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Whiting Harbor Research
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Applicant: The State of Alaska Department of Fish and Game and the Smithsonian Environmental Research Center

Figure 1. Aerial view of the Whiting Harbor in Sitka Sound, looking north. A man-made embayment adjacent to the Sitka Rocky Gutierrez Airport.

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Cover photo: Aerial view of the Whiting Harbor in Sitka Sound, looking north. A man-made embayment adjacent to the Sitka Rocky Gutierrez Airport.

ACRONYMS

ADF&G	Alaska Department of Fish and Game
BLM	Bureau of Land Management
EFH	Essential Fish Habitat
FAA	Federal Aviation Administration
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPFMC	North Pacific Fisheries Management Council
ROD	Record of Decision
SERC	Smithsonian Environmental Research Center
T&E	Threatened and Endangered
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

1.1 Summary of Proposed Action

The State of Alaska Department of Fish and Game (ADF&G) and the Smithsonian Environmental Research Center (SERC) have submitted a proposal to conduct field testing of several biocide compounds in Whiting Harbor, Sitka, Alaska to respond to a marine invasive species. They will be testing equipment and measuring the concentration and duration of biocide compounds needed to cause mortality of the invasive tunicate *Didemnum vexillum* (*D. vexillum*) (Figure 2). Rock salt (block or granular), chlorine (granular or puck), cement dust, dye, and chlorine-salt combination treatments will be delivered into dome-enclosures (1.25 m in diameter and 0.5 m in height), via a 3/4" hose. No more than 200 m^2 of seafloor will receive treatments during the entire project. The project will occur either before or after the subsistence and commercial herring egg fishery. This assessment will identify proven and cost-effective eradication methods to determine if a bay-wide control treatment is a feasible means to attempt to eradicate invasive *D. vexillum* from Whiting Harbor.

Figure 2. *Didemnum vexillum* growing on an oyster farm net removed from Whiting Harbor.

1.2 Project Area Description and Land Status

Whiting Harbor (Figure 2) is located in Sitka, Alaska. Ownership of lands surrounding Whiting Harbor is a mixture of State and Native conveyed and Bureau of Land Management (BLM) administered lands. The intertidal and filled submerged lands within Whiting Harbor are BLM lands (Figure 3) per Executive Orders 8216, 8877, and 9526. The federal government reserved approximately 190 acres of property around Charcoal and Alice Islands in 1939 with Executive Order 8216, which withdrew lands and water in Alaska for Naval purposes. In 1941, properties around the present causeway comprising approximately 700 acres of lands and water known as the Makhnati Island area were withdrawn by the federal government with Executive Order 8877. The tidelands and submerged areas encompassing Executive Order 8877 lands did not transfer to the State at statehood; similarly, the tidelands and submerged areas within the Executive Order 8216 were recently determined to be under BLM jurisdiction. As a result, the marine submerged lands and filled lands in the Makhnati Island area are under the administration of the BLM. The BLM administered lands associated with this proposal include all intertidal and filled submerged lands located in Whiting Harbor within the NE¼, Section 3, T. 56 S, R. 63 E., Copper River Meridian.

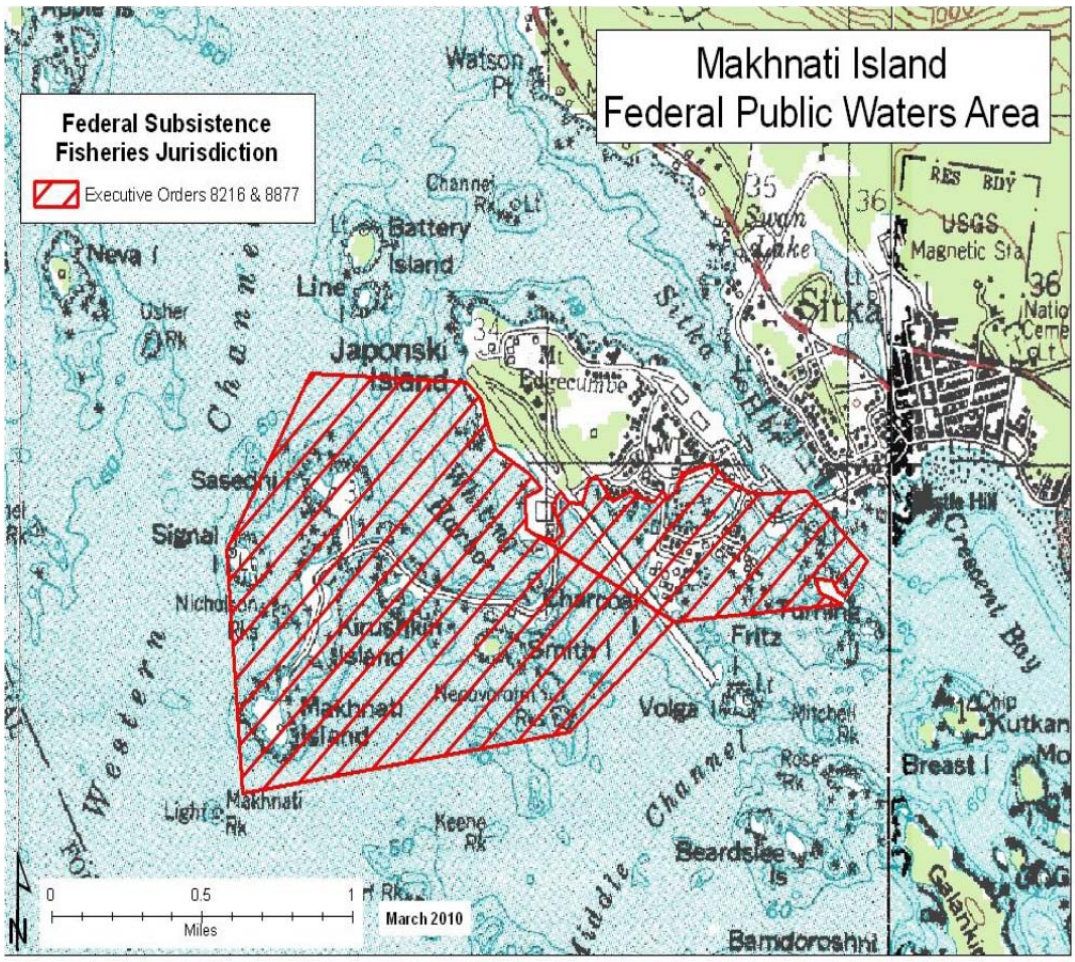

Figure 3. Showing extent of the Federal jurisdiction in Makhnati Island group, Sitka, Alaska.

1.3 Purpose and Need

The BLM action under consideration is to authorize ADF&G and SERC to conduct field testing to evaluate equipment and measure the concentration and duration of biocide compounds needed to cause mortality of the invasive tunicate *D. vexillum.* The need for the action is driven by the potential for the invasive to cause economic or environmental harm to the waters in and surrounding Whiting Harbor. This is consistent with goals identified within the Ring of Fire Management Plan, specifically Management Action U-2a, Water Resources. "Through management of water resources and protection of aquatic habitat, the BLM will support the health objectives of the fisheries program by protecting the water resources." The purpose of the action is to identify proven and cost-effective eradication methods to determine if a bay-wide control treatment is a feasible means to attempt to eradicate invasive *D. vexillum* from Whiting Harbor**.**

1.3.1 Decision to be Made

The decision to be made is whether to authorize ADF&G and SERC to conduct field testing to evaluate equipment and measure the concentration and duration of biocide compounds needed to cause mortality of the invasive tunicate *D. vexillum.*

1.4 Land Use Plan Conformance

The Ring of Fire Resource Management Plan and Record of Decision (ROD 2008) provide the overall long-term management direction for lands encompassed by the proposed project. The proposed action and alternatives are consistent with the ROD. Specifically, the proposed action is consistent with the following decisions in the ROD:

U. Water Resources
U-2a: Management Actions
- Through management of water resources and protection of the aquatic habitat, the BLM will support the health objectives of the fisheries program and the recreation program by protecting the water (ROD 2008).

1.5 Other Applicable Laws, Regulations, Policies, etc.

The proposed action would be subject to various laws, regulations, and acts including, but not limited to:

- National Historic Preservation Act as Amended 1992
- Executive Order 11987 of May 1977 (Exotic Organisms)
- Endangered Species Act of 1973
- Marine Mammal Protection Act of 1972

1.6 Summary of Public Involvement

A summary of the proposed project was posted to the BLM's National Environmental Policy Act register website ePlanning, on November 25, 2014. A feature piece that requested comments was written by the Daily Sitka Sentinel Record newspaper the week of November 28, 2014.

A Notice of the Proposed Action and solicitation of comments was published on the What's Up Alaska list server, and mailed to Sitka Tribe of Alaska, Shee Atika Incorporated, Sealaska Corporation, Central Council Tlingit & Haida Indian Tribes of Alaska, and Sitka Representative Jonathan Kreiss-Tomkins. Eighty-three stakeholders with a previously demonstrated interest in the issue also received a notice. The mailings were sent on November 21, 2014. A public service radio announcement was placed on the regional radio station, KCAW, on the week of November 24, 2014. Public service announcement flyers were posted in Sitka at grocery stores (3), post offices (2), and three other locations in town on November 28, 2014. The deadline for comments was Monday December 8, 2014.

A total of five comments were received. One comment was received that raised a potential new issue not identified by the interdisciplinary review team. The issue consisted of questioning what chemical compounds are in the treatment dye and could they enter the food chain and contaminate subsistence resources? Four commenters did not reveal any new issues or provide any new information not already identified. All commenters were supportive of the project.

1.7 Issues Identified / Issues Eliminated from Further Analysis

Scoping revealed the following issues for analysis:

- What are the effects of cement dust to non-target organisms inside and outside the treatment dome?
- What are the effects of rock salt (sodium chloride) to non-target organisms inside and outside the treatment dome?
- What are the effects of chlorine to non-target organisms inside and outside the treatment dome?

The following issues were identified but eliminated from further analysis for the reasons provided:

- *Effects to herring subsistence egg fishery*. The subsistence herring egg harvest in Sitka usually occurs sometime between the last weeks of March to the second or third week of April. No in-water work will be performed during the subsistence egg fishery to eliminate any potential conflict with subsistence herring egg take.

- *Effects to Essential Fish Habitat (EFH)*. According to National Marine Fisheries Service (NMFS) and North Pacific Fisheries Management Council (NPFMC), EFH within the Gulf of Alaska includes all estuarine and marine waters and substrates from the shoreline to the seaward limit of the Exclusive Economic Zone, an area that includes Sitka Sound and the project area. In order to avoid, minimize, mitigate, or otherwise offset adverse

effects to Essential Fish Habitat, BLM will coordinate with ADF&G and SERC and consult with local ADF&G biologists in Sitka to determine specific timing windows to avoid the potential exposure of living marine resources, including EFH, to biocide during sensitive life history stages as recommended by the NMFS in their scoping response letter dated December 8, 2014. NMFS stated project measures in the proposed action should provide enough protection from biocides being tested to avoid impacts to spring spawning herring and out-migrating salmonids. NMFS deferred specific determination of no in-water work windows to protect spawning herring and out-migrating salmonids to local ADF&G biologists who track these events on a real time basis.

- *What chemical compounds are in the treatment dye and will they enter the food chain and contaminate subsistence resources*? Rhodamine water-tracing dye is an inert and non-toxic dye and will have no effect on any organisms inside or outside of the treatment dome. Each dome will receive 100 ml of dye in addition to the biocide. The dye will aide in detecting the efficacy of the enclosures.

- *What actions will be taken to mitigate the risk of spreading D. vexillum during treatments*? During all phases of the project all gear and equipment, including enclosures used in Whiting Harbor will be disinfected after use in Whiting Harbor and/or before it is used in marine waters elsewhere. Dive gear will be treated in a hyper saline or freshwater bath, and equipment will be washed with freshwater, hyper saline water. or allowed to dry completely. Boats with a bilge pump will avoid the infested area and skiffs used by divers will be washed with freshwater, a hyper saline solution, or allowed to dry completely. When necessary project equipment used in infested areas of Whiting Harbor will be towed to the causeway and removed from the water via the old floatplane ramp. Anything removed at this location will be washed with freshwater, a hyper saline solution, or allowed to dry completely after use in Whiting Harbor and/or prior to use in marine waters elsewhere.

- *Concern that the project will coincide with the most active seasonal stage of D. vexillum and work during this time would increase the risk of spreading D. vexillum outside Whiting Harbor through fragmentation of tendrils*. The introduction and spread of *D. vexillum* is thought to be predominantly the result of three transport vectors; hull fouling, aquaculture, and ballast water. Since the aquaculture infrastructure has been removed from Whiting Harbor it no longer serves as a concern for spread. Historical hull fouling has been the primary vector for the transport and introduction of nonindigenous species in marine habitats (Carlton 1989). While *D. vexillum* can be observed growing in tendril formation when hanging in the water column, most often the colonial tunicate grows in undulating mats when established on the seafloor. Where possible, work will be occurring in shallow water. Dive gear and anything used in the infested waters of Whiting Harbor will be disinfected according to the above mentioned standards.

- *Is there a potential for the proposed treatment tests to adversely affect any underwater historic resources associated with the Fort Rousseau site (SIT-0732), a part of the Sitka Naval Operating Base National Historic Landmark (SIT-0079), near Whiting harbor, Alaska?* The project will take place on submerged lands that are part of the Fort

Rousseau site (SIT-0732), which contain a variety of historic artifacts dumped in the harbor and along neighboring beaches by the military (Pullnow 2014). However, the proposed project is designed to minimally disturb the seafloor due to the project's goal of minimizing the spread of the invasive *D. vexillum*; therefore there will be no foreseeable disturbance of any associated underwater historic resources. Additionally, the project's underwater treatments using chlorine, salt and cement dust will have no adverse chemical effects on submerged cultural resources, which are constructed of steel, lead, ceramic and concrete, during the short period of time that the treatment solutions are applied. Treatments will be quickly diluted and dispersed by strong current circulation.

- *Effects to threatened and endangered (T&E) species.* Humpback whales are the only T&E species thought to inhabit the area. Humpback whales congregate in Sitka Sound and near Whiting Harbor in the late winter to early spring to feed on pre-spawn Pacific herring, and then disperse in April, presumably following the herring. Through the T&E evaluation (Attachment 1, Threatened and Endangered Species Evaluation) a determination of no effect to threatened or endangered species was determined.

2.0 ALTERNATIVES

2.1 Alternative 1 - No Action Alternative

Under the No Action Alternative, the BLM would deny the request for ADF&G and SERC to conduct field testing to measure the concentration and duration of biocide compounds and equipment needed to cause mortality of the invasive tunicate *D. vexillum*.

2.2 Alternative 2 - Proposed Action Alternative

The BLM would authorize ADF&G and SERC to conduct field testing to measure the concentration and duration of biocide compounds and equipment needed to cause mortality of the invasive tunicate *D. vexillum*. Rock salt (block and granular), chlorine (granular/puck), cement dust (in solution), dye, and chlorine-salt combination treatments will be delivered into dome-enclosures (1.25 m in diameter and 0.5 m in height), via a 3/4" hose. Meters and timers will be used to determine when the effective dose and duration is achieved, which will be based on information from prior scientific aquarium-scale treatment trials. The goal is to use as little of each biocide as necessary to achieve mortality of *D. vexillum*. Field work will consist of at least four trips: two trips when biocides are introduced into containment enclosures and at least two trips to photograph and monitor efficacy of the treatments. The first trips will include field testing of methods after which a monitoring trip will occur approximately six weeks later. Later in the season field visits to determine success of treatments and investigate feasibility of a larger scale treatment will occur, with at least one monitoring trip to follow.

The first trip in late May, consisting of field testing of methods, will be done to mark treatment locations, test enclosures, and perform treatment delivery and duration. A maximum of 20 treatments in dome-enclosures will be conducted over a one-week field trip. See Table 1 for estimates of treatment applications. A post-field test monitoring trip will occur approximately six weeks later to photograph and monitor the test sites to assess efficacy of treatments. Divers

will collect data on the genus and species, and the number of organisms affected by the treatments.

The second trip will consist of field experiments and measuring the concentration and duration of compounds needed to cause mortality of the invasive tunicate, *D. vexillum*. A maximum of 68 treatments of salt, chlorine, cement, and chlorine-salt combination will be conducted, requiring up to a two-week field trip. See Table 2 for estimates of treatment applications. No more than 200 m^2 of seafloor will receive treatments during the entire project. The second trip will also involve post-treatment photographing and monitoring to evaluate efficacy of treatments.

	Salt	**Cement dust**	**Chlorine (granule)**	**Dye** (only in absence of chlorine)
Number of treatment plots	5	5	5	5
Application per treatment	200-600 lbs (90-272kg)	4 lbs (1.82kg)	1.5 lbs (0.7kg)	100 ml (100µl per liter)
Application (cumulative)	3000 lbs (1360kg)	20 lbs (9kg)	7.5lbs (3.4 kg)	500 ml

Table 1: Treatment applications for Trip 1

	Salt	**Chlorine (granule)**	**Cement dust**	**Salt-Chlorine combo**	**Enclosed control**	**Open control**
Number of treatment plots	6	6	6	6	6	6
Application per treatment	200-600 lbs (90-272kg)	24 oz (.7kg)	4 lbs (1.82kg)	400 lbs 1.5 lbs	N/A	N/A
Application (cumulative)	3600 (1633kg)	9 lbs (4 kg)	24 lbs (11 kg)	2400lbs 9 lbs	N/A	N/A

Table 2: Treatment applications for Trip 2

2.3 Design Features and Best Management Practices

The following design features and best management practices would be incorporated into Alternative 2 to minimize impacts to marine resources.

1. No in-water work will be performed during the commercial or subsistence herring egg fishery to eliminate any potential conflicts. All treatment approaches will leave the physical habitat intact and unaltered.
2. The chorine and salt will be in a solid form: granular, block, or puck. This is primarily for safety and handling reasons as it remains visible before it dissolves and in the event of an accidental spill it is more easily cleaned-up.

3. Levels of rock salt and chlorine will be closely monitored in the treatment domes with sensors to determine the correct dosage for treatment and to ensure an overdose does not occur in the marine environment outside the treatment dome.
4. Plots with fewer non-target organisms will be chosen to reduce impacts to non-target organisms.
5. During all phases of the project all gear and equipment used in Whiting Harbor will be decontaminated after use in Whiting Harbor and/or before it is used in marine waters elsewhere
6. Dive gear will be treated in a hyper saline bath or freshwater and dried completely, and equipment will be washed with freshwater, a hyper saline water or allowed to dry completely.
7. Boats with a bilge pump will avoid the infested area and skiffs used by divers will be washed with freshwater, a hyper saline solution or allowed to dry completely.
8. Where possible, gear used in infested areas of Whiting Harbor will be towed to the causeway and removed from the water via the old floatplane ramp. Anything removed at this location will be washed with freshwater, hyper saline solution or allowed to dry completely after use in Whiting Harbor and/or prior to use in marine waters elsewhere.
9. The project will follow Leave No Trace Principles. No debris from the project will be left behind and the area will be kept clean and free of litter.
10. Notices will be placed in Sitka at high use areas such as grocery stores, post office and harbors announcing when in-water work will be taking place.
11. Boats and divers will abide by all the Marine Mammal Viewing Guidelines and Regulations (NOAA, 2014)
12. In order to not disrupt the normal behavior or prior activity of the humpback whale, if a humpback whale is sighted in research area of Whiting harbor, all research is to cease until the humpback whale is at least 100 yards away from the research area.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL EFFECTS

3.1 ISSUE 1 – WHAT ARE THE EFFECTS OF CEMENT DUST TO NON-TARGET ORGANIMS INSIDE AND OUTSIDE THE TREATMENT DOME?

3.1.1 Affected Environment

The seafloor in the area immediately surrounding the airport and Whiting harbor has been surveyed using side scan sonar and found to contain a mosaic of bottom types including a mixed-soft bottom (mixture of silt, sand, pebbles, cobbles, boulders, and shell) within which there are numerous outcrops of native bedrock. These scattered rocks provide a substrate for a moderate bottom cover by many of the same species of algae found at similar depths on rocky bottoms in Sitka Sound. Lower intertidal and subtidal rock habitats throughout Sitka Sound support extensive beds of kelp (giant kelp, *Macrocystis pyrifera* and bull kelp, *Nereocystis luetkeana*) that are evident on the sea surface. The most dominant and visible marine organisms are the large browsing sea cucumber and a variety of sea stars (especially the large sunflower star) that prey on an abundance of several species of clams. The swimming scallop is common in this habitat as are cerianthid anemones and burrows of ghost or mud shrimp. Sea pens and the sea whip are also common filter feeders within the area (FAA 2009).

Macroinvertebrates, zooplankton, and phytoplankton all serve as key forage (food for other species) in the Sitka Sound ecosystem. Marine and some terrestrial birds feed on invertebrates in the intertidal zone, shallow subtidal zone, and portions of open water habitat. Smaller crustaceans (shrimp-like animals), including mysids, amphipods, euphausiids, and copepods are heavily preyed upon by birds, invertebrates, and fish. Large whales such as humpback whales (*Megaptera novaeangliae*) also forage on these small crustaceans as well as on forage fish such as herring. Additionally, over a dozen bivalve species such as blue mussels (*Mytilus trossulus*), cockles (*Clinorcardium* sp.), butter clams (Saxidomus gigantea), and horse clams (*Tresus* sp.) are abundant in the rock, sandy, and muddy intertidal zone. Worms, marine snails, chitons, abalone (*Haliotus kamtschatkana*), sea stars, crabs, sea urchins (*Strongylocentrotus* spp.), and octopus also flourish in the Sound (FAA 2009).

Pacific herring (*Clupea pallasi*) serves a paramount ecological role within Sitka Sound. All stages of herring are important prey for invertebrates, birds, mammals, and larger fish. Other forage fish species such as surf smelt (*Hypomesus pretiosus*), sand lance (*Ammodytes hexapterus*), and salmon (*Oncorhynchus* spp.) are also abundant in the sound. All five species of Pacific salmon are found within the Sound and are common prey for Steller sea lions (Eumetopius jubata), harbor seals (Phoca vetulina), killer whale (*Orcinus orca*), bald eagles (*Haliaeetus leucocephalus*), and other species (FAA 2009).

3.1.2 Direct and Indirect Effects from No Action Alternative

The Whiting Harbor discovery represents a 620 mile northward leap in distribution from other known occurrences of *D. vexillum* in the northeast Pacific, and no other populations are known to occur in Alaska. While the proposed action is a feasibility study to determine if eradication or control is viable, the consequence of no action on the distribution and persistence of *Didemnum vexillum* is largely unknown, though it is likely that it will persist within Whiting Harbor and a risk of spread from this site to others in Alaska will remain.

3.1.3 Direct and Indirect Effects from Proposed Action Alternative

Cement dust will not stay suspended in solution, but will adhere to the bottom substrate in the treatment dome, forming a thin (< 1 mm) concrete veneer (K. Holzer pers. obs.) As the cement dust is settling and adhering to the bottom it will be retained in the waterproof treatment dome which will anchored by 3/8” chain around its bottom perimeter and staked to the bottom. This will retain the cement dust in the dome during the application period and prevent any cement dust from escaping and affecting marine life outside of the dome.

Existing non-motile biota inside the treatment dome will be smothered by cement dust. Algae, sessile invertebrates, and infauna (animals living within the sediments) can be expected to be buried. Preliminary data have indicated that treatment with cement dust resulted in over a 90% decline in the *D. vexillum* population within five weeks (K. Holzer pers. obs).

The (spherical) dome treatment area is approximately 2 m^2. Cement dust will be used in eleven treatment plots; a total 22 m^2 of Whiting Harbor bottom surface area will be affected by cement dust. The bottom surface area of Whiting Harbor is approximately 717,725 m^2. In total, the

cement dust footprint would alter marine fauna in approximately .003 percent of bottom surface area in Whiting Harbor.

The effects would be extremely localized and unlikely to produce any significant direct or indirect impacts on marine life. It can be assumed that there will also be a temporary loss of all benthic flora and fauna inside the dome, but they are expected to recolonize quickly. In a similar project, Piola et al., (2010) used dredge spoil to smother *Didemnum* in treatment plots and then compared the results to control plots. The dredge spoil was a mixture of fine mud (70%), sand (20%) and small cobble (10%) which prevented the organism from filter-feeding and then caused death. After the six month assessment the average abundance of the majority of species encountered in the control and treatment plots were relatively similar, suggesting the community had recovered from any treatment effects.

3.1.4 Cumulative Effects

No cumulative impacts are anticipated to the non-target organisms of Whiting Harbor from cement dust inside and outside the treatment domes.

3.2 ISSUE 2 - WHAT ARE THE EFFECTS OF ROCK SALT (SODIUM CHLORIDE) TO NON-TARGET ORGANISMS INSIDE AND OUTSIDE THE TREATMENT DOME?

3.2.1 Affected Environment

The same as described in 3.1.1

3.2.2 Direct and Indirect Effects from No Action Alternative

The same as described in 3.1.2

3.2.3 Direct and Indirect Effects from Proposed Action Alternative

Salt is a natural element of marine waters; the salinity of marine waters naturally varies by location and season (Jenkins et al. 2010). Salinity is reported to range from 24 to 30 parts per thousand (ppt) in the Sitka area (Heather Meuret Woody, unpublished data).

Aquarium-scale data indicated that continuous immersion in a hyper saline solution (at least twice the salinity of ambient seawater) produced 98 percent die-back after four hours (h) and 100 percent mortality of organisms after 24 h. In SERC lab experiments, 62 ppt of rock salt in solution proved fatal to the invasive tunicates (*D. vexillum*) when they were exposed for 4 hours. The objective for the rock salt treatment is to obtain a dose of approximately 60 ppt inside the dome. Sensors within the domes will monitor levels of rock salt to determine the correct dosage for treatment and to ensure an overdose does not occur in the marine environment. The (spherical) dome surface treatment area is approximately 2 m^2. Rock salt will be used in eleven treatment plots; 22 m^2 of bottom surface area of Whiting Harbor will be affected by rock salt. The bottom surface area of Whiting Harbor is approximately 717,725 m^2. Rock salt treatments would displace mobile biota and eliminate non-motile biota in approximately .003 percent of

bottom surface area in Whiting Harbor. Due to the very small percentage of non-motile biota eliminated relative to the size of the Whiting Harbor and Sitka Sound, population level effects would not be measurable. The newly exposed habitat would be expected to quickly recolonize with infauna and epifauna. Areas directly adjacent to the treatment dome site would likely provide local sources for recolonization.

Rock salt mixed with ocean water will be retained inside a waterproof dome which will be anchored by 3/8" chain around its bottom perimeter and staked to the bottom. Some of the treatment plots may include challenging habitat to isolate from surrounding water in order to achieve and sustain high salinity concentrations for sufficient duration to achieve mortality. An effective enclosure is anticipated above and to the side of the dome, but it can be expected that some high salinity water will escape by percolating through the interstices in the heterogeneous sea floor, which will be quickly diluted and dispersed by strong current circulation. Factors influencing circulation in Whiting Harbor and Sitka Sound include tides, winds, and large-scale regional and local currents. Whiting Harbor has two large natural channels that flank it, the Western Channel to the north and the Middle Channel to the south. The overall net circulation in the Sitka Sound area is northwestward, parallel to the coastline, and the normal tidal range in the area exchanges about 25 percent of the water on each tide (Corps 2013). There are two high and two low tides every 24 hours and 50 minutes, exchanging approximately 100 percent of water each day. Regional currents are typically driven by water density differences and weather conditions. Local currents are tidally driven with predicted flood tides (rising tides) generally less strong (0.6 knot maximum) than ebb tides (receding tides, 1.2 knots maximum) through the channels on either end of Whiting Harbor and Japonski Island (FAA 2009). The extreme tide range is approximately 15 feet and the high tide line is at +12.7 feet.

Eleven salt treatment domes will contain a volume of approximately 4.4 m^3 of high salinity water. The volume of water in Whiting harbor is 6,986,441 m^3. The salt treatment domes would affect .00006 percent of water in Whiting Harbor. Treatment dome volumes are extremely small relative to the large volume of water available in Whiting Harbor and Sitka Sound (150 square miles). The net effect to salinity level and to the marine environment in Whiting Harbor from the treatments will be inconsequential and non-detectable because of dilution and disbursement from the large volume of water and the strong current circulation.

3.2.4 Cumulative Effects

No cumulative impacts are anticipated to the non-target organisms of Whiting Harbor from rock salt inside and outside of the treatment domes.

3.3 ISSUE 3 - WHAT ARE EFFECTS OF CHLORINE TO NON-TARGET ORGANISMS INSIDE AND OUTSIDE THE TREATMENT DOME?

3.3.1 Affected Environment

The same as described in 3.1.1

3.3.2 Direct and Indirect Effects from No Action Alternative

The same as described in 3.1.2

3.3.3 Direct and Indirect Effects from Proposed Action Alternative

Chlorine (Trichloroisocyanuric acid) is commonly used to treat municipal drinking water, disinfect food service areas and equipment, and as an anti-bacterial for environmental disinfection within the agricultural and aquaculture industries. Some oil and gas facilities and large vessels use chlorine generators to defoul sea chests and intakes for firewater and seawater lift systems.

According to SERC lab experiments, tunicates (*D. vexillum*) and non-target organisms exposed to 1 percent chlorine bleach solution for ten minutes were effectively killed. The objective of chlorine treatment will be to reach a concentration of 1 percent chlorine in the domes by adding chlorine granules and/or "pucks," typically used in home swimming pools. Levels of chlorine will be closely monitored in the treatment domes with sensors to determine the correct dosage for treatment and to ensure an overdose does not occur in the marine environment. It can be assumed that all benthic flora and fauna inside the dome will be killed. The new exposed benthic habitat will be quickly colonized by flora and fauna from adjacent local populations after treatment trials have concluded. Long-term impacts would be negligible to beneficial, as native marine flora and fauna would recolonize the habitat that was once inhabited by *D. vexillum.*

The (spherical) dome treatment area is approximately 2 m^2. Chlorine will be used in eleven treatment plots; a total of 22 m^2 of bottom surface area in Whiting Harbor will be affected by chorine. The bottom surface area of Whiting Harbor is approximately 717,725 m^2. In total, the chlorine would alter marine flora and fauna in approximately .003 percent of Whiting Harbor.

Holt and Cordingley (2011) wrapped *D. vexillum* colonies in treatment bags that contained chlorine powder. They reported that effects from chlorine powder treatments to flora and fauna outside of the bags were un-detectable. Once the bags were opened after the treatment was completed any chlorine powder left inside the bags was relatively weak and dissociated, and therefore instantly dispersed and diluted into the surrounding ocean.

Some chlorine may escape the domes by percolating through the interstices in boulder habitat. Eleven treatment domes will contain a total volume of approximately 4.4 m^3 of one percent chlorinated water. The volume of water in Whiting harbor is 6,986,441 m^3, so .00006 percent of water in Whiting Harbor will be affected by chlorine treatments. Treatment dome volumes are extremely small relative to the large volume of water and tidal circulation in Whiting Harbor and Sitka Sound. Any escaped chlorine would be quickly diluted and disperse by strong tidal and current circulation in Whiting Harbor.

The factors influencing circulation in Whiting Harbor and Sitka Sound include tides, winds, and large-scale regional and local currents. Whiting Harbor has two large natural channels that flank it, the Western Channel to the north and the Middle Channel to the south. The overall net circulation in the Sitka Sound area is northwestward, parallel to the coastline, and the normal tidal range in the area exchanges about 25 percent of the water on each tide (USACE 2013). There are two high and two low tides every 24 hours and 50 minutes, exchanging 100 percent of

water each day. Regional currents are typically driven by water density differences and weather conditions. Local currents are tidally driven with predicted flood tides (rising tides) generally less strong (0.6 knot maximum) than ebb tides (receding tides, 1.2 knots maximum) through the channels on either end of Whiting Harbor and Japonski Island (FAA, 2009). The extreme tide range is approximately 15 feet and the high tide line is at +12.7 feet. The net effect of the chlorine levels and to the marine environment in Whiting Harbor from the treatments will be inconsequential and non-detectable because of dilution and disbursement from the large volume of water and the strong current circulation. After treatments are complete the domes will be removed and any remaining dissolved chlorine will be weak from dissociation and will quickly dilute and disperse. Any remaining chlorine in solid form (pucks) within the enclosures will be bagged, removed, and discarded appropriately at a land-based facility.

3.3.4 Cumulative Effects

No cumulative impacts are anticipated to the non-target organisms of Whiting Harbor from chlorine inside and outside of the treatment domes.

4.0 CONSULTATION AND COORDINATION

Sitka Tribe of Alaska
Shee Atika, Incorporated
Sealaska Corporation
Central Council Tlingit & Haida Indian Tribes of Alaska,
Sitka Representative Jonathan Kreiss-Tomkins

5.0 LIST OF PREPARERS

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