Commercial aquaculture permit application NWS-2007-1213 requests placement of 80,000 on- bottom bags and additional on-beach oysters within the highest use area for waterfowl and shorebirds on Dungeness National Wildlife Refuge (Refuge). It is our understanding that operation of this commercial enterprise (e.g., setup, maintenance, harvest) will require year-round access. The JARPA did not quantify the number of days or people, needed for the operation. SEPA documents estimate up to 15 people are needed up to 90 days/yr for maintenance and harvest. Additional operational access (e.g., setup, outplanting) does not appear to be addressed in the application materials. The site will be accessed by boat, with an identified landing location in its easternmost corner.

Dungeness National Wildlife Refuge was established with the purpose of providing “a refuge, preserve and breeding ground for native birds” (E.O. 2123). Refuge concerns related to wildlife and habitat impacts from aquaculture in this location have been stated historically, including a request from the Refuge manager in 1990 that “oyster operation(s) be conducted in such a manner as to minimize interference with waterfowl…” In 1983 the Ecological Services Field Supervisor also requested that “harvest only be allowed May 1 – September 30 to avoid the greatest waterfowl concentrations.” Also, Exhibit B of the lease agreement signed in 2007 (20-A13012), recognizes the importance of the area to Brant and the potential for impacts by stating, “Human activity in the area should be limited to May 15 – July 30, when cultivation activities will be least disruptive to the use of the Bay by Brant and other waterfowl.” This lease agreement is currently in holdover status and outlines shellfish activities that are small in scale and primarily experimental in nature.

Due to its importance for migrating and wintering waterfowl and shorebirds, the tidelands encompassing the proposed site have been closed to public use from October 1 – May 15, since 1997 (USFWS 1997). To reduce impacts to habitat and wildlife during May 16 – September 30, only non-wake causing activities are allowed and a 300 ft’ buffer is maintained along the shoreline. Adjacent uplands are also closed to public access year round. Our recommendations to reduce impacts from commercial aquaculture to the highest shorebird and waterfowl use area of the Refuge are provided at the conclusion of this comment letter.

**Concerns Related to On-Bottom Structure**

We recognize there has been little research on the specific impacts of commercial, on-bottom or on-bottom bag aquaculture on the species found on this Refuge and much of the existing literature regarding the impacts of aquaculture in general is contradictory, such as those published by Connolly and Colwell (2005; shorebird response to longline aquaculture) and Kelly et al (1996; shorebird response to on-bottom bag aquaculture). However, during a five-year investigation of on-bottom bag aquaculture practices, Kelly et al. (1996) found that Dunlin and Western Sandpiper (the two most abundant shorebirds in their study and on the Refuge) ‘significantly avoided aquaculture areas’ and their ‘results suggest a net decrease in total shorebird use of areas developed for aquaculture’ in the form of on-bottom bags. On-bottom bags and on-beach oysters could also restrict growth of eelgrass within the proposed site due to ground disturbance from human trampling, on-bottom bags, and on-beach oysters (depending on density). The applicant’s willingness to provide a 25” buffer from eelgrass beds will largely avoid effects to currently identified eelgrass beds, however a 2016 eelgrass survey jointly conducted by the Refuge and Jamestown S’Klallam Tribe staff identified eelgrass turions outside of the identified eelgrass area. When 1987 eelgrass survey maps (Wilson 1988) are displayed in GIS, these surveys appear to identify eelgrass (although sparse) within the portion of the site proposed for cultivation, further documenting its suitability for eelgrass growth. Consequently, 80,000 on-bottom bags at densities of 4,000 bags/acre would exclude eelgrass from this growth area. Eelgrass growth in higher tidal elevations, such as on this site, is important because Brant forage almost exclusively on eelgrass and availability is limited during high tides due to the depth at which Brant can forage and eelgrass can grow. However, actions that could reduce impacts to eelgrass from aquaculture structures (e.g., bags) by moving their location to a portion of the site outside of the growth zone, would compound impacts to shorebirds by increasing the proximity of operations to one of the most highly used foraging areas.

**Concerns Related to Human Disturbance**

Since many of our concerns are based on disturbance from human activities occurring on the site, studies assessing disturbance from human uses that are similar to, or components of, the aquaculture operation provide insight into potential impacts to waterfowl and shorebirds in this high use area. Activities considered similar to those associated with maintenance of a commercial aquaculture plot include bait digging or clamming (comparable to harvesting “on-beach” oysters grown in the sediment), walking on tide flats (walking to and from the main anchorage point and the plot as well as within the plot) and boat access. Because Wigeon, Brant and Dunlin are among the most abundant species using the Refuge and Brant and Wigeon rely on eelgrass for forage, we focused on these species when studies provided species-specific impacts.

Because the effects of human disturbance on wildlife and their response is complex and dynamic based on species, species assemblages, flock size, activity (i.e. foraging or roosting), tidal stages, different types of disturbance and time of year impacts vary considerably (Cayford 1993, Mori et al 2001, Smit and Visser 19943, Owens 1977). For example, Brant response to disturbance was highest to boat traffic (27% of events) and clamming (22%) on Humboldt Bay (Henry 1980). In addition, Mori et al (2001) studied the flushing distance of waterfowl to boats and found that response varied by species (i.e. up to 480’ vs 300’ for Wigeon and Mallard respectively), with multi-species flock flushing distance usually driven by the most sensitive species in the flock. They also found that response to disturbance varies by activity with foraging birds flushing at a greater distance from disturbance than those that are resting. They concluded that the behavior of actively foraging birds may be more affected by human disturbance than those that are at of resting, compounding the negative effects of energetically expensive flight with lost foraging time. This is important from an energetic standpoint which will be discussed in the next section. Owens (1977) found that Brant are more sensitive to human disturbance (from bait diggers, people walking out to shellfish beds or moored boats) when foraging at low tides. Further, repeated encounters (two) of people walking toward Brant on eelgrass beds can increase the flushing distance to 2400’ (Owens 1977). Brant forage exclusively on eelgrass. Because Brant are dabblers, they are only able to forage on eelgrass within 1.5 feet of the water surface requiring them to utilize eelgrass at different tidal elevations as water depths change throughout the day (Lewis et al 2013, Wilson and Atkinson 1995, Davidson and Rothwell 1993). As a result, it is important to protect foraging areas at varying tidal elevations from disturbance to maintain availability of this temporally limited food resource. In addition to impacts to foraging Brant, human disturbance will cause Wigeon foraging on eelgrass beds at low tides to abandon the bed until the next tidal cycle (Fox et al 1993), and frequent or severe disturbance can cause wildlife to abandon a foraging site entirely (Fox et al 1993, Smit and Visser 1993). Aquaculture operations, transportation travel paths and boat anchorage are located within the highest use area for waterfowl on the Refuge and adjacent to eelgrass beds. The boat anchorage area will likely be hub of activity for workers as they come and go from the site and perform work (e.g., unloading and load supplies, equipment and oysters). If commercial aquaculture operations are allowed in this location it would seem likely, based on the aforementioned studies, that foraging Brant and Wigeon to will flush and potentially abandon eelgrass in and adjacent to the aquaculture site reducing their access to this important and limited forage resource. It is also likely that waterfowl using the Refuge adjacent to boat travel paths and anchorage sites will be flushed by workers accessing the site.

Shorebirds also display flushing response to activities that are similar to those associated with commercial aquaculture. For instance, Smit and Visser (1993) found that Dunlin foraging on the tideflats will flush in response to walkers approaching them by up to 900’, creating an exclusion area due to disturbance of 32 acres. They also noted that Dunlin will tolerate bait diggers working at the same spot for long periods at much closer distances than walkers approaching them on the tide flat, but did not quantify the distance (Smit and Visser 1993). One of the few high quality foraging sites for Dunlin in Dungeness Basin is located adjacent to the proposed aquaculture location and within the flushing distances recorded by Smit and Visser (1993). Since wildlife cannot distinguish between workers approaching them, or walking in their direction to attend to work or approach a boat, it is likely that common activities associated with commercial aquaculture will result in flushing Dunlin (and other birds flocked with them) from this important foraging area.

Finally, multiple studies have shown that wildlife become more sensitive to human disturbance when compounded by additional external disturbances. Both Owens (1977) and Smit and Visser (1993) noted a heightened response (i.e. more frequent flushing and at longer distances) from Brant and shorebirds to other forms of human disturbance, particularly during the hunting season or during instances of cumulative disturbance (i.e. multiple approaches by people walking on the mud flats). Further, Townshend & O'Connor (1993) found that Wigeon abundance and use of sites over the winter months decreased during the hunting season primarily when bait-diggers were present in key areas in which hunting was prohibited (i.e. places of refugia from hunting). This is relevant to the development of a commercial aquaculture plot in the highest wildlife use area of the Refuge because there are six public and private hunting areas in and around the Bay. Since the Refuge is closed to public use during the hunt season, it provides one of the few disturbance-free areas during this time. The existence of hunting outside of the Refuge boundary coupled with activities associated with commercial aquaculture will likely increase the quantity and magnitude of flushing occurrences within the highest use area of the Refuge for waterfowl and shorebirds, during the sensitive wintering season.

**Repercussions of Human Disturbance**

Given that disturbance of waterfowl and shorebird species is likely to occur in and adjacent to the proposed commercial aquaculture farm based on the scientific evidence described above, it is important to understand the impact that this disturbance would have on these species. Reducing or eliminating impacts to these species is important because the area was established and currently managed to provide Refuge for migratory birds. However, potential impacts to waterfowl and shorebirds could extend to a larger scale since Refuge counts can account for up to 98% of Brant and 61% of Wigeon in Clallam County during midwinter (USFWS/WDFW unpublished data). This area of the Refuge is also important state-wide, because it provides a high tide haul-out and gritting site for Brant which is adjacent to eelgrass beds in an undisturbed state (K. Skaggens, pers comm). Gritting sites are necessary for digestion and must be accessed every three days. However, these sites are limited because Brant are very selective of grit characteristics (e.g. grain size) and location. The close proximity of these three habitat components are believed to be the reason for an increase in abundance of Brant observed on the Refuge, not observed elsewhere in the state in recent years (Kyle Skaggens, pers comm). The Refuge is also important for this species internationally because it supports spring staging Brant that breed in Russia and the Canadian high arctic (K. Skaggens pers comm). Finally, the south shore of Dungeness Spit immediately adjacent to the project area (i.e. 2 miles from the base of the spit to Graveyard Lagoon) is one of the few high quality foraging sites for Dunlin in Dungeness Basin. This species is the most abundant shorebird species on the Refuge during winter and migration with abundance of up to 2,000 birds/day.

Flushing in response to human disturbance from activities necessary to set up and maintain a commercial aquaculture project on the Refuge could reduce the time shorebirds and waterfowl spend feeding or resting and increase energetic demands of flight. If the disturbance is severe or regular enough, they could abandon preferred sites (Henry 1980, Fox et al 1993, Cayford 1993). Reoccurring, severe or cumulative disturbance further increases energetic costs to waterfowl and can lead to reduced fitness, decreased productivity or increased mortality rates (Buchanan 2006, Davidson and Rothwell 1993, Baldassarre and Bolen 1994, Ward and Andrews 1993). During severe weather in winter, energy demand for thermoregulation increases which increases the need to forage (Davidson and Rothwell 1993). When severe weather lasts for a few days or more and waterfowl and shorebirds are unable to forage or experience additional stressors resulting in flushing, mortality rates can increase (Buchanan 2006, Davidson and Rothwell 1993). In spring and fall most waterfowl must gain large stores of fat and protein in preparation for their major migrations. In some years, if spring snow-melt is late and weather conditions are bad, arctic-breeding shorebirds and waterfowl need to draw heavily on their stores soon after arriving on the breeding grounds and the reduced energy stores may affect breeding success or adult survival (Belanger and Bedard 1990, Buchanan 2006, Davidson and Rothwell 1993). Studies have shown that human disturbance during winter and the spring staging period is of particular concern for Brant, because it can negatively affect their ability to build energy reserves for migration and breeding and thus lower reproductive success (Henry 1980, Lewis et al. 2013, Ward et al. 2005). In fall, waterfowl undergo a major molt and impacts on fitness from disturbance during this period are high due to increased energy demands for the growth of new feathers. In addition, some waterfowl undergo flightless molt in fall and become more vulnerable to human disturbance that causes them to move from safe refuges to areas where depredation risk is greater and/or forage is scarcer. Shorebirds share the same basic energetic requirements as waterfowl with dramatic changes in body mass during their time on the Refuge (McEwan and Whitehead 1984, Buchanan 2006).

Multiple studies have shown that if forage availability is limited, waterfowl and shorebirds will forage at night (Fox et al 1993, Cayford 1993, Owens 1977). This adaptation is key in tidally influenced areas such as Dungeness NWR when higher tidal elevations prevail during the day in winter. If night-time foraging coincides with periods of high human disturbance during periods of high energetic demand (i.e. molt, spring staging, etc.), additional mortality or displacement can occur.

**Recommendations to Reduce Impact**

Based on the likely impacts to migrating and wintering shorebirds and waterfowl within the highest use area for these species groups on the Refuge, we would recommend that an alternate site be identified in a location that is less impactful to wildlife, is appropriate for commercial aquaculture, and meets the goals of the Tribe.

If no alternate locations can be identified, we would recommend only allowing human access to the site for activities associated with commercial aquaculture from May 15 to July 31 (consistent with 20-A13012). This recommended timing restriction is based on unpublished wildlife use data for the Refuge, previously shared with the Tribe, and the following references: Paulson 1993; Wilson and Atkinson 1995; and the Birds of North America Accounts for the primary species that occur on the refuge (Mallard, American Wigeon, Brant, Northern Pintail, Dunlin, Western Sandpiper, Least Sandpiper, Black-bellied Plover and Sanderling) available online at <https://birdsna.org/Species-Account/bna/home>.

We recognize that the recommended time frame does not coincide with public use closures on Refuge tidelands (October 1 - May 14). From August - October, our highest concern is for shorebirds foraging along the shoreline adjacent to the proposed commercial aquaculture farm, in one of the most highly used forage areas of the Bay. Commercial aquaculture farming activities will be concentrated in and adjacent to this high use area and impacts, as described above, are likely. These high use areas are protected from impacts associated with the minimal public use of the tidelands by a closure of the adjacent uplands, a 300’ public use closure of the waters adjacent to the shoreline, water depth limitations keeping boaters away during low tide and no-wake regulations. Current, limited public use is also spread out throughout the tidelands, not concentrated within the highest use area of the Refuge.

We also recommend that no hazing or lethal control of wildlife be allowed by the commercial aquaculture operator and request that any entanglements or strandings are also reported to the Refuge. We support adhering to all terms, conditions and conservation measures as identified in the most recent Army Corps of Engineers, US Fish and Wildlife Service, and National Marine Fisheries Programmatic Biological Opinions for shellfish activities in Washington State (Corps 2015, NMFS 2016, USFWS 2016), except for measures related to removal of aquaculture debris. Because of concerns related to potential impacts to eelgrass and State Imperiled Habitats, as well as disturbance to Refuge wildlife we request inclusion in further discussion related to the timing of aquaculture debris removal and implementation of other conservation measures that may require access that is contradictory to the recommended timing provided above. Finally, if no alternate site can be identified, we request further discussion with the permitting agencies and the applicant to identify additional ways to reduce impacts from this commercial operation.

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