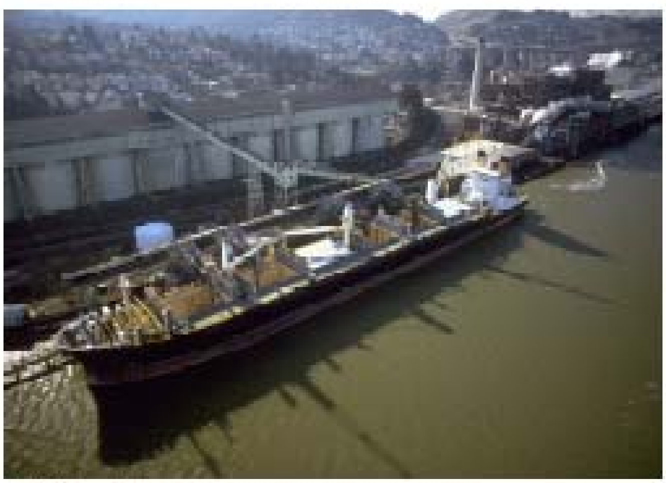
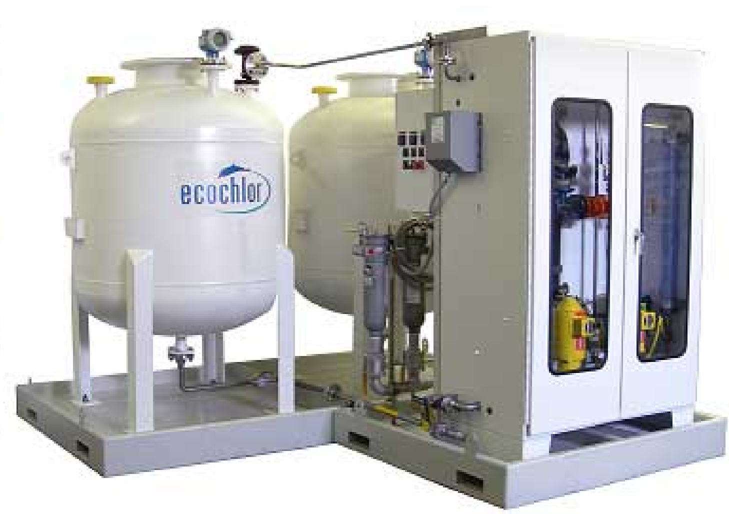
Environmental Assessment
Review of the Application for Acceptance of the Matson Navigation M/V *Moku Pahu* and Ecochlor Inc. Technology into the Shipboard Technology Evaluation Program (STEP)



ITB Moku Pahu Photo courtesy of Matson Navigation Company, Inc.



October 2007

Prepared by
US Coast Guard

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1.0 PURPOSE AND NEED FOR ACTION

1.1 Introduction

The United States Coast Guard (USCG) established the Shipboard Technology Evaluation Program (STEP) in 2004 (USCG 2004). STEP was established to facilitate the testing of prototype ballast water treatment systems under operational conditions on board vessels. Under STEP, treatment system developers acquire increased access to ships for purposes of testing prototype treatment systems; vessel owners get assurances that prototype systems installed on their vessels will be deemed acceptable by the Coast Guard; and the Coast Guard and the public acquire rigorous and credible data on the actual performance of the prototype systems. While in STEP, owners are required to use the prototype treatment system as the primary method of Ballast Water Management (BWM) during the five year evaluation period. The applicants must monitor the engineering performance of the system, and in all years, submit detailed reports to the Coast Guard on the system performance and results of efficacy tests per the vessel's study plan (USCG 2004).

The USCG previously prepared a Programmatic Environmental Assessment (PEA) for the implementation of the USCG's Shipboard Technology Evaluation Program (STEP). The STEP PEA, along with the Finding of No Significant Impact, was published in the Federal Register on December 8, 2004 (USCG 2004). This Environmental Assessment(EA), the review of the Matson Navigation Inc. (Matson) and their vessel the Integrated Tug and Barge *Moku Pahu* with the Ecochlor BWT system application for inclusion in STEP tiers from the PEA and is being prepared as part of the application evaluation process for inclusion in STEP. Please see the PEA for much greater background information, legislative history and detail on the STEP goals and requirements as well as additional discussion of environmental and social impacts.

This EA was prepared in accordance with the Council on Environmental Quality (CEQ) National Environmental Policy Act (NEPA) implementing regulations, the Department of Homeland Security Management Directive 5100.1 and the United States Coast Guard Commandant Instruction 16475.1D (COMDTINST 16475.1D). Specifically, this EA examines the probable impacts of accepting the MATSON *Moku Pahu* with the Ecochlor BWT system into STEP, including the experimental test and evaluation of the routine operation of the Chlorine dioxide treatment system described in the application.

1.2 Background

The *Moku Pahu* is a 209m integrated tug and dry bulk cargo barge of 37,713 gross tons and holds up to 23 crew. It runs an oceans route carrying sugar from Hawaii to San Francisco Bay during the early summer through late fall. Typically, this voyage is completed ten times per sugar-growing season. The cargo loading switches between the Kahului (Maui) and Nawiliwili (Kauai) and ballast water uptake of up to 18,180 mt takes place in Crockett, CA,as the sugar is offloaded. This ballast water is then discharged in Hawaii as the next sugar cargo is loaded. A roundtrip voyage usually lasts about 18 days. The remainder of the year, the vessel may travel elsewhere around the globe on other shipping routes, depending on specific charters (Matson 2006).

The Ecochlor treatment system uses chlorine dioxide (ClO_2) in a single stage treatment of ballast water. The system injects a dilute solution of ClO_2 into the ballast water piping as ballast water is loaded. The ClO_2 solution strength is determined by operational parameters (flow rate, target dosage) and adjusted automatically during the ballasting operation to maintain the target initial treatment concentration of 5.0 ppm ClO_2 (Matson 2006). Treated water remains in the ballast water tanks for the duration of the ocean transit (approximately 7 days) during which time the ClO_2

continues to degrade. Ecochlor has presented data showing ClO_2 levels of 0.0 ppm in the discharged treated water, and very low levels of other chlorine species. These other residuals include chlorate and chlorite which also act as biocides as they interact with organic matter in the ballast water. Further study on the fate of these residuals is part of the testing program.

1.3 Purpose and Need

The purpose of the action considered within this EA (accepting the *Moku Pahu* with the Ecochlor BWTS into STEP) is to gain valuable scientific information on the system's efficacy.

The USCG is the lead agency to prevent the introduction and spread of Non-Indigenous Species (NIS) from ballast water discharges. The USCG has recognized that alternatives to the existing approved procedures of: 1) Ballast Water Exchange (BWE) and 2) Retention of ballast water could be useful to prevent the introduction and spread of NIS. (33CFR151)

Participants in STEP, such as the *Moku Pahu* with the Ecochlor BWTS, will aid in fulfilling the need of the Coast Guard to develop and implement a BWM Program as directed by the National Invasive Species Act of 1996.The development of effective ballast water treatment (BWT) technologies will create more options for vessel owners seeking to comply with NISA but having concerns about or limitations in the practicability of BWE. The USCG believes that information gained through STEP will provide scientific validation for new systems and aid in the deployment of effective and practicable BWT technologies which will result in reducing or eliminating ballast water as a source of further NIS invasions.

1.4 PEA for STEP

The PEA examined the reasonably foreseeable consequences that could result from the implementation of the program as a whole. It considered the potential environmental impacts of all the vessels wishing to use unique experimental technologies to control ballast water invasive species introductions.

The main conclusions of that analysis were STEP as a program would not represent significant environmental impacts because:

- a very small number of ships relative to the total number calling on the US would be involved in STEP, so any possible impacts would be very small;
- a treatment system passing the STEP acceptance criteria would almost certainly provide greater protection of US waters from NIS than the current requirements for BWE which allows for discharge of ballast water with no treatment at all under frequent circumstances; and
- there is a positive benefit of having considerable data to validate and verify BWT system efficacy and impacts.

The PEA also found that any impacts abroad would also be less than significant, because the Coast Guard's primary interest with STEP is vessels that discharge ballast water in U.S. ports rather than foreign ports. When operating outside of the STEP application specified route, the experimental treatment system may be used, only if the operator does so in full compliance with US, foreign and international BW management rules as applicable.

1.5 Scope

The STEP PEA established the need for site-specific analyses for each of the applicants to the program to verify no significant localized impacts.

This analysis tiers off the STEP PEA, considering the potential resource issues pertinent to the technology and vessel route being proposed.

There were several resources that were initially considered but dismissed from further analysis. After initial analysis it was determined that the following resources would not be impacted in a significant manner and will not be considered further in this EA:

transportation,
infrastructure,
coastal barrier systems,
topography and floodplains,
geology and soil,
cultural and historic resources,
socioeconomic resources
air quality.

The *Moku Pahu* is not expected to operate more frequently with the BWT system installed. Thus, the proposed action should not have any measurable effects on routes or frequency of transportation, or any relevant infrastructure. We expect the impact on coastal barrier systems to be minimal because the action does not involve increased vessel activity and the treatment system is expected to have no impact on water quality, biological resources, currents, sediment transport, or other mechanisms that might affect such systems. As the Proposed Action deals solely with a vessel, no measurable effects on land resources, including floodplains or soils are expected. There are no vulnerable historic properties (e.g., shipwrecks) located in the potentially affected port areas. The technology examined involves one ship making infrequent (up to 10/year) port arrivals, therefore there is very minimal economic impact. The BWT system is not expected to have a measurable effect on the vessel's electrical service capacity and therefore will not engender any additional vessel emissions. Additionally, there should be no emissions from the BWT systems itself, with the exception of the off-gassing of chlorine dioxide. Because of the small amounts and sporadic use of the chemical, any off-gassing is not expected to result in significant adverse impacts to air quality at the locations where the system is used (see Appendix C). The public health and safety aspect of chlorine dioxide off-gassing is addressed in Section 4.3 of this EA.

This EA is vessel, treatment technology and route specific. Therefore any significant changes to operations (e.g., schedule changes involving new U. S. ports where treated ballast water would be discharged, or changes in the engineering and operation of the BWT system) would require revisions to the application, and a new review and approval decision by the USCG.

2.0 ALTERNATIVES

The USCG has received an application to STEP from Matson, and therefore has two options to consider: grant or deny the *Moku Pahu* with the Ecochlor system acceptance to the program. This EA will examine these two alternatives and their associated potential impacts.

2.1 Alternative 1: No Action Alternative- Deny application

Under the no action alternative, the *Moku Pahu* with the Ecochlor BWTS would continue to manage ballast water under the provisions of the current regulations. When transiting to U.S. ports from outside the exclusive economic zone (EEZ), the vessel would conduct BWE. If BWE is not possible due to safety or route constraints, the vessel is allowed to discharge sufficient un-exchanged (and untreated) water in order to conduct cargo operations. When moving between ports within the U.S. EEZ , the current USCG regulation provides that vessels are not required to conduct BWE.

2.1.1 IMPACTS

If the *Moku Pahu* with the Ecochlor system is denied acceptance into STEP, the USCG would miss the opportunity to acquire novel scientific data on the performance of the prototype treatment system and on the practicability of the test methods under operational circumstances. This ground truth data, in advance of establishing and implementing a general program for BWT systems would be of considerable benefit to the environmental protection goal of the NIS prevention laws, treaties and policies. With a denial of the application, the USCG would lose this opportunity to gain information that would be critically important for establishing effective discharge standards and procedures for BWT system testing and approval.

2.2 Alternative 2: Proposed Action Alternative- Accept application

Under the proposed Action Alternative, the Coast Guard would accept the vessel into STEP. While participating in STEP, in addition to making the ship and BWT system available for initial and periodic physical inspections by USCG personnel, Matson would submit to the USCG detailed annual reports on the performance of the treatment system, including the results and interpretations of rigorous tests of system performance in reducing the concentration of living organisms and quality and quantity of chemical residuals related to the treatment process. The USCG would take this information into consideration during the development or refinement of regulations, policies, and procedures related to BWM strategies, requirements and the regulatory program procedures for treatment system approval and compliance testing

Acceptance to STEP would grant the applicant equivalency to current (at the time of application) and future BWM regulations regarding transportation of invasive species in ballast water. The period of equivalency for the *Moku Pahu with the Ecochlor system* would be the life of the vessel or of the treatment system, whichever is shorter. Under this alternative, the vessel would be free to discharge ballast water treated by the experimental treatment system into U.S. waters as their operations dictated. The actual amounts of ballast water taken on and treated and available for discharge would vary between zero and 18,180 metric tons depending on voyage-specific cargo loading and unloading.

2.2.1 Description of Technology

The ballast system on the *Moku Pahu* barge consists of 15 dedicated tanks designed and used for ballast only. Tanks are gravity fed with ballast water and then topped off with one ballast water pump. For vessel safety purposes cross-connections with the ballast system are present, however they are not utilized as part of standard procedure. (Matson 2006).

The Ecochlor™ system consists of a ClO_2 generation module, a programmable logic controller (PLC), a water booster pump (to ensure sufficient motive water pressure to drive the chlorine dioxide solution mixture mechanism) and two self-contained chemical storage modules. The system onboard the *Moku Pahu* is a skid-mounted unit located in a forward compartment (used previously as a spare parts storage area) located near the BW pumps and control spaces (Matson 2006).

A licensed Deck Officer is responsible for ballasting operations. Ballast quantity monitoring is conducted by sounding, with sole control of the ships ballast system at the ballast water pumps themselves (no remote control) (Matson 2006). The PLC interface with the ship's ballast water system is via a ballast water flow meter wired into the treatment system control panel. When the Ecochlor™ system senses that there is sufficient flow in the ships ballast water system it arms itself for activation and illuminates an activation ready light on the treatment system control panel. The first officer then must engage the Ecochlor™ treatment system which commences treating the incoming ballast water. The system itself, once engaged, is fully automated and will deliver the targeted chlorine dioxide concentration regardless of flow rate. Finally it will shut itself off upon detection of no flow in the ballast piping (Ecochlor 2006a).

The Ecochlor™ System monitors a variety of key parameters, including but not limited to; key ballast water valve positions, ballast water flow direction, ballast water flow rate, and ballast tank levels. This information is processed by the PLC and appropriate decisions on ClO_2 solution feed rates are made automatically. The system identifies when the ballasting operations are terminated or interrupted and stops feeding accordingly. There is system feedback available to the crew during ballasting operations. There are also capabilities for enable/disable as well as emergency shut down at the treatment system control location (Matson 2006).

Chemical residuals

The Ecochlor system establishes a target concentration of 5.0 ppm of ClO_2 in the incoming ballast water in the main ballast line. In approximately 30 minutes, the ClO_2 concentration is typically reduced to between 1.0 ppm and 3.0 ppm by a rapid reaction with living and non-living organic matter within the ballast water (Matson 2006). This initial consumption is defined as the "ClO_2 demand" of the treated ballast water. Residual ClO_2 then exponentially decays at a substantially lower rate until it is totally consumed.

The half-life of ClO_2 in the treated ballast water depends greatly on the organic matter content of the water into which it is introduced (which will vary with the source where ballast water is taken into the ship) and temperature. Laboratory studies conducted by Ecochlor have shown that the half life of ClO_2 in Oakland harbor water ranges between 5.4 hours and 11 hours at 20°C and 10°C, respectively (the typical seasonal temperature range experienced in that area). Chlorine dioxide injected into ballast tanks is typically 99% consumed after 1.5 days at 20°C and 3 days at 10°C (Ecochlor 2006b).

Because the voyages of the *Moku Pahu* are greater than five days, residual ClO_2 should be decayed to undetectable levels by the time the ship arrives in Hawaii for cargo loading and deballasting. Should there be any remaining ClO_2 discharged in Hawaii waters, it would likely decay to extinction quickly by thermal effects alone due to relatively warm receiving water temperatures. (Ecochlor 2006b)

Use of ClO_2 in reaction with organic matter will form some chlorite as an intermediate. Ecochlor's testing has found in the laboratory, and through shipboard testing, that chlorite appears in ballast water at maximum levels between 25% and 60% of the initial ClO_2 concentration (5ppm) (Matson 2006). This chlorite level will also decay over time as it reacts with various substances (organics, metals) in the water. Laboratory studies by Ecochlor have revealed that chlorite has a half-life of up to 30.3 days at 20°C in Newark and 10.5 days at 20°C in Baltimore waters. By these numbers, it would take approximately 200 days in Newark waters to achieve 99% decomposition of chlorite. Similarly, it could take up to 70 days in Baltimore waters for chlorite to decompose by 99%. Data are not yet available for the San Francisco Bay source nor the Hawaiian receiving waters. Anticipated discharge of chlorite during these voyages would be on the order of approximately 2 ppm. Previously, it was assumed that the organic matter contained in the receiving waters would provide sufficient "chlorite demand" (i.e., an initial rapid consumption of chlorite in 15-30 min by reaction with organic matter contained in the ballast water) to rapidly consume any chlorite discharged. However, availability of reactive organic matter does not seem to be the sole determining factor in the reaction with chlorite. Environmental chlorite demand consumes a relatively constant fraction of chlorite, irrespective of the degree to which it is diluted in the environment. Also, it appears that different receiving waters possess differing chlorite demand. For example, Newark water demand consumes half to two-thirds of the available chlorite within the first 30 minutes following discharge, whereas Baltimore water consumes only about one-fourth of available chlorite in the initial time frame. Therefore, until further site specific data are collected, ***dilution of chlorite in the receiving waters*** is the primary determinant considered in reducing its concentration.

The reaction of chlorite (and ClO_2) appears to accelerate in sunlight. While studies have shown that ClO_2 is very rapidly consumed in sunlight, only qualitative evidence suggests this for chlorite. No studies have quantitatively determined the fate of chlorite in sunlight.

Chlorate will be a relatively minor end product of the ultimate fate of ClO_2 the bulk of which is decomposed into chloride. Studies suggest that ClO_2 will largely decompose into chloride, with approximately 10% of the ClO_2 dose, levels of about 0.5 ppm or less, appearing as chlorate (Ecochlor 2006b).

Chlorine Dioxide, Sodium Chlorate and Sodium Chlorite are all EPA Registered chemicals for use as proposed by the applicant.

Conditioning of Treated Water Prior to Discharge, and Assessment of Discharge

The *Moku Pahu's* treatment system subjects ballast water to Chlorine Dioxide at 5.0 ppm level. The treated water then remains stored in dedicated ballast tanks for the duration of the voyage. Residual chemical levels are thought to be below applicable EPA and state discharge standards, but as part of STEP the ballast water will be tested to determine actual residual levels.

Management of treatment waste streams

Other than residuals discussed above, this treatment system generates no separate waste streams. The source chemicals used to generate the ClO_2 are: Sulfuric acid (H_2SO_4) and Purate (a proprietary mixture of Sodium Hypochlorite ($NaClO_3$) and Hydrogen peroxide (H_2O_2)). The chemical reaction yields ClO_2, Oxygen, Water and Sodium Sulfate (Na_2SO_4). All reaction products and uncombined reactants are injected and mixed into the ballast water and subsequently discharged to the sea when the ship deballasts.

3.0 AFFECTED ENVIRONMENT

To assist the USCG in understanding the potential environmental impacts of these alternatives, this chapter describes the potentially affected environmental resources in their current condition. Based on this description of potentially affected aquatic ecosystems, the impacts of the alternatives are presented and compared in Chapter 4. Further detail on the broader programmatic scale is in the STEP PEA.

The affected environment for this project is based on the *Moku Pahu's* typical cruise itineraries between California and Hawaii (Matson 2006). Therefore, since the affected environment is limited to U.S. locations where the *Moku Pahu* takes on and discharges treated ballast water, the areas of interest analyzed in this EA are the marine ecosystems within the relevant ports of California and Hawaii.

3.1 Biological Resources

This section presents information on the specific characteristics of the affected aquatic ecosystems, biological resources, threatened and endangered species, essential fish habitat, and open-ocean resources. For information on the general characteristics and biological organisms of U.S. aquatic ecosystems, general NIS impacts, and relevant regulatory background, refer to the STEP PEA.

3.1.1 California

The following description is for the source water used in ballasting the vessel. This is the water that will be treated and discharged in Hawaii. There are no normal circumstances where the *Moku Pahu* would discharge any ballast water, treated or not in California waters. Cargo discharge occurs in the town of Crockett, located in Northern California on the southern shore of the Carquinez Strait near San Pablo Bay. The Carquinez Strait is part of the tidal estuary of the Sacramento and the San Joaquin rivers as they drain into the San Francisco Bay. The strait connects Suisun Bay, which receives the waters of the combined rivers, with San Pablo Bay, a northern extension of the San Francisco Bay. The Bay area, the fifth largest metropolitan region in the country has, at 844 person/mile^2, the highest population density on the west coast (EPA 2007). Unless otherwise indicated, the term "Bay" in the following description refers to the greater San Francisco Bay which includes all of the above river delta embayments.

Plants and Wetlands

Over 500,000 acres of wetlands in the Bay area have been lost to development, but recent efforts have targeted protecting remaining wetland areas and have succeeded in setting aside thousands of acres of undeveloped salt marshes and mudflats (EPA 2007).

Fish and Invertebrates

Commercial and recreational fishing are important parts of the economic activity of the Bay. Commercially important fisheries include: striped bass (*Morone saxatilis)*, green sturgeon *(Acipenser medirostris)*, american shad (*Alosa* sapidissima), pacific herring *(Clupea pallasi)*, pacific sardine *(Sardinops sagax)* , northern anchovy (*Engraulis mordax)*, starry flounder *(Platichthys stellatus),* California halibut *(Paralicthys californicus)*, Chinook salmon (Oncorhynchus tshawytscha), surfperch *(Rhacochilus toxotes)*, and bay shrimp *(Crangon sp)*. Commercially important invertebrates include: clams and mussels; Dungeness crab *(Cancer magister)*, California market squid *(Loligo opalescens)* and octopus. (CDFG 2006).

Recreational fishing in the Bay targets striped bass, sturgeon, black bass (*Micropterus spp)* , halibut, salmon, surf perch, steelhead trout (*Oncorhynchus mykiss*), and American shad.

Wildlife

The Bay area is highly developed with several major urban areas. As such, most of the terrestrial wildlife are types adapted to coexistence with humans. Marine mammals including California sea lions (*Zalophus californianus*) and harbor seals (*Phoca vitulina*) are plentiful and as a result of protective laws in many cases the populations of these species are burgeoning. As a key link of the Pacific Flyway, millions of migratory birds and waterfowl use the shallow waters of the bay for winter refuge. San Francisco Bay is home to the nation's first wildlife refuge, Oakland's artificial Lake Merritt (constructed in the 1860s and now a national Historic Landmark) and America's first urban National Wildlife Refuge, the San Francisco Bay National Wildlife Refuge (SFBNWR). Much of the northern shore of the bay is protected as part of the San Pablo Bay National Wildlife Refuge. Many species of birds and waterfowl inhabit the Bay waters year round, using the mudflats, marshlands, and open water. Wading birds such as Herons and egrets *(Ardeidae family*), Sandpipers (*Scolopacidae family*), and Avocets (*Recurvirostra Spp)* are commonly seen on the mudflats of the Bay. Birds inhabiting the open waters of the Bay include numerous species of ducks (*Anatidae* family), gulls (*laridae* family), cormorants (*Phalacrocoracidae* family), grebes (*Podicipedidae* family), and brown pelicans (*Pelecanus occidentalis*).

Threatened and Endangered Species

There are several federally endangered species inhabiting the San Francisco Bay area, including two species of birds (the California clapper rail (*Rallus longirostris obsoletus*), the California least tern (*Sternula antillarum brownii*), one species of reptile (the San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)), and two mammal species (the San Joaquin kit fox (*Vulpes macrotis mutica*) and the salt marsh harvest mouse (*Reithrodontomys raviventris*)). The Salt-marsh Harvest Mouse is a common inhabitant of the San Francisco Bay marshlands. The tidewater goby *(Eucyclogobius newberryi)* is an endangered fish known in the area; additionally, the delta smelt (*Hypomesus transpacificus)* is threatened and has critical habitat in the area. There are also a large number of other protected species within the San Francisco Bay including: invertebrates, fish, amphibians, reptiles, birds, mammals, and plants (for a complete list see the agency consultation letters in Appendix D). They are all managed under the federal Endangered Species Act by the U.S. Fish and Wildlife Service.

Essential Fish Habitat

In San Francisco Bay, the Pacific Fishery Management Council has designated essential fish habitat for groundfish species (e.g., rockfishes, sharks, skates, flatfishes) and free swimming coastal species (e.g., anchovies, sardines) (NMFS 2007).

Non-indigenous Species

The northern portion of San Francisco Bay where Crockett is located is already heavily impacted by invasive species (e.g., the highly successful Asian clam *Potamocorbula amurensis*). In the entire Bay, over two hundred NIS species had been identified by 1995. The NIS identified are spread across several groups of taxa (approximately 69 percent are invertebrates, 15 percent fish and other vertebrates, 12 percent are plants, and 4 percent are protists). Many of these NIS, including the Atlantic green crab (*Carcinus maenas*) and over 30 species of fish, dominate the food webs and have dramatically altered ecosystem functions in the bay. As a result of the large number of nonindigenous species, San Francisco Bay has been identified as the most invaded aquatic ecosystem in North America (Cohen and Carlton, 1998).

3.1.2 Hawaii

Hawaii is home to a diverse array of living resources. Hawaii has examples of most of the planet's major ecosystem types including coral reefs, wetlands, coastal and mountain areas, many climate zones, and a vast diversity of natural resources, all within a relatively small land area. Because of its geographic isolation (over 2,000 miles in any direction from its neighbors), the native plants and animals that inhabit Hawaii evolved in distinct ways (USGS 2006). Over 90 percent of Hawaii's native flora and fauna are endemic or found nowhere else on Earth. About 450 species of inshore fishes inhabit Hawaiian waters, of which approximately 25 percent are endemic. Approximately 25 percent of sponges and 28 percent of marine worms (polychaetes) in the area are also endemic.

Marine life including invertebrates (e. g., corals and anemones, sea slugs, crabs, shrimp, and sea urchins), and marine pelagic vertebrates (e. g., bony fish, rays and sharks, marine turtles, and marine mammals, abounds.

The Port of Kahului is a deep-draft harbor with a protective breakwater located on the north shore of central Maui. Kahului, is the largest town on the island. The Port is composed of three major areas, and has three piers that provide different cargo handling functions (EPRI 2004).

The Nawiliwili Harbor on the island of Kauai is a commercial deep-water port located on the southeast side of the island. The port is located at the mouth of the Hule`ia Stream, creating a natural channel for incoming vessels (Hawaii web 2006). The harbor basin is protected by a jetty, and contains a fill area on the west side. The entrance to the harbor is a 40 foot deep dredged channel; the harbor basin is dredged to 35 feet deep. Waterfront port facilities are located along the north side of the basin (EPRI 2004).

Coral Reefs

Overall, a total of 47 coral species are found in Hawaiian waters. Common species include: *Porities lobata, P. compressa, Pavona varians, Montipora capitata,* and *Pocillopora meandrina. P. compressa* and *M. capitata* are endemic.

Sub-tidal coral reefs are a key feature of the near-shore marine ecosystem in Hawaii, although the islands lie close to the northern environmental limit for coral reefs. Ocean waters of Hawaii are just within the temperature bounds for coral, explaining the limited diversity. Further, much of the coral in Hawaii exist as veneers on the active volcanic substrate rather than being hundreds of feet thick as in classic coral reefs of atolls.

The main Hawaiian Islands contain large areas of coral reefs (880 sq km) largely located in federal waters. Overall a recent review of coral reef health in Hawaii concluded that 90% of coral reefs in the main Hawaiian Islands state and Federal waters are healthy. The best developed reefs are in state waters sheltered from damage caused by storms and open ocean swells in bays. However bays are also the most common sites of reef degradation caused principally by coastal pollution and over-fishing. Storm damage and habitat depths are major factors that affect species diversity and the community structure of reefs in Hawaii, with human-caused problems important in selected areas (NOAA 2006).

Atolls, barrier reefs, fringing reefs, patch reefs, and reef communities all occur in the Hawaiian Islands. Reef communities and fringing reefs are the dominant reef types found within the Hawaiian Islands Humpback Whale National Marine Sanctuary boundaries (see Threatened and Endangered Species subsection below). Most of Kauai's coastline is bordered by fringing reefs. In many areas, reef flats are wide and extend more than 1 km from shore. Offshore, significant reefs are found around much of the island at 5 to 30 m depths. However, due to the creation and upkeep of the harbor, there are no coral reefs located in the harbor.

Scattered fringing reefs and reef communities characterize Maui's southern and western shores. Along much of Maui's north coast where Kahului harbor is located, reefs are sparsely developed.

This sparse development is common along unprotected areas of the north coasts of the islands due to the prevailing northeast winter swells and trade winds.

Within Kahului Harbor, scattered tunicates and solitary heads of coral (*Montipora* spp.) occur on predominantly sandy bottom. Outside the harbor, a shallow reef of consolidated limestone reef rock extends to the east. A limestone shelf reef with high vertical relief extends to the north. *Porites lobata* and *Montipora flabellata* dominate the east running reef, and the soft coral *Palythoa tuberculosa* is also abundant. The dominant coral north of the harbor is *Montipora patula*. A number of fish species are known to be common within the harbor, including *Mugil cephalus, Selar crumenothalmus, Decapterus macarellus, Acanthurus triostegus, Etrumeus micropus, Kuhlia sandvicensis, Caranx ignoblis, and Canos chanos*. The fish assemblage of the reefs outside the harbor is is made up primarily of *Scarus* spp., *Acanthurus leucopareius, A. triostegus, Kyphosus* sp., juvenile carangids, *Thalassoma duperryi, stegastes fasciolatus, Bodianus bilunulatus*, and *Plectroglyphidodon imperipennis*. Green sea turtles, *Chelonia mydas* are commonly seen outside the harbor. The crab *Macrophthalmus telescopicus* is abundant within the harbor. The mussel *Brachidontes crebristriatus* and the sea urchin *Echinothrix* sp. are common north of the harbor. The benthic substrata of sand and coral rubble supports a diverse assemblage of invertebrates, including polychaete worms alpheid shrimp, xanthid crabs, and ophiuroids, The solitary hard coral *Fungia scutaria* is abundant in places. *Laurencia* spp., *Halymenia Formosa*, *Amansia glomerata*, and *Martensia* spp. are the primary algal species found on the reefs outside of the harbor, and are generally in low abundance, although the green algae *Enteromorpha* spp.and *Cladophoropsis* spp. are quite abundant in the warm water plume from a power station east of the harbor. Algae and some angiosperms are also abundant north of the harbor on an area of the reef platform fronting a beach park, *Ulva* spp. are the most abundant of the more than 16 species of algae observed. (Ziemann, 2003)

The Nawiliwili Harbor is largely developed and existing surroundings are predominantly industrial and commercial in nature. Developed areas are highly disturbed and are dominated by manmade structures such as wharfs, jetties and asphalt and cement paving. Previous disturbance of harbor lands and ongoing industrial/commercial operations at Nawiliwili do not provide conducive habitat for marine life. The harbors have been designated as class A waters by the state- for maintenance of use for recreation and aesthetic enjoyment. However Nawiliwili has been delineated an impaired water body by the Department of Health in response to Section 303 (e) of the Clean Water Act, and without further action to control non-point source pollution, the harbor is not expected to attain or maintain state water quality standards. Turbidity and nutrients are the pollutants of concern in Nawiliwili harbor.

Wetlands

Between the 1780’s and 1980’s, Hawaii lost an estimated 31% of its coastal wetlands to development. This estimate, however, did not examine site quality, and functional losses are believed to be much greater. The primary threats to Hawaiian wetlands and the native biota are human altered hydrology, pollution and invasive species. Hawaiian wetlands are habitat for 6 endangered Hawaiian water birds, five of which require wetlands for their survival. The decline of these latter five species’ populations can be correlated to loss of wetland habitat throughout the Hawaiian Islands. These habitats are also important to the 36 species of migratory waterfowl and 48 species of migratory shorebirds identified in Hawaii. Of these, 14 waterfowl species and 20 shorebird species are occasional to common visitors that depend on Hawaii’s wetlands for stopover or wintering habitat (DLNR 2003).

The shoreline of Kahului Harbor has been extensively filled, armored and built up. Currently, there is very little remaining wetland habitat. An unlined drainage ditch fed by a County maintained lined drainage channel has been designated as a wetland.

Fisheries

The Hawaiian ecosystem supports a variety of fisheries in the Main Hawaiian Islands (MHI). Commercial catches include: snappers (Pristipomoides ssp), jacks (Caranx spp), numerous billfish, shark and tuna (Thunnus spp). A small-scale fishery for lobster (Scyllarides squammosus) exists in the MHI. A resource of deepwater precious coral (*Corallium rubrum)* including gold, bamboo, and pink corals) also exists in the Hawaiian ecosystem. Precious corals occurring in the U.S. EEZ are managed under a Fisheries Management Plan implemented in 1983 by the Western Pacific Regional Fishery Management Council. Very limited quotas are allowed under regular permits, and experimental permits are required for unassessed coral beds.

Marine Mammals

The Hawaiian Islands are home to many marine mammal species. Large whales include the endangered North Pacific humpback whale (*Megaptera novaeangliae)*, sperm whale (Physeter macrocephalus), and (rarely) fin whales (*Balaenoptera physalus*). Small whales include false killer whales (*Pseudorca crassidens*), pilot whales (*Globicephala spp),* and occasionally the pygmy killer whale (*Feresa attenuata*), pygmy sperm whale (*Kogia breviceps*) and dwarf sperm whale (*Kogia sima*). There have been occasional sightings of North Pacific right whales (*Eubalaena japonica*), blue whales (*Balaenoptera Musculus*), melon-headed whales (*Peponocephala electra*) and orcas (*Orcinus orca*). Sei whales (*Balaenoptera borealis*) have been documented near Maui (HWRF 2006). Dolphins in the area include Pacific spotted (*Stenella attenuate*), spinner (*Stenella longirostris*), bottlenose (*Tursiops truncatus)* and occasionally Risso's (*Grampus griseus*) dolphin. The only seal species found in Hawaiian waters is the endemic Monk seal (*Monachus schauinslandi)* which is also endangered.

Threatened and Endangered Species

The Hawaiian Islands are the world's most isolated island archipelago, inhabited by animals and plants derived from ancestors that found their way over thousands of miles of ocean (USGS 2006). This results in a unique and fragile ecological diversity. Ongoing habitat destruction and invasive species (over 1,400 introduced, non-native species inhabit the islands) are the greatest threats to Hawaii's natural ecosystems. According to scientific estimates, Hawaii has more extinct and endangered species than any other place in the United States and more endangered species per surface area than any other place on the planet (BM 2006).

Hawaii has hundreds of plants and animals listed as threatened and endangered. The USFWS list includes: two mammal species, thirty bird species, five reptiles and amphibians, one snail, and 279 taxa of plants (FWS 2006). The USFWS has provided a list of potentially affected species in the project area which has been included in Appendix D. Additionally, according to correspondence from the NOAA Pacific Islands regional office, the species of concern in the project area would be the many listed marine mammals (23 species) and sea turtles (five species). In particular, the waters off the coasts of Hawaii are known for hosting endangered humpback, blue, fin, and sperm whales, as well as Hawaiian monk seals (NOAA 1999).

Nonindigenous Species in Hawaii

NIS are a serious problem in Hawaii, posing a significant threat to Hawaii's native plants, animals, and associated native ecosystems, as well as to residents and visitors. Since Hawaii also happens to be a major agricultural area, transportation hub and tourist destination, it is already extensively invaded. Scientists predict that unless drastic changes are made in National and State policies relating to prevention of invasions, the number of new introductions and invasions in Hawaii will continue to increase (DLNR 2003).

Some NIS examples:

At least 19 species of macro algae have been intentionally or passively introduced into Hawaii since the mid-1950s. At least five of these have successfully established and dispersed around the Hawaiian Islands, and are now ecologically dominant in some locations, where they appear to be out competing native benthic species (DLNR 2003).

At least thirty-four species of marine fishes have been introduced into Hawaiian waters, and at least twenty of these introduced species have become established. Of those know to be established thirteen species were authorized, planned releases, the other seven species were accidental introductions. (DLNR 2003).

In addition to direct habitat loss, introduced predators and aquatic plants further degrade remaining habitat for species inhabiting wetlands. In lowlands, fresh and brackish water wetlands are heavily altered by humans and typically dominated by dense mats of invasive species such as red mangrove (*Rhizophora mangle*), pickleweed (*Batis maritima*), and California grass (*Brachiaria mutica*). These plants encroach on prime waterbird feeding, loafing, and nesting areas (banks and shallow emergent zones) and degrade habitat value. (DLNR 2003).

3.2 Water Quality

3.2.1 California

Water quality standards, identifying contaminant concentrations that are harmful to aquatic life or human health, have been established for a number of contaminants found in the Bay but, for many chemicals, no guidelines exist. The Water Quality Index has five indicators, each based on a class of contaminants or water quality conditions: trace elements, pesticides, PCBs, PAHs, and dissolved oxygen content.

The San Francisco Bay Water Quality Index aggregates the results of the Trace elements, Pesticides, PCBs, PAHs, and Dissolved oxygen indicators. Between 1993 and 2001, water quality in the open waters of the Bay was fair to good. Although the Water Quality Index has fluctuated slightly from year to year, it has not significantly increased or decreased during the nine-year period for which indicator data were available (TBI 2006).

The San Pablo Bay-Carquinez Strait where cargo offloading and ballast water uptake occur, is a partially mixed estuary within the San Francisco Bay with a salinity gradient strongly influenced by season and precipitation (periods of low and high runoff from the Sacramento-San Joaquin river system. Salinities vary with rainfall and river level between winter (wet season) and summer (dry). Based on the vessels service, salinity values are expected to be in the higher range associated with low seasonal fresh water river flow.

3.2.2 Hawaii

While Hawaii does not have a comprehensive coastal monitoring program, the State has assessed 99% of its 55 estuarine square miles and 83% of its 1,052 miles of shoreline for its biannual Clean Water Act report. Of the assessed estuarine resources, 43% fully support their designated uses, and some form of pollution or habitat degradation impairs 57%. Of assessed shoreline, 97% fully supports its designated uses, 1% is threatened for one or more uses, and some form of pollution or habitat degradation impairs 2% (EPA 2005).

Temperature and salinity values indicate that the region is well flushed and minimally affected by surface runoff of terrestrial sediments. Although coastal water quality is usually considered excellent (and generally described as pristine) throughout the islands, two concerns regarding pollution have been cited: (1) runoff associated with development, and (2) groundwater percolation may be occurring along the shorelines. These problems have led to algal blooms in coastal waters around Hawaii (Hawaii 2006).

The State of Hawaii currently lists Kahului Bay inshore of the breakwater as an impaired water body due to high levels of nutrients and turbidity, under Section 303(d) of the Clean Water Act. Water quality sampling in 2002 associated with an environmental assessment for a proposed harbor improvement project (Ziemann, 2003) documented variable turbidity within the harbor, ranging from 1.9-9.4 NTU. Higher turbidities were associated with wind-driven wave action and land run-off. Elevated chlorophyll levels were recorded along the shoreline of the harbor.

3.3 Public Health and Safety

The relevant geographic scope of the Proposed Action, with regard to public health and safety is onboard the ship and within the port facilities themselves and their immediate environs. It does not include surrounding public spaces and buildings, residential areas, or businesses. The ports themselves are industrialized areas, only appropriately authorized and trained personnel have general access. The treatment system is constructed in accordance with applicable codes for shipboard machinery, electrical installation and chemical storage. It has been assessed by an independent classification society for conformance to these codes. Finally it is located in a normally unoccupied vessel space and operates autonomously. Therefore little crew contact with the equipment is likely and when such proximity is required, the crew have the same level of safety protection as with all other ships machinery installations.

3.4 Socioeconomic Resources

The activities evaluated under this EA involve a single system on a single ship making occasional visits (up to 10 per year) to any given U.S. port. Therefore there are no social or economic issues of significance to be addressed

3.5 Environmental Justice

Consideration of environmental justice falls under the authority of Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations”, and Executive Order 13175, “Consultation and Coordination with Indian Tribal Governments”. Low-income and minority populations may be present within the cities adjacent to these ports. However, given the proposed action, any potential impacts would be focused on the marine environment. Hence, the only impact of concern may be subsistence fishing.

There are no known treaties governing native American fishing rights in the ports reviewed.

4.0 ENVIRONMENTAL CONSEQUENCES

The following discussion of potential environmental consequences focuses on the two locations in Hawaii where treated ballast water would be discharged by the *Moku Pahu*: Kahului Harbor, Maui, and Nawiliwili Harbor, Kauai. The vessel does not discharge ballast water in San Francisco Bay, California, therefore there is no potential for environmental impacts due to the discharge of treated ballast water on resources in San Francisco Bay. The only potential impact in San Francisco Bay from use of the treatment system on the *Moku Pahu* would be due to the toxic properties of the chlorine dioxide generated to treat ballast water as it was taken on in Crockett while sugar was being unloaded.

Chlorine dioxide is a reactive substance. It is poisonous to humans; it is also a skin, eye, and respiratory irritant. Additionally, it can enhance the combustion potential of other substances. (OSHA, 2007). However, even though chlorine dioxide is a poisonous gas, there are no applicable emissions standards regulating emissions of chlorine dioxide. This is because chlorine dioxide quickly breaks down in air; and, it is unlikely for the average person to be able to breathe air containing dangerous levels of chlorine dioxide. There could be adverse consequences to public health and safety from the production of chlorine dioxide during treatment of ballast water on the *Moku Pahu* if the chlorine dioxide is not handled appropriately. However, the Ecochlor system does not store any ClO_2, rather it generates it as needed as a 0.25% solution, which is immediately diluted down to a concentration of 5 ppm in the ballast water tanks (Matson 2006). Finally, chlorine dioxide has been used in municipal and industrial water disinfection for over 50 years, and safe handling procedures are well developed and have been incorporated into the standard operation and maintenance procedures for the Ecochlor system, which comply with OSHA handling standards. Therefore, although adverse consequences are possible with the use of chlorine dioxide, the risk in this particular case would be low and therefore impacts to public health and safety are reasonably concluded to be well mitigated and not significant.

4.1 Biological Resources

4.1.1 No Action Alternative

Under the No Action Alternative, the *Moku Pahu* with the Ecochlor BWT system would not be admitted to the program. The vessel could continue to test or operate the experimental technology as a private action. However, the *Moku Pahu* would not be granted equivalency to current and future BWM regulations, and therefore would be required to comply with current BW management requirements, and any applicable future Coast Guard regulations.

4.1.2 Proposed Action Alternative

Under the Proposed Action, the *Moku Pahu* with the Ecochlor BWT system would be admitted to STEP, and would be granted equivalency for applicable future USCG BWM regulations. The BWT system would process all ballast water taken on and discharged by the ship.

This alternative may slightly reduce the chance of a release of non-indigenous organisms in ballast water discharge from the *Moku Pahu* since the existing rules allow for the release of untreated and unexchanged ballast water in port areas under certain circumstances. It is believed that use of the system will be more effective in reducing the delivery of healthy nonindigenous species relative to BWE, and thus also likely to reduce the probabilities of invasion.

In accordance with ESA, the USCG has initiated informal consultation with the USFWS and the NMFS to determine if any threatened and endangered species in the affected environment could be affected by implementing the subject BWTS. Initial responses received from the consulted agencies have been considered in this analysis and are included in Appendix D

The USFWS believes that the proposed discharge of treated ballast water would not likely affect ESA listed species in Appendix D.

A possible impact to biological resources could occur from the residuals of chlorite, chlorate and chlorine dioxide remaining in the discharged water. Given the highly reactive nature of chlorine dioxide, chlorate and chlorite with organic matter, especially in the presence of light, and the relatively small volumes of discharged ballast water involved (compared to the waters of the ports where discharges of treated water will occur) it is unlikely that the discharges treated with the Ecochlor BWTS will have any discernable effect on the highly organic environments of the port waters in the Hawaii sites. Because any residual chlorite, chlorate of chlorine dioxide are expected to be degraded rapidly due to consumption or sunlight, the potential impacts from this action will primarily be to the planktonic community and possibly plankton consuming fish in the near vicinity of the vessel during discharges. Birds would only be affected indirectly through any change (decline) in their food supply (plankton and fish). EPA-compiled toxicity data for all three chemical species (Appendix E) suggest strongly that the expected concentrations on discharge of ClO_2 (30 ug/l), chlorite (2,000 ug/l), and chlorate (500 ug/l) are likely below the levels associated with significant toxicity to aquatic organisms. The compiled toxic levels (LC50) are mostly greater than 1000 ug/l for ClO2; greater than 75,000 ug/l for chlorite (although two aquatic zooplankters, *Daphnia* and *Americamysis* had LC50 concentrations under 500 ug/l); and greater than 1,000,000 ug/l for chlorate.

Another possible impact arises if the system is less effective than BWE or ballast water retention for reduction of introduction of NIS. Current regulations provide vessel masters with a provision whereby they may not conduct BWE for reasons of either ship safety or route constraints. Therefore, even if the Ecochlor BWTS fails to achieve the level of treatment during shipboard use that the application materials indicate may be possible, its consistent use should still be more effective than current regulations for reducing the introduction of nonindigenous species.

A failure to achieve even moderate treatment efficacy, would result in further review by the Coast Guard and the potential to withdraw or suspend the STEP acceptance pending improvements in the system.

4.2 Water Quality

4.2.1 No Action Alternative

Under the No Action Alternative the *Moku Pahu* with the Ecochlor BWT system would not be accepted to the STEP and would continue to be required to comply with current and future Coast Guard ballast water management regulations. Therefore, under the No Action Alternative, the practices of the *Moku Pahu* would be expected to remain unchanged. Therefore no significant impacts to water quality are expected as a result.

4.2.2 Proposed Action Alternative

In the Hawaiian island ports (Kahului, Nawiliwili), organic matter discharged with ballast water should not increase the input that would have occurred without the implementation of the BWTS. Rather, the killing of various species, and their degradation in the ballast tanks during transit, may, as a result of settling, net a lower organic matter load at discharge.

The BWTS also will sometimes discharge treated ballast water that is of a lower pH (<0.6 units lower) than the harbor receiving waters. However, as pH typically varies more than 0.2 units in many nearshore waters and since the discharge pH will still generally be near neutrality, the slightly acidic discharged water would not likely pose a significant negative impact. In addition, as waters being discharged can come from a variety of ballasting locations, even without the BWTS it is likely that the characteristics of the discharge waters will differ from the waters receiving the discharge (e.g.- San Francisco Bay source versus Hawaii receiving).

Finally the system will discharge a small quantity of treatment residuals possibly including some or all of the following chemical substances: Chlorine Dioxide, Chlorate ion, Chlorite ion, and Sodium Sulfate. Existing research indicates that the levels of all of these chemicals in the discharged water will be negligible, and concentrations should decline rapidly in the receiving waters due to degradation and dilution.

Overall, it is expected that the potential water quality impacts associated with the *Moku Pahu* discharging treated ballast water will be negligible.

4.3 Public Health and Safety

Since the system has already been installed, either alternative has the same risk to public health and safety arising from the chlorine dioxide gas used for the treatment.

Chlorine dioxide is a reactive substance. It is poisonous to humans; it is also a skin, eye, and respiratory irritant. Additionally, it can enhance the combustion potential of other substances. (OSHA, 2007). However, even though chlorine dioxide is a poisonous gas, there are no applicable emissions standards regulating emissions of chlorine dioxide. This is because chlorine dioxide quickly breaks down in air; and, it is unlikely for the average person to be able to breathe air containing dangerous levels of chlorine dioxide. There could be adverse consequences to public health and safety from this action if the chlorine dioxide is not handled appropriately. However, the Ecochlor system does not store any ClO_2, rather it generates it as needed as a 0.25% solution, which is then diluted down to a concentration of 5 ppm in the ballast water tanks (Matson 2006). Finally, chlorine dioxide has been used in municipal and industrial water disinfection for over 50 years, and safe handling procedures are well developed and have been incorporated into the standard operation and maintenance procedures for the Ecochlor system, which comply with OSHA handling standards. Therefore, although adverse consequences are possible with the use of chlorine dioxide, the risk would be low and therefore impacts to public health and safety are reasonably concluded to be well mitigated and not significant.

4.4 Socioeconomics and Environmental Justice

Similarly to public safety, because the system is already installed, all environmental justice impacts are the same for either alternative. Operation of the Ecochlor system on the *Moku Pahu* while participating in STEP will not alter the frequency of port visits or magnitude of cargo handling by the vessel. Matson may realize a minor financial benefit from treating ballast water with the Ecochlor system as compared to conducting ballast water exchange on each ballast voyage. However, the necessity to conduct a set of complicated experiments and to closely monitor the operational performance of the system while in STEP will also entail some financial cost to Matson. Although there are likely low income and minority populations living, working and recreating in the vicinity of the discharge locations, the lack of expected significant impacts to biological resources, water quality, air quality, wetlands, or other environmental parameters means that these populations are not likely to be disproportionately affected by accepting the *Moku Pahu* to STEP. Therefore, acceptance of the *Moku Pahu* to STEP is not expected to have a significant impact on socioeconomics or environmental justice in the vicinity of the discharge ports.

5.0 CUMULATIVE IMPACTS

The CEQ defines cumulative effects as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions” (40 CFR 1508.7).

This section summarizes the cumulative impacts of the alternatives analyzed in this EA. As stated in section 5.1, the potential impacts from the alternatives should be placed in the context of the impacts associated with other actions, in order to determine the total cumulative environmental changes, as well as which changes result from the alternatives and which result from other actions.

5.1.1 No Action Alternative

Under the no action alternative, there will be continued discharge of NIS associated with the *Moku Pahu’s* current BWM practice of infrequent, low-volume ballast water discharges in the port areas of Kahului and Nawiliwili Harbors in Hawaii. These discharges may be treated by the experimental system, exchanged, or not managed to remove organisms at all, depending upon voyage circumstances and local requirements.

As described in section 3, marine and coastal resources in the affected environments are under increasing pressure from human activities, including coastal development, fishing, industrial processes, resource exploitation, and biological invasions by nonindigenous species via numerous pathways including vessel operations. The cumulative effects of these activities are significant impacts to marine and coastal habitats, biodiversity, and resource sustainability. In the context of increasing rates of aquatic NIS invasions and consequences on marine and coastal resources, the incremental cumulative effect of the No Action alternative for a single specific ship would likely be negligible, although the potential for continued NIS introductions from the *Moku Pahu* would remain the same.

5.1.2 Proposed Action Alternative

Under the Proposed Action alternative, the *Moku Pahu* would be accepted into STEP and would operate the Ecochlor system to treat all discharged ballast water, resulting in reduced concentrations of organisms. Given the low frequency and volumes of discharges in the ports receiving discharged ballast water, the primary impact of the proposed action will be the gathering of data for development and refinement of a ballast water discharge standard and BWT testing procedures. Indirectly, this will lead to a net cumulative environmental benefit as a more robust and effective ballast water management regulatory regime will be promulgated.

6.0 COMPARISON OF THE ALTERNATIVES AND CONCLUSION

Table 6-1 compares the potential consequences of the Proposed Action Alternative and the No Action Alternative.

Table 6-1: Comparison of the Environmental Impacts Associated with the NEPA Alternatives

Category	No Action Alternative	Proposed Action Alternative
Biological Resources	No adverse impacts	Negligible adverse impacts; potential

		beneficial impacts
Water Quality	No adverse impacts	Negligible adverse impacts;
Air Quality	No adverse impacts	Negligible adverse impacts
Public Health and Safety	No adverse impacts	No adverse impacts
Socioeconomics and Environmental Justice	Negligible adverse impacts.	No adverse impacts,

6.1 Conclusion

There is a long term, programmatic benefit of the Proposed Action alternative. By accepting the *Moku Pahu* and the Ecochlor BWT system into STEP, the USCG would acquire valuable information on the shipboard performance and treatment effectiveness of the Chlorine Dioxide dosing BWT system. This information will be critical in the further development of effective ballast water treatment technologies and in the development of feasibly sound ballast water management policy and regulations as mandated by Congress. Such benefits would have wide geographic scope as prototype treatment technologies move to larger scale production and installation on larger numbers of ships as type-approved systems.

The conclusion of the environmental consequences analysis is that negligible adverse impacts would result from the implementation of the Proposed Action. Additionally, based on the logic presented in Sections 4 and 5, the Proposed Action may potentially result in minor, though unquantifiable, beneficial impacts through the reduction of risk of the introduction of NIS from the *Moku Pahu*.

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10.0 APPENDICES

Appendix A. Acronyms and Abbreviations

ANS	Aquatic Nuisance Species
BWD	Ballast Water Discharge
BWE	Ballast Water Exchange
BWM	Ballast Water Management
BWTS	Ballast Water Treatment System
CAA	Clean Air Act of 1990
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
ClO_2	Chlorine Dioxide
EA	Environmental Assessment
E.O.	Executive Order
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act of 1973
FONSI	Finding of No Significant Impact
NAAQS	National Ambient Air Quality Standards
NANPCA	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990
NEPA	National Environmental Policy Act of 1969
NIS	Nonindigenous Species
NISA	National Invasive Species Act of 1996
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NVIC	Navigation and Vessel Inspection Circular
PEA	Programmatic Environmental Assessment
PLC	Programmable Logic Controller
ppm	Parts Per Million
psu	Practical Salinity Units
SSDG	Ship Service Diesel Generator
STEP	Shipboard Technology Evaluation Program
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOCs	Volatile Organic Compounds

Appendix B. Example of Section 7 letter sent to resource agencies.

September 15, 2006

Contact Name, Title
Address

Dear [Title],

I am writing you on behalf of the United States Coast Guard (USCG), who is currently using the NEPA process to evaluate the impacts of a proposed project under the USCG's Shipboard Technology Evaluation Program (STEP). STEP is a voluntary program through which vessel owners can apply for acceptance of experimental ballast water treatment (BWT) systems installed and tested on board their operating vessels. STEP is available to all vessels subject to the USCG Ballast Water Management (BWM) regulations (33 CFR § 151 Subparts C and D). The USCG prepared a Draft Programmatic Environmental Assessment (PEA) for the implementation of the Shipboard Technology Evaluation Program (STEP) in April 2004.

The program is designed to provide incentive to ship owners and operators to install experimental treatment systems with demonstrated potential for effective removal or destruction of non-indigenous species (NIS) in ballast water. The USCG and the applicant enter into an agreement where the applicant's vessel is accepted into the STEP for a specific period of time, whereby valuable experimental data accrues to the Federal government and, during which operation of the experimental system is considered equivalent to meeting applicable regulatory requirements for ballast water management.

In order to be accepted into the STEP, each application must undergo an associated environmental review. Matson Navigation Company (Matson) has applied to the STEP for its vessel, the *Moku Pahu*, thereby initiating a review for acceptance to the program. Matson plans to utilize the Ecochlor treatment system, which uses chlorine dioxide as the key treatment element, on the vessel to remove the NIS from the ballast water taken from and dispelled to these locations. According to their application, Matson operates a regular route from the San Francisco Bay area to Maui (Kahului) and Kaui (Nawiliwili) during the summer and fall. The vessel is chartered the remainder of the year.

The USCG is proposing to grant Matson acceptance to the program, and will be evaluating the impacts of the proposed action in an Environmental Assessment. A concerning issue to be examined in the EA is the residuals discharged from the system and any potential impacts associated with those discharges. According to their application, the Ecochlor treatment system uses a chlorine dioxide dosage level of 5 ppm, residuals of which quickly decay. Chlorine dioxide may also form chlorite and chlorate as a by-product. According to testing completed by Matson and Ecochlor, the levels of chlorite ions in the ballast water discharge may range from 2.09-2.48 mg/L. The testing regarding levels of by-products are currently being reviewed, and further tests will ensue toward this end.

The purpose of this letter is to notify you that concurrent with the NEPA process, the USCG intends to meet its obligations under the Endangered Species Act (ESA) of 1973. In accordance with Section 7c(1) of the ESA, the Migratory Bird Treaty Act, and any other pertinent legislation, regulations, or treaties regarding the protection of endangered species, I am writing to officially request information on whether any species, or their critical habitats, which are listed, proposed to be listed, candidates to be listed, or otherwise protection may be present within the potential study areas. The USCG will use this information to determine potential effects of the proposed action on those identified species and habitats.

We will be sending you a copy of the Draft EA shortly. Please advise us of any environmental concerns that you feel should be addressed. Should you have any questions, please feel free to contact me.

Sincerely,

Nicole R. Grewell
Environmental Protection Specialist
USDOT Volpe Center
55 Broadway
Cambridge, MA 02142
617-494-2494
617-494-2789 (f)

Appendix C. Air Quality Analysis

Air Quality Standards

The Federal Clean Air Act of 1990 (CAA) protects and enhances the quality of the Nation's air resources, promoting public health and welfare and the productive capacity of its population. The CAA regulates air pollutant emissions via the establishment of National Ambient Air Quality Standards (NAAQS). Since the system under consideration is already installed onboard the ship, the two alternatives considered in this EA use the same amount of ships service electricity to operate and the amount of energy required to operate the system is negligible relative to the overall ship generation needs.

Air Quality in the Affected Environment

California and Hawaii monitor air quality to assess compliance with NAAQS. If levels of an air pollutant violate the NAAQS, the EPA designates the area as a 'nonattainment area' and measures must be taken to improve air quality for that pollutant. An area can also be designated as a 'maintenance area', which means that it recently exceeded the ambient standards, but it is now in attainment. Of the U.S. ports listed in the planning area, both Hawaii ports were in attainment areas for all pollutants. However, San Francisco was found to be in a nonattainment or maintenance area for at least one pollutant.

Environmental Consequences

Under the Proposed Action Alternative, air quality impacts associated with the BWT technology being evaluated in this EA may arise from one source: the emissions from the SSDG that powers the Ecochlor treatment system. Such emissions are particularly of concern at the port of San Francisco in California, as it is located in a nonattainment or maintenance area for at least one pollutant.

As mentioned, the *Moku Pahu* uses the SSDG to generate shipboard electrical power, and this electricity powers the Ecochlor system. In general, vessels such as the *Moku Pahu* would have 2-3 SSDGs sized between 2000 and 5000 kW on board. Thus, during ballasting operations (when the Ecochlor system is in use), there would be some incremental added loading of the SSDG – the Ecochlor system uses a maximum of 4.74 kilowatts (kW) of the ship's electrical power. The Ecochlor technology would likely be activated for less than a total of 200 hours annually.

A preliminary emissions inventory, using emissions factors (for stationary internal combustion sources) found in AP 42 (EPS 1995), indicated that 5 kW of energy supplied by a large stationary diesel-fuel engine for 200 hours annually would result in annual emissions of each pollutant of far less than one ton. If an emissions amount of one ton were put into a screening model (e.g. SCREEN3 (EPA's air pollution screening model)), using conservative inputs for characteristics from a vessel such as the *Moku Pahu*, then the ground level concentrations of that pollutant would be negligible to immeasurable (Noel 2006).

Furthermore, it is unlikely that an SSDG would be activated solely for the purposes of operating the BWT system; in other words, the BWT system would simply draw more current from an SSDG that is running regardless. Finally, no additional sources of electrical power would be installed onboard to accommodate the BWT system. Therefore, using the Ecochlor system would not result in any new emissions, as it is possible that no additional electrical power sources are being operated or installed.

As emissions from the operation of the Ecochlor system are negligible, local or regional levels of pollutants will not be affected, including levels in the aforementioned area of concern in California.

Emissions of chlorine dioxide gas are of concern when evaluating air quality impacts of the Ecochlor system. However, because chlorine dioxide gas is so unstable, it would exist only in the immediate vicinity of the point of release, and disintegrate quickly to chlorine gas and oxygen (EPA 1997). Regarding air quality in the workplace environment, the concentration of chlorine dioxide in the workplace air of industries that use chlorine dioxide has been measured at anywhere from <1 to 300 parts per billion (ppb) (EPA 1997). OSHA sets the occupational exposure limit for an 8-hour workday, 40-hour workweek at 0.1 ppm. The high end of the range of measured levels of chlorine dioxide in workplace air has the potential to exceed the OSHA regulation. However, that higher concentration of chlorine dioxide (300 ppb) was measured in the bleach/chemical preparation area of a pulp mill. It is unlikely that such ambient concentrations of chlorine dioxide would be produced as a result of the sporadic use of the Ecochlor system for BWT. Nevertheless, all applicable and prudent workplace safety regulations and precautions should be taken during the operation of the Ecochlor system. It can be concluded that the Proposed Action Alternative will have negligible impacts on air quality.

Appendix D. Correspondence received via agency consultation.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1601 Kapiolani Blvd., Suite 1110
Honolulu, Hawaii 96814-4733
(808) 944-2200 • Fax: (808) 973-2941

NOV 0 7 2006

Ms. Nicole R. Grewell
Environmental Protection Specialist
U.S. Department of Transportation Volpe Center
55 Broadway
Cambridge, MA 02142

Dear Ms. Grewell:

This letter responds to your September 14, 2006 letter received by our office on September 18, 2006, regarding the U.S. Coast Guard's (USCG) evaluation of Matson Navigation Company's (Matson) application into the Shipboard Technology Evaluation Program (STEP). Your letter requested information on listed species and their critical habitats as well as proposed and candidate species for listing that may occur within the potential route of Matson's vessel from California to the harbors of Maui and Kauai. The National Marine Fisheries Service (NMFS) Pacific Islands Regional Office Protected Resources Division provides ESA-listed marine protected species information under our statutory authorities under the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. §1531 *et seq*.).

The STEP is a voluntary program whereby vessel owners may apply for the installation and on-board testing of experimental ballast water treatment systems on their operating vessels. The program provides incentive to ship owners and operators who install experimental treatment systems with demonstrated potential for effective removal or destruction of non-indigenous species in ballast water. Although a Draft Programmatic Environmental Assessment was developed for this USCG program in April 2004, each application must undergo an environmental review prior to acceptance into the program. The USCG is reviewing Matson's vessel operating route from the San Francisco Bay area to Kahului, Maui and Nawiliwili Harbor, Kauai during the summer and fall and the vessel's Ecochlor treatment system for removal of non-indigenous species in ballast water taken from and disposed of to these locations.

Based on the map (provided via electronic mail on October 20, 2006) indicating the vessel route from California to Maui and Kauai, several highly mobile marine protected species occur in the open ocean as well as outside and within the harbor sites. Marine protected species include four endangered whales, two endangered turtles, the endangered Hawaiian monk seal, three threatened turtles, and at least 18 additional cetacean species. Although these cetacean species are not ESA-listed, they are protected under the Marine Mammal Protection Act of 1972. No additional marine species are proposed or are candidates for listing at this time. We have enclosed a list of the above-mentioned species, including their scientific names and listing status. We expect potential vessel encounters with several whale species when in the open ocean and with green and hawksbill sea turtles and Hawaiian monk seals when approaching and docking at the harbor.

Thank you for working with NMFS to protect our nation's living marine resources. Should you have any other questions regarding this project or the consultation process, please contact Arlene Pangelinan on my staff at (808) 944-2258, or at the email address arlene.pangelinan@noaa.gov. Please refer to consultation #: I-PI-06-542-CY.

Sincerely,

Chris E. Yates
Assistant Regional Administrator
For Protected Resources

HAWAII PROTECTED SPECIES

MARINE MAMMALS:

HAWAIIAN MONK SEAL	*Monachus schauinslandi*
HUMPBACK WHALE	*Megaptera novaeangliae*
SPERM WHALE	*Physeter macrocephalus*
BLUE WHALE	*Balaenoptera musculus*
FIN WHALE	*Balaenoptera physalus*
COMMON DOLPHIN	*Delphinus delphis*
NORTHERN ELEPHANT SEAL	*Mirounga Angustirostris*
ROUGH-TOOTHED DOLPHIN	*Steno bredanensis*
RISSO'S DOLPHIN	*Grampus griseus*
BOTTLENOSE DOLPHIN	*Tursiops truncatus*
PANTROPICAL SPOTTED DOLPHIN	*Stenella attenuata*
SPINNER DOLPHIN	*Stenella longirostris*
STRIPED DOLPHIN	*Stenella coeruleoalba*
MELON-HEADED WHALE	*Peponocephala electra*
PYGMY KILLER WHALE	*Feresa attenuata*
FALSE KILLER WHALE	*Pseudorca crassidens*
KILLER WHALE	*Orcinus orca*
SHORT-FINNED PILOT WHALE	*Globicephala macrorhynchus*
BLAINVILLE'S BEAKED WHALE	*Mesoplodon densirostris*
CUVIER'S BEAKED WHALE	*Ziphius cavirostris*
PYGMY SPERM WHALE	*Kogia breviceps*
DWARF SPERM WHALE	*Kogia sima*
BRYDE'S WHALE	*Balaenoptera edeni*

SEA TURTLES:

LEATHERBACK TURTLE	*Dermochelys coriacea*
HAWKSBILL TURTLE	*Eretmochelys imbricata*
GREEN TURTLE	*Chelonia mydas*
OLIVE RIDLEY TURTLE	*Lepidochelys olivacea*
LOGGERHEAD TURTLE	*Caretta caretta*

THREATENED
ENDANGERED

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Regional Office
911 NE 11th Avenue
Portland, Oregon 97232-

In Reply Refer to:
AES/Consultation

NOV 30 2006

Nicole R. Grewell
Environmental Protection Specialist
U.S. Department of Transportation - Volpe Center
55 Broadway
Cambridge, Massachusetts 02142

Dear Ms. Grewell:

This letter is in response to your September 14, 2006, request for a list of endangered, threatened, proposed, and candidate species, and their designated or proposed critical habitat, and any Migratory Bird Treaty Act (MBTA) concerns that may be present where the United States Coast Guard's (USCG's) Shipboard Technology Evaluation Program (STEP) will be implemented. STEP is a voluntary, experimental, onboard ballast water treatment program available to all vessels subject to the USCG Ballast Water Management (BWM) regulations.

We received two separate requests for which we are providing a combined response. The two projects referenced in your requests are as follows: (1) Princess Cruise Lines' summer operations with ballasts in Cozumel, Mexico, and Skagway, Alaska; and (2) Matson Navigation Company's (Matson) summer and fall operations with ballasts in San Francisco Bay, California, and Maui (Kahului) and Kauai (Nawiliwili), Hawaii. Based on your letter, we are assuming the Princess Cruise Lines application is for ballast transfer only in Mexico and Alaska; these States fall outside of the jurisdiction of the U.S. Fish and Wildlife Service's (Service's) Pacific Region and California/Nevada Operations offices. Therefore, we are providing no information for the proposed Princess Cruise Lines project. We understand that you have contacted our Alaska Region for information relative to this proposed action.

Based on your letter, we are assuming that the Matson application is for ballast transfer only in San Francisco Bay, Maui, and Kauai during the summer and fall. There are no listed or proposed aquatic or aquatic dependent species under the jurisdiction of the Service in the Maui and Kauai area likely to be affected by the Matson project. Enclosed is a list of federally endangered, threatened, proposed, and candidate species, and designated or proposed critical habitat under the Service's jurisdiction known to occur in the San Francisco Bay area; as well as a list of migratory birds that are designated as Birds of Concern in the San Francisco Bay area and Hawaii. Please contact Penny Ruvelas at the National Marine Fisheries Service (NMFS) Southwest Region at (562) 980-4197 for a list of species and critical habitat under NMFS' jurisdiction that may occur at these locations.

Your letter mentioned that an environmental assessment (EA) would be sent to us shortly. Please send your draft EA to Ryan Olah (916-414-6725), Coast Bay-Delta Branch Chief, and Daniel Russell (916-414-6636), Section 7 Branch Chief, 2800 Cottage Way, W-2605, Sacramento Fish and Wildlife Office, Sacramento, California, 95825; Michael Molina (808-792-9400), Environmental Review Coordinator, Pacific Islands Fish and Wildlife Office, P.O. Box 50088, 300 Ala Moana Blvd., Room 3-122, Honolulu, Hawaii, 96850; and Brad Bortner, Migratory Birds and Habitat Programs, 911 NE 11th Avenue, Portland, Oregon, 97232. For further assistance with section 7 consultation needs, please coordinate with Daniel Russell.

As for the Service's concerns relative to migratory birds, we remind you of your responsibilities under Executive Order 13186, which requires Federal agencies to "support the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the maximum extent practicable, adverse impacts on migratory bird resources when conducting agency actions." Additionally, we recommend that your National Environmental Policy Act (NEPA) review address the effects of chlorine dioxide on the marine environment, which in turn would potentially affect migratory seabirds and their prey. This would presumably depend upon where the ballast materials were discharged, the amount discharged, and the toxicological potential of chlorine and its breakdown products at the concentrations being proposed. It will be important at the Pacific Islands and San Francisco Bay area locations to demonstrate that the chlorine dioxide in the vessel discharge will dissipate fast enough to not cause significant impacts to sensitive marine life. The Service intends to coordinate with NMFS and the Environmental Protection Agency in providing a separate response on the forthcoming NEPA review.

This response partially fulfills our requirements under section 7(c) of the Endangered Species Act of 1973, as amended. If you have any questions regarding this response, please contact Daniel Brown (telephone: 503-231-6281). We look forward to assisting you further with this effort.

Sincerely,

Assistant Regional Director
Ecological Services

Enclosure

cc:
Vicki Campbell, Jim Haas, California Nevada Operations Office
Susan Moore, Dan Welsh, Ryan Olah, Sacramento Fish and Wildlife Office
Patrick Leonard, Michael Molina, Pacific Islands Fish and Wildlife Office

List of Federally Endangered, Threatened, Proposed, and Candidate Species, and Designated or Proposed Critical Habitat Known to Occur in the San Francisco Bay Area and Birds of Conservation Concern Known to Occur in the San Francisco Bay Area and Hawaii

Scientific Name	Common Name	Status
Brachyramphus marmoratus	marbled murrelet	T
Brachyramphus marmoratus	Critical habitat, marbled murrelet	CH
Charadrius alexandrinus nivosus	western snowy plover	T
Charadrius alexandrinus nivosus	Critical habitat, western snowy plover	CH
Coccyzus americanus occidentalis	Western yellow-billed cuckoo	C
Diomedea albatrus	short-tailed albatross	E
Eucyclogobius newberryi	tidewater goby	E
Haliaeetus leucocephalus	bald eagle	T
Hypomesus transpacificus	delta smelt	T
Hypomesus transpacificus	Critical habitat, delta smelt	CH
Pelecanus occidentalis californicus	California brown pelican	E
Rallus longirostris obsoletus	California clapper rail	E
Reithrodontomys raviventris	salt marsh harvest mouse	E
Sternula antillarum browni	California least tern	E
Cirsium hydrophilum var. *hydrophilum*	Suisun thistle	E
Cirsium hydrophilum var. *hydrophilum*	Critical habitat, Suisun thistle	PCH
Cordylanthus mollis ssp. *mollis*	soft bird's-beak	E
Cordylanthus mollis ssp. *mollis*	Critical habitat, soft bird's-beak	PCH
Lasthenia conjugens	Critical habitat, Contra Costa goldfields	CH
Lasthenia conjugens	Contra Costa goldfields	E
Suaeda californica	California sea blite	E
Phoebastria immutabilis	Laysan albatross	BCC
Phoebastra nigripes	Black-footed albatross	BCC
Puffinus nativitatis	Christmas shearwater	BCC
Oceanodroma castro	Band-rumped stormpetrel	BCC
Oceanodroma tristrami	Tristam's stormpetrel	BCC
Oceanodroma homochroa	Ashy Stormpetrel	BCC
Synthliboramphus hypoleucus	Xantus's Murrelet	BCC
Ptychoramphus aleuticus	Cassin's Auklet	BCC
Haematopus bachmani	Black Oystercatcher	BCC
Numenius phaeopus	Whimbrel	BCC
Numenius americanus	Long-billed Curlew	BCC
Limosa fedoa	Marbled Godwit	BCC
Arenaria melanocephala	Black Turnstone	BCC
Calidris canutus	Red Knot	BCC
Limnodromus griseus	Short-billed Dowitcher	BCC

Key: Species Status: E – Endangered; T – Threatened; C – Candidate; P – Proposed, CH – Critical Habitat; PCH – Proposed Critical Habitat, BCC – Birds of Conservation Concern

1

Appendix E. Ecochlor chemistry

Chlorine dioxide is generated in a turnkey system in which a commercially available feedstock, Purate (a mixture of sodium chlorate [$NaClO_3$] and hydrogen peroxide [H_2O_2]), is mixed with commercial sulfuric acid. The resulting ClO_2 containing solution is metered into the flowing ballast water (upon uplift via a manifold that is downstream of the ballast pump) to achieve a target dosage of 5.0 parts per million (ppm) ClO_2. Chorine dioxide is a strong oxidant and readily reacts with organic matter including organisms contained in the ballast water. The typical transformation of ClO_2 in its interaction with organic matter follows the general sequence of reactions in Equation 1:

$$ClO_2 \rightleftharpoons ClO_2^{1-} \rightarrow ClO_3^{1-} + Cl^{1-} \qquad \text{Equation 1}$$

Equation 1 shows the transformation of ClO_2 first into the intermediate chlorite (ClO_2^{1-}) and ultimately into the terminal products chlorate (ClO_3^{1-}) and chloride (Cl^{1-}). A fraction of the ClO_2^{1-} formed can be disproportionated back into ClO_2. The relative rates of these reactions are very much influenced by temperature, pH, organic matter content of the water, and the presence or absence of light. Within approximately 30 minutes, the ClO_2 concentration is typically reduced to a residual concentration between 1.0 ppm and 3.0 ppm by a rapid reaction with organic matter within the ballast water (Ecochlor 2006). The initial rapid consumption is defined as the "ClO_2 demand" of the treated ballast water. This residual then decays at a substantially lower rate until it is totally consumed.

- According to Ecochlor, there should be no ClO_2 residual in the ballast water at the time of discharge (Ecochlor 2006). The application present holding times for treated ballast water on the *Moku Pahu* would typically be approximately 7 days, consistent with the BWTS effectiveness testing using a 5 day end-point.

While the barge has capacity of over 18,000 metric tons, the maximum quantity of ballast water discharged in any port over the previous 2 years was 16,151 metric tons.

Analysis of residuals examined both short (one to two days), intermediate (three to five days) and long duration (30 days) voyages (see Ecochlor 2006b). The half-life of ClO_2 in seawater depends greatly on the organic matter content of the water into which it is introduced and temperature. Organic content of water can vary greatly among locations, depending on numerous circumstances, and this will affect the amount of residual remaining in the ballast water. For example, laboratory studies conducted by Ecochlor (2006b) have shown that the half life of ClO_2 in Oakland harbor water is quite short lived, only 1 hour at 20^oC, the typical seasonal temperatures the *Moku Pahu* would experience. At this temperature, ClO_2 is 99 % consumed in approximately 24 hours.

Appendix F. Toxicity of Applicable Chlorine species

Table F-1. Toxicity of chlorine dioxide on all organisms.

F.1Toxicity Studies for Chlorine dioxide on All Organism Groups –

Toxicology studies from the primary scientific literature on aquatic organisms

Use(s): Microbiocide, Water Treatment Chem Class: Inorganic U.S. EPA PC Code: 020503 CAS Number: 10049-04-4

Sorted by Organism Group, Effect, Measurement, Endpoint and LatinName.

Note: Only partial study information is reported on these pages. Full study information can be found at the U.S. EPA AQUIRE web site.

Records 1 to 37 of 37

First Previous Next Last

Common Name Scientific Name	Effect	Measurement	Life Stage	Study Time	Toxicity Endpoint	Toxic Dose			Conc Units	Conc Type	Chem Desc	Exper. Type	Acute Tox Rating	Outlier	Year
						Mean	Min	Max							
Green or Europeon shore crab Carcinus maenas	Mortality	Mortality	ADULT	48 h	LC50	500,000	-	-	ug/L	T	DOXCIDE	Renewal	Not Acutely Toxic		1971
Common shrimp, sand shrimp Crangon crangon	Mortality	Mortality	ADULT	48 h	LC50	500,000	-	-	ug/L	T	DOXCIDE	Renewal	Not Acutely Toxic		1971
Aesop shrimp Pandalus montagui	Mortality	Mortality	ADULT	48 h	LC50	500,000	-	-	ug/L	T	DOXCIDE	Renewal	Not Acutely Toxic		1971
Red swamp crayfish Procambarus clarkii	Mortality	Mortality	adult	48 h	LC50	610,000	503,000	774,000	ug/L	F	NR	Static	Not Acutely Toxic		2000
Purple sea urchin Strongylocentrotus purpuratus	Growth	Abnormal	EMBRYO	48 h	NR	25,000	-	-	ug/L	T	AQ, 25 %	Static			1989
Purple sea urchin Strongylocentrotus purpuratus	Growth	Abnormal	EMBRYO	48 h	NR	2,500	-	-	ug/L	T	AQ, 25 %	Static			1989
Harlequinfish, red rasbora Rasbora heteromorpha	Mortality	Mortality	1-3 CM	24 h	LC50	9,600,000	-	-	ug/L	F	2% CHLORINE DIOXIDE, DOXCIDE 50	Flow through	Not Acutely Toxic	Outlier	1975
Harlequinfish, red rasbora Rasbora heteromorpha	Mortality	Mortality	1-3 CM	96 h	LC50	6,500,000	-	-	ug/L	F	2% CHLORINE DIOXIDE, DOXCIDE 50	Flow through	Not Acutely Toxic		1975
Brown trout Salmo trutta	Mortality	Mortality	YEARLING, FINGERLING	48 h	LC50	10,000,000	-	-	ug/L	F	DOXIDE 50	Not reported	Not Acutely Toxic		1974
Atlantic salmon Salmo salar	Mortality	Mortality	199.5 DEGREED, POST STRIPPING EGGS	24 h	LD50	1,807,500	-	-	ug/L	T	NR	Not reported			1993
Kelp bass Paralabrax clathratus	Mortality	Mortality	EGGS, 24 H	48 h	NR	2,500	-	-	ug/L	T	AQ, 25 %	Static			1989

Atlantic salmon Salmo salar	Mortality	Mortality	EGGS, 233.2-334 DEGREE DAYS POST/	21 d	NR	-	6,250	25,000	ug/L	T	NR	Pulse			1993
Fungi Saprolegnia parasitica	Population	Abundance	NR	1 h	NR	-	12,500	25,000	ug/L	T	NR	Pulse			1993
Zebra mussel Dreissena polymorpha	Behavior	Ability to detach from substrate	NR	NR d	NR	-	125.0	500.0	ug/L	T	NR	Flow through			1993
Cockle Cerastoderma edule	Mortality	Mortality	ADULT	48 h	LC50	500,000	-	-	ug/L	T	DOXCIDE	Renewal	Not Acutely Toxic		1971
Zebra mussel Dreissena polymorpha	Mortality	Mortality	NR	24 h	LC50	400.0	-	-	ug/L	T	NR	Flow through	Highly Toxic		1992
Zebra mussel Dreissena polymorpha	Mortality	Mortality	ADULT, >=10 MM	NR d	LC50	13,000	-	-	ug/L	F	NR	Pulse	Slightly Toxic		1996
Zebra mussel Dreissena polymorpha	Mortality	Mortality	ADULT, >=10 MM	72 h	LC50	490.0	-	-	ug/L	F	NR	Flow through	Highly Toxic		1996
Zebra mussel Dreissena polymorpha	Mortality	Mortality	ADULT, >=10 MM	96 h	LC50	350.0	-	-	ug/L	F	NR	Flow through	Highly Toxic		1996
Asiatic clam Corbicula manilensis	Mortality	Mortality	<1.0 MM, JUVENILE	~ 0.7 d	LT50	1,210	-	-	ug/L	T	NR	Flow through			1989
Asiatic clam Corbicula manilensis	Mortality	Mortality	<1.0 MM, JUVENILE	~ 0.6 d	LT50	4,740	-	-	ug/L	T	NR	Flow through			1989
Green algae Cladophora sp.	Biochemistry	Chlorophyll	THREE 3 CM FILAMENTS, 300 CELLS	24 h	NR	2,600	-	-	ug/L	T	NR	Static			1969
Green algae Cladophora sp.	Cell(s)	Cell changes	THREE 3 CM FILAMENTS, 300 CELLS	24 h	NR	52,000	-	-	ug/L	T	NR	Static			1969
Giant kelp Macrocystis pyrifera	Reproduction	Reproduction, general	MEIOSPORES	48 h	NR	25,000	-	-	ug/L	T	AQ, 25 %	Static			1989
Giant kelp Macrocystis pyrifera	Reproduction	Reproduction, general	MEIOSPORES	48 h	NR	2,500	-	-	ug/L	T	AQ, 25 %	Static			1989
Water flea Daphnia pulex	Intoxication	Immobile	adult	48 h	EC50	1,800	900.0	2,700	ug/L	F	NR	Static			2000

Table F-2. Toxicity of Sodium Chlorite on all Organisms

F-2: Toxicity Studies for Sodium chlorite on All Organism Groups –

Toxicology studies from the primary scientific literature on aquatic organisms

Use(s): Microbiocide, Water Treatment Chem Class: Inorganic U.S. EPA PC Code: 020502 CAS Number: 7758-19-2

Sorted by Organism Group, Effect, Measurement, Endpoint and LatinName.

Note: Only partial study information is reported on these pages. Full study information can be found at the U.S. EPA AQUIRE web site.

Common Name Scientific Name	Effect	Study Time	Toxicity Endpoint	Toxic Dose	Conc Units	Exper Type	Acute Tox Rating	Year
Sheepshead minnow Cyprinodon variegatus	Mortality	96 h	LC50	75,000	ug/L	Flow through	Slightly Toxic	2000
Bluegill Lepomis macrochirus	Mortality	96 h	LC50	196,000	ug/L	Static	Not Acutely Toxic	2000
Bluegill Lepomis macrochirus	Mortality	96 h	LC50	231,000	ug/L	Static	Not Acutely Toxic	2000
Bluegill Lepomis macrochirus	Mortality	240 h	LC50	165,000	ug/L	Flow through	Not Acutely Toxic	2000
Bluegill Lepomis macrochirus	Mortality	96 h	LC50	-	ug/L	Static	Not Acutely Toxic	2000
Bluegill Lepomis macrochirus	Mortality	72 h	LC50	207,000	ug/L	Static	Not Acutely Toxic	2000
Bluegill Lepomis macrochirus	Mortality	96 h	LC50	270,000	ug/L	Static	Not Acutely Toxic	2000
Rainbow trout,donaldson trout Oncorhynchus mykiss	Mortality	96 h	LC50	216,000	ug/L	Static	Not Acutely Toxic	2000
Rainbow trout,donaldson trout Oncorhynchus mykiss	Mortality	312 h	LC50	38,000	ug/L	Flow through	Slightly Toxic	2000
Fungi Trichoderma hamatum	Populati on	48 h	LOEC	-	ug/L	Not reported		1998
Marine sponge	Cell(s)	10 mi	NR	-	ug/L	Static		1997

Microciona prolifera								
American or virginia oyster Crassostrea virginica	Intoxication	96 h	EC50	14,300	ug/L	Flow through		2000
Zebra mussel Dreissena polymorpha	Mortality	30 mi	NR	-	ug/L	Flow through		1996
Green algae Selenastrum capricornutum	Population	4 d	EC50	1,180	ug/L	Static		2000
Blue-green algae Nostoc calcicola	Population	14 d	EC50	-	ug/L	Not reported		1998
Green algae Selenastrum capricornutum	Population	96 h	EC50	-	ug/L	Not reported		1998
Brown algae Ectocarpus variabilis	Population	14 d	LOEC	-	ug/L	Not reported		1998
Blue-green algae Nostoc calcicola	Population	14 d	LOEC	-	ug/L	Not reported		1998
Green algae Selenastrum capricornutum	Population	96 h	LOEC	-	ug/L	Not reported		1998
Green algae Selenastrum capricornutum	Population	96 h	LOEC	-	ug/L	Not reported		1998
Brown algae Ectocarpus variabilis	Population	14 d	NOEC	-	ug/L	Not reported		1998
Blue-green algae Nostoc calcicola	Population	14 d	NOEC	-	ug/L	Not reported		1998
Green algae Selenastrum capricornutum	Population	96 h	NOEC	-	ug/L	Not reported		1998
Water flea Daphnia magna	Intoxication	48 h	EC50	21.0	ug/L	Static		2000
Water flea Daphnia magna	Intoxication	48 h	EC50	250.0	ug/L	Flow through		2000

Opossum shrimp Americamysis bahia	Mortality	96 h	LC50	440.0	ug/L	Flow through	Highly Toxic	2000

Table F-3. Toxicity of Sodium Chlorate on all Organisms

F-3: Toxicity Studies for Sodium chlorate on All Organism Groups –

Toxicology studies from the primary scientific literature on aquatic organisms

Use(s): Defoliant, Herbicide, Microbiocide Chem Class: Inorganic U.S. EPA PC Code: 073301 CAS Number: 7775-09-9

Sorted by Organism Group, Effect, Measurement, Endpoint and LatinName.

Note: Only partial study information is reported on these pages. Full study information can be found at the U.S. EPA AQUIRE web site.

Common Name Scientific Name	**Effect**	**Measurement**	**Life Stage**	**Study Time**	**Toxicity Endpoint**	**Conc Units Mean**	**Conc Type**	**Exper. Type**	**Acute Tox Rating**	**Year**
Duckweed Lemna perpusilla	Mortality	Mortality	NR	7 d	NR	1,000,000	ug/L	Not reported		1974
Aquatic sowbug Asellus hilgendorfi	Mortality	Mortality	1-5 MG	24 h	LC50	4,100,000	ug/L	Static	Not Acutely Toxic	1976
Aquatic sowbug Asellus hilgendorfi	Mortality	Mortality	1-5 MG	48 h	LC50	3,400,000	ug/L	Static	Not Acutely Toxic	1976
Aquatic sowbug Asellus hilgendorfi	Mortality	Mortality	1-5 MG	96 h	LC50	2,800,000	ug/L	Static	Not Acutely Toxic	1976
Cherry salmon, yamame trout Oncorhynchus masou	Avoidance	Chemical avoidance	PARR, 4 G	2 d	NR	-	ug/L	Lotic		1975
Sea lamprey Petromyzon marinus	Behavior	Observed stress	LARVAE, 8-13 CM	24 h	NR	5,000	ug/L	Static		1957

Rainbow trout,donaldson trout Oncorhynchus mykiss	Growth	Growth, general	8.6-8.8 G	NR wk	NR	60,000	ug/L	Lotic		1975
Cyprinus carpio	Mortality	Mortality	NR	96 h	LC50	2,340,000	ug/L	Static	Not Acutely Toxic	1986
Cherry salmon, yamame trout Oncorhynchus masou	Mortality	Mortality	3.0 G, 6.9 CM, FINGERLING	24 h	LC50	4,000,000	ug/L	Renewal	Not Acutely Toxic	1976
Cherry salmon, yamame trout Oncorhynchus masou	Mortality	Mortality	3.0 G, 6.9 CM, FINGERLING	48 h	LC50	3,300,000	ug/L	Renewal	Not Acutely Toxic	1976
Cherry salmon, yamame trout Oncorhynchus masou	Mortality	Mortality	3.0 G, 6.9 CM, FINGERLING	96 h	LC50	1,100,000	ug/L	Renewal	Not Acutely Toxic	1976
Rainbow trout,donaldson trout Oncorhynchus mykiss	Mortality	Mortality	NR	48 h	LC50	1,100,000	ug/L	Static	Not Acutely Toxic	2000
Hasu fish Opsariichthys uncirostris	Mortality	Mortality	NR	96 h	LC50	2,340,000	ug/L	Static	Not Acutely Toxic	1986
Minnow Phoxinus phoxinus	Mortality	Mortality	NR	96 h	LC50	2,340,000	ug/L	Static	Not Acutely Toxic	1986
Fathead minnow	Mortality	Mortality	0.91-2.56 G, 3.7-	96 h	LC50	13,800,000	ug/L	Static	Not Acutely Toxic	1974

Pimephales promelas			5.4 CM							
Fathead minnow Pimephales promelas	Mortality	Mortality	0.56-2.88 G, 3.8-5.5 CM	96 h	LC50	13,600,000	ug/L	Static	Not Acutely Toxic	1974
Fathead minnow Pimephales promelas	Mortality	Mortality	0.65-1.78 G, 3.6-5.0 CM	96 h	LC50	13,500,000	ug/L	Static	Not Acutely Toxic	1974
Harlequinfish, red rasbora Rasbora heteromorpha	Mortality	Mortality	1.3-3 CM	24 h	LC50	8,600,000	ug/L	Renewal	Not Acutely Toxic	1969
Roach Rutilus rutilus	Mortality	Mortality	NR	96 h	LC50	2,340,000	ug/L	Static	Not Acutely Toxic	1986
Brown trout Salmo trutta	Mortality	Mortality	YEARLING, FINGERLING	48 h	LC50	7,300	ug/L	Not reported	Moderately Toxic	1974
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.5 G, 4.0 CM	6 h	LC50	4,900,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.5 G, 4.0 CM	12 h	LC50	4,700,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.5 G, 4.0 CM	24 h	LC50	4,200,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel	Mortality	Mortality	0.5 G, 4.0 CM	48 h	LC50	3,800,000	ug/L	Static	Not Acutely Toxic	1976

Tribolodon hakonensis										
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.5 G, 4.0 CM	96 h	LC50	3,800,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.25 G, 3.2 CM	24 h	LC50	4,000,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.25 G, 3.2 CM	48 h	LC50	3,800,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.25 G, 3.2 CM	96 h	LC50	3,300,000	ug/L	Static	Not Acutely Toxic	1976
Japanese barbel Tribolodon hakonensis	Mortality	Mortality	0.25 G, 3.2 CM	10 d	LC50	2,000,000	ug/L	Static	Not Acutely Toxic	1976
Goldfish Carassius auratus	Mortality	Mortality	60-90 MM, 3-5 G	> 4 d	NR	1,000,000	ug/L	Static		1937
Cherry salmon, yamame trout Oncorhynchus masou	Mortality	Mortality	PARR, 8 G	1 d	NR	-	ug/L	Lotic		1975
Cherry salmon, yamame trout Oncorhynchus masou	Mortality	Mortality	PARR, 4 G	4 d	NR-ZERO	-	ug/L	Lotic		1975
Fungi	Popul	Populati	DSM	48 h	NOEC	796,17	ug/L	Not		1998

Penicillium verrucosum	ation	on growth rate	1250 STRAIN			1		reported		
Fungi Trichoderma hamatum	Population	Population growth rate	DSM 63055 STRAIN	48 h	NOEC	796,171	ug/L	Not reported		1998
Caddisfly Stenopsyche griseipennis	Mortality	Mortality	0.35 G	24 h	LC50	3,100,000	ug/L	Static	Not Acutely Toxic	1976
Caddisfly Stenopsyche griseipennis	Mortality	Mortality	0.35 G	48 h	LC50	3,100,000	ug/L	Static	Not Acutely Toxic	1976
Caddisfly Stenopsyche griseipennis	Mortality	Mortality	0.35 G	96 h	LC50	2,700,000	ug/L	Static	Not Acutely Toxic	1976
Mayfly Ephemera japonica	Mortality	Mortality	NYMPH	4 d	NR	-	ug/L	Lotic		1975
Mayfly Baetis tricaudatus	Mortality	Survival	FINAL INSTAR NYMPH	10 d	NR	-	ug/L	Static		1997
Dasycorixa hybrida	Mortality	Survival	ADULTS	10 d	NR	-	ug/L	Static		1997
Beetle Haliplus sp.	Mortality	Survival	ADULTS	10 d	NR	-	ug/L	Static		1997
Stonefly Isoperla longiseta	Mortality	Survival	FINAL INSTAR NYMPH	10 d	NR	-	ug/L	Static		1997
Stonefly Isoperla transmarina	Mortality	Survival	FINAL INSTAR NYMP	10 d	NR	-	ug/L	Static		1997

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Mayfly Tricorythodes minutus	Mortality	Survival	FINAL INSTAR NYMPH	10 d	NR	-	ug/L	Static		1997
Planarian Polycelis nigra	Mortality	Mortality	NR	48 h	LT50	15,966,000	ug/L	Static		1941
Green algae Scenedesmus subspicatus	Development	Color	CCAP 276/20 STRAIN, EXPO GRO PHASE	NR h	LOEC	3,137,000	ug/L	Static		1995
Green algae Scenedesmus subspicatus	Development	Color	CCAP 276/20 STRAIN, EXPO GRO PHASE	NR h	NOEC	1,569,000	ug/L	Static		1995