technical reports and documents related to JCEP's development of a Compensatory Wetland Mitigation Plan and an Eelgrass Mitigation Site to offset impacts to eelgrass habitat from the construction and operation of the JCEP LNG terminal. The proposed project components include re-contouring of an existing un-vegetated sandbar located near the end of the airport runway to create an area of optimal eelgrass habitat, and then transplanting eelgrass from an adjacent donor site into the mitigation area.

ODFW has identified several issues regarding eelgrass impacts and mitigation raised by the proposed JCEP, including characterization of permanent and transitory impacts to existing eelgrass, and shortcomings inherent in the proposed Eelgrass Mitigation Plan. The most recent (2018) JCEP eelgrass surveys indicate that construction of the Access Channel and Rock Apron will result in displacement of 2.26 acres of eelgrass. This estimate is consistent with the JCEP application which identifies "anticipated impacts to at least 2.3 acres of eelgrass habitat in the

Coos Bay estuary from the Jordan Cove LNG Project" but inconsistent with the FERC FEIS which identified impacts to only 2 ac of eelgrass.

The JCEP Project description identifies permanent removal of eelgrass associated with dredging and excavation of the access channel that will be constructed to provide ship access to the LNG terminal. Eelgrass beds that currently inhabit the intertidal and subtidal zones in the area of the proposed access channel will be dug up, salvaged and relocated into the intertidal zone at the Jordan Cove Embayment site.

It is not clear why eelgrass plants that currently inhabit the intertidal and subtidal zones (+2.0 to -10.0 ft MLLW) at the access channel site will be transplanted only into the intertidal zone at an elevation of +1.3 and -2.0 ft MLLW. The eelgrass plants salvaged from the intertidal zone will occupy a similar tidal elevation at the transplant site, whereas eelgrass plants that occupy the subtidal zone (where they are constantly submerged) will be placed into a new environment characterized by periodic exposure to air and desiccation. The proposed mis-match in tidal elevation between eelgrass plants harvested from the access channel site (intertidal and subtidal) and the Jordan Cove transplant site (intertidal only) provides evidence that the transplants may face a high likelihood for failure.

The JCEP Project Description proposes to excavate an existing sandy shoal located near the end of the North Bend airport runway to serve as an Eelgrass Mitigation Site. Specifically, the JCEP proposal is to "reduce and re-contour a 9.34 acre area of the intertidal shoal down to an average depth of 1.0 to -2.0 ft NAVD 88 (-0.28 to -1.28 ft MLLW) to create 6.78 acres of optimal eelgrass habitat." The existing sandy shoal currently has an elevation in the intertidal zone that reaches about +2.7 ft MLLW, so the excavation will reduce the tidal elevation by about 1.7 to 4.7 ft and remove about 0.04 million cubic yards (MCY) of the shoal material to create the shallow tidal basin that will serve as the mitigation area. The proposal is to re-contour the shoal material and create 6.78 acres of "Optimal Eelgrass Habitat" at a tidal elevation of -0.28 to -1.28 ft MLLW. The rationale for designation of the narrow tidal range of -0.28 to -1.28 ft MLLW as optimal eelgrass habitat is poorly developed. More specifically, Thom et al. (2003) shows that eelgrass clearly occupies a more extended tidal range of +3.0 to -1.6 ft MLLW in Coos Bay. The rationale provided by JCEP for designation of only a portion of the tidal elevation range as "optimal" for eelgrass at the proposed mitigation site is not clear.

The JCEP project description states that "an evaluation of both eelgrass distribution and depth indicates that the principal limiting factor for eelgrass in the general vicinity of the Eelgrass Mitigation Site is elevation." However, JCEP fails to point out that eelgrass can (and does) currently exist in Coos Bay at sites that have a tidal elevation of +2.7 ft MLLW, and that eelgrass is largely missing from the sandy shoal habitat at this tidal elevation at the proposed Eelgrass Mitigation Site. Earlier research (Thom et al. 2018) has shown that eelgrass beds are typically limited by the availability of proper substrata, light, heat stress, and desiccation. The virtual absence of eelgrass currently at the proposed Eelgrass Mitigation Site is likely due to a combination of ecological factors other than simply tidal elevation.

The JCEP includes excavation of about 0.04 million cubic yards (MCY) of the shoal material to create a shallow circular tidal basin that will retain estuarine water and serve as the primary site for eelgrass mitigation activities. Concern has been repeatedly raised about the likelihood for poor water quality conditions (including low dissolved oxygen concentrations and elevated temperature), and trapping of decaying drift algae and other organic materials within the shallow excavated basin. JCEP does not provide any technical analysis nor rationale for the shape of the shallow excavated tidal basin, nor any explanation about the time frame that is expected for the newly excavated basin to re-fill with sediments. It will be beneficial for the excavated mitigation basin to include channels that have a substantial hydrodynamic connection to the primary tidal channel in an effort to enhance tidal flushing and help ensure adequate water quality conditions to support eelgrass, invertebrates, and fish within the excavated basin.

The proposed eelgrass mitigation site should be designed to include a functional hydrodynamic connection to the primary tidal channel. The supplementary technical report generated by JCEP (Section 3.2.2; page 18) indicates that "the proposed grading boundary of the Site may be re-contoured from the current design to allow drainage from the Site so it does not become a shallow bowl that retains water at minus low tides." However, the proposed short channel (excavated at -1.3 ft MLLW) that extends to deeper water is not clearly identified, and further clarification is needed to illustrate the expected directional pathways for water, sediment, and debris to enter and exit the excavated mitigation basin during flood and ebb tides. It is not clear at this point where the short channel will be located, and whether the short channel will persist over time at the project site. Bathymetry maps should be revised and updated for the proposed JCEP Eelgrass Mitigation Site to include the "short channel" at -1.3 ft MLLW to make a hydrodynamic connection to adjacent channels to improve flushing of the excavated shallow basin.

ODFW is concerned that the excavated JCEP mitigation basin may refill with sediment, and that the rate of sedimentation may not be conducive to survival, growth, and propagation of the planted eelgrass plants. For example, Mills and Fonseca (2003) conducted a series of field experiments to determine the susceptibility of eelgrass (*Zostera marina*) to burial by estuarine sediments. Results from the study demonstrate that eelgrass plants experience an increased likelihood of mortality and decreased productivity under burial conditions, and that the threshold level of burial tolerance for *Z. marina* is extremely low. Burial of eelgrass to depths as low as 25% of the aboveground plant height (4 cm) substantially increase mortality of eelgrass, causing death of >75% of the plants. Moreover, the probability of eelgrass mortality reached 100% for burial depths of 50% (8 cm) to 75% (12 cm) of plant height, depending on the types of sediment (e.g., sand, silt, combined) in which the plants were buried. These empirical observations indicate that eelgrass can only tolerate rapid sedimentation events that cover less than half of its photosynthetic surfaces, and that small levels of rapid sedimentation are detrimental to survival of *Z. marina*.

The methods proposed by the applicant to detect sedimentation within the excavated mitigation basin have a coarse depth resolution of + 4 inches (10 cm). These proposed methods are insufficient to detect the finer-scale measurement of local sedimentation (i.e., 2-4 cm) that can result in damage and loss of eelgrass plants.

Existing sediments at the sandy shoal that is proposed for excavation at the Eelgrass Mitigation Site currently consist of medium to coarse sand, and the site is characterized by wind chop during high tides. The JCEP includes excavation of about 0.04 million cubic yards (MCY) of the intertidal shoal material down to an average depth of -0.28 to -1.28 ft MLLW to create the 6.78 ac shallow tidal basin. The project description, however, does not include a detailed description or characterization of the underlying sediments that will be exposed by the dredging and excavation work. The characteristics of the underlying sediment are important, because these underlying sediments will provide the foundation for transplanted eelgrass plants. It is likely that the characteristics of the underlying sediment differ substantially from the surface sediment, and that the underlying sediment may be compacted and anaerobic with relatively little interstitial space for the establishment of eelgrass roots/rhizomes and the movement of water. These expected characteristics of the underlying sediment are not conducive to survival and growth of the transplanted eelgrass. The project description points out that the dredging work and excavation will occur about 1-year before transplants of eelgrass from a donor area, and it is expected that the excavated tidal basin will naturally receive transported sediment from the greater Coos estuary. Moreover, the expected rate of sediment accretion is not identified by the JCEP Project Description, nor the time frame when the excavated tidal basin is expected to fill with transported sediment. Further technical analysis is required to characterize the underlying sediments and to identify the rate of sediment accretion that is expected within the excavated eelgrass mitigation site.

The JCEP should include establishment of a series of experimental test plots to determine the likelihood of success for eelgrass plants transplanted into the excavated Eelgrass Mitigation Site. These replicated test plots should be constructed in a manner that mimics the excavated elevations within the proposed shallow tidal basin, and should also be carried out in a manner to evaluate the success/failure of the proposed transplant techniques. The test plots should be established 1-2 years in advance of the excavation and dredging activities, and should be evaluated on a quarterly basis to determine standard metrics for the survival, growth, cluster coalescence, and seed production by the eelgrass plants. For example, Thom et al. (2018) recently used test plantings as one of several criteria to evaluate the likelihood for success at numerous potential eelgrass restoration sites in Puget Sound. Results and information derived from the test plots indicated that fine-scale data are needed to improve the predictive capability of proposed restoration, enhancement, and mitigation activities. The technical approach outlined by Thom et al. (2018) provides a clear roadmap and analytical process to identify and evaluate potential eelgrass mitigation sites and increase the overall likelihood for project success.

The JCEP monitoring activities and adaptive management plan make progress toward identification of contingencies that may be encountered in the event that the transplanted eelgrass fails to become established or fails to grow and expand as expected over the timeframe for the Project. The adaptive management plan, however, has not yet identified a series of quantitative thresholds or metrics for sedimentation rates that will be used to trigger corrective or remedial adaptive management actions (such as re-planting, re-dredging, or abandonment of the excavated site). In addition, JCEP has not yet identified a suitable alternate site located elsewhere in Coos Bay that can be used for the mitigation work in the event that the primary eelgrass mitigation basin becomes unworkable.

ODFW recognizes that the ODSL mitigation ratio must be at 1.5:1 for creation of a new eelgrass bed at the proposed JCEP eelgrass mitigation site. However, the transplanting of eelgrass proposed by JCEP only achieves a mitigation ratio of 1:1, which is insufficient to meet ODSL standards. The Applicant predicts that the transplanted eelgrass will survive, grow, and expand over a period of five years to fill out the excavated basin in order to achieve the required mitigation ratio of 1.5:1. The expectation by JCEP for the transplanted eelgrass to flourish has a great deal of uncertainty, and optimism by the applicant should not be considered as a guarantee to meet DSL’s required mitigation ratio.

ODFW recommends that the applicant increase the spatial extent of eelgrass transplants to achieve the mitigation ratio of 1.5:1 at the initiation of the planting (time-zero) rather proceed with the expectation that the required ration will be met after a period of five years. The Applicant will not meet the ODSL mitigation policy standards unless the transplant activities begin with a ratio of 1.5:1.

Kentuck Slough Mitigation Plan:
ODFW has requested, but has not yet received, a long-term management plan for the Kentuck mitigation site, including:

- Long-term protection and stewardship strategies to ensure the mitigation site will be durable for the life of the project's impacts
- Long-term water management strategies for the Kentuck Creek water control structure.

Without this information, ODFW does not consider the Compensatory Wetland Mitigation Plan complete, in accordance with the ODFW Fish and Wildlife Habitat Mitigation Policy.

The applicant has verbally committed to redesigning the Kentuck mitigation elevation plan to develop additional acreage that will be below elevation +5.5 NAVDD88 *(*the elevation threshold for saltmarsh development) on the site. This will offset loss of Category-2 Algae/Mud/Sand habitats that will be dredged and regraded at the eelgrass mitigation site south of the North Bend Airport runway. The exact acreage (6.81 acres + slope area) of grading/dredging at the eelgrass location has of yet not been finalized. ODFW will need updated Kentuck mitigation design plans and a complete eelgrass site dredging/grading plan in order to determine if the loss of the Category-2 Algae/Mud/Sand will be offset. ODFW recommends that the applicant include this information in a revised Compensatory Wetland Mitigation Plan.

The Kentuck site is slated for disposal of 300,000 cubic-yards of dredge spoils from development of the JCEP access channel. ODFW will need to understand where fill proposed to be disposed of at Kentuck will be relocated in order to allow the Kentuck grading plan to produce the additional acres below elevation +5.5ft. There will also be a need to update the grading and erosion control plans for both the eelgrass mitigation site and Kentuck Mitigation site, which may have additional or different impacts to fish and wildlife.

Pipeline Mitigation, Generally:
ODFW has reviewed the applicant's Comprehensive Mitigation Plan (submitted to the FERC Docket in September 2019; also see the FERC FEIS Sections 2.1.4 and 2.1.5), in particular the proposed mitigation for permanent impacts to streams and riparian habitats impacted by the pipeline. ODFW does not find the proposed mitigation meets the Fish and Wildlife Habitat Mitigation Policy's goal of no net loss of fish and wildlife habitat. Also, the mitigation actions are almost entirely on U.S. Forest Service (USFS) and Bureau of Land Management (BLM) lands even though impacts will also occur on private lands. While ownership is not necessarily a requirement in the ODFW Fish and Wildlife Habitat Mitigation Policy, having mitigation be in-kind and in-proximity to the impacts are standards of the policy.

For a fuller discussion of ODFW's concerns, please see ODFW's recent *Protest of the BLM Proposed RMP Amendments (DOI-BLM-ORWA-M000-2017-0007-EIS)* dated December 20, 2019 and *Protest of the USFS Proposed Forest Plan Amendments (#28132) to the Umpqua, Rogue River-Siskiyou, and Fremont-Winema National Forests* dated January 6, 2020. Both of these protests have been provided as attachments to this letter, for your reference.

Since the project's inception, ODFW has recommended the applicant crosswalk the federal land compensatory mitigation plans with the standards in the ODFW mitigation policy to ultimately ensure that fish and wildlife impacts are avoided, minimized, and mitigated across all land ownerships (see ODFW's comments on page 80 of Oregon State Agency Comments on FERC's

Draft Environmental Impact Statement for Docket Nos. CP-17-494-000 and CP17-495-000 dated July 3, 2019). As of the date of this letter, this crosswalk has not been included in the FEIS or in the DSL removal-fill application. Therefore ODFW does not have the information it needs to ensure the project's impacts will be offset to the standards of its Fish and Wildlife Habitat Mitigation Policy.

Freshwater wetland impacts:
ODFW has been reviewing the GIS files provided by the PCGP consultant for pipeline permanent and temporary impacts to freshwater wetland habitats. The specific impact acreages by type of wetland and ODFW Habitat Category have not been incorporated into the Compensatory Wetland Mitigation Plan, nor has the plan been assessed for its consistency with the ODFW Fish and Habitat Mitigation Policy. ODFW acknowledges that permanent impacts will result in a limited quantity of permanent impacts (0.91) acres. However, ODFW has substantive concern with temporal loss of function for the 112.19 acres of freshwater wetland that will be heavily damaged and then addressed through revegetation measures outlined in the applicant's Erosion Control and Revegetation Plan. It is ODFW's opinion that recovery of the functions and values in many of these freshwater wetland habitats will likely require 5 to 7 years, which is beyond DSL's 24-month definition of 'temporary' and is deserving of additional compensatory mitigation to address temporal loss of habitat for fish and wildlife.

Stream/riparian impacts:
The pipeline will cross 155 perennial streams. The pipeline right-of-way will impact a 75-foot wide corridor through riparian habitats. The excavation of the trench to install the 36" pipe will result in direct stream channel impacts at least 20 feet in width and bank to bank. A number of these stream locations are Essential Salmonid Habitat. Stream habitats often require a number of years post-disturbance for the channel bed, banks, and upslope to stabilize and recover at least minimal function. Normally in stream channel restoration projects, a minimum of three to five years are often needed moderate function recovery. It is ODFW's understanding that the applicant is developing Stream Function Assessment Method (SFAM) information for stream crossings. However, ODFW has not yet received this information and therefore cannot determine whether or how this information might affect mitigation plans.

ODFW has noted that the PCGP applicant has not developed a plan to address:

- The temporal loss of function to aquatic habitats and associated riparian forest (*see ODFW Protest of BLM and USFS Plan Amendments, cited above and attached to this letter).*
- Consistency with the habitat categories and mitigation standards of the ODFW Fish and Wildlife Habitat Mitigation Policy,
- SFAM evaluations for each crossing and how that might change compensatory mitigation,
- Large Woody Debris that adequately offsets impacts. The PCGP Large Woody Debris Plan (included in the September 2019 Comprehensive Mitigation Plan) documented that up to four pieces of LWD will be placed where streams are rebuilt after trenching and installation of the 36" pipe. This is considered inadequate for restorative uplift to replace lost function (*see ODFW protest of the BLM RMPA).*
- Specific mitigation proposals previously submitted by ODFW. There were a number of mitigation proposals submitted in 2015 by ODFW local and headquarters staff that specifically address offsetting impacts of the Project to stream and riparian habitats. These were resubmitted in the July 3, 2019 State of Oregon Comments on the 2019 FERC DEIS.

ODFW greatly appreciates the opportunity to provide technical assistance to DSL on this project and always. Should you have any questions or require additional information from ODFW, I will continue to be your primary point of contact. I may be reached at 503-947-6082 or sarah.j.reif@state.or.us.

Respectfully submitted,

/Sarah Reif/
Sarah Reif

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Initial Herring Spawn Yaquina Bay

SPAWN SURVEYS		
Year	Initial Date	Julian Day
2016	2/11/2016	42
2015	2/23/2015	54
2014	3/13/2014	72
2013	3/4/2013	63
2012	*	*
2011	2/16/2011	47
2010	2/17/2010	48
2009	3/4/2009	63
2008	2/14/2008	45
2007	2/20/2007	51
2006	3/2/2006	61
2005	2/12/2005	43
2004	2/9/2004	40
2003	2/14/2003	45
2002	2/27/2002	58
Average spawn date 2/21 (Julian: 52)		
Minimum spawn date 2/9 (Julian 40)		

* denotes no systematic sampling in this year

ACOUSTIC SURVEYS		
Year	Initial Date	Julian Day
2019	1/24/2018	24
2018	1/24/2018	24
2017	2/1/2017	32
2016	2/13/2016	44
2015	2/20/2015	51
2014	1/28/2014	28
Average staging date 2/3 (Julian 34)		
Minimum staging date 1/24 (Julian 24)		