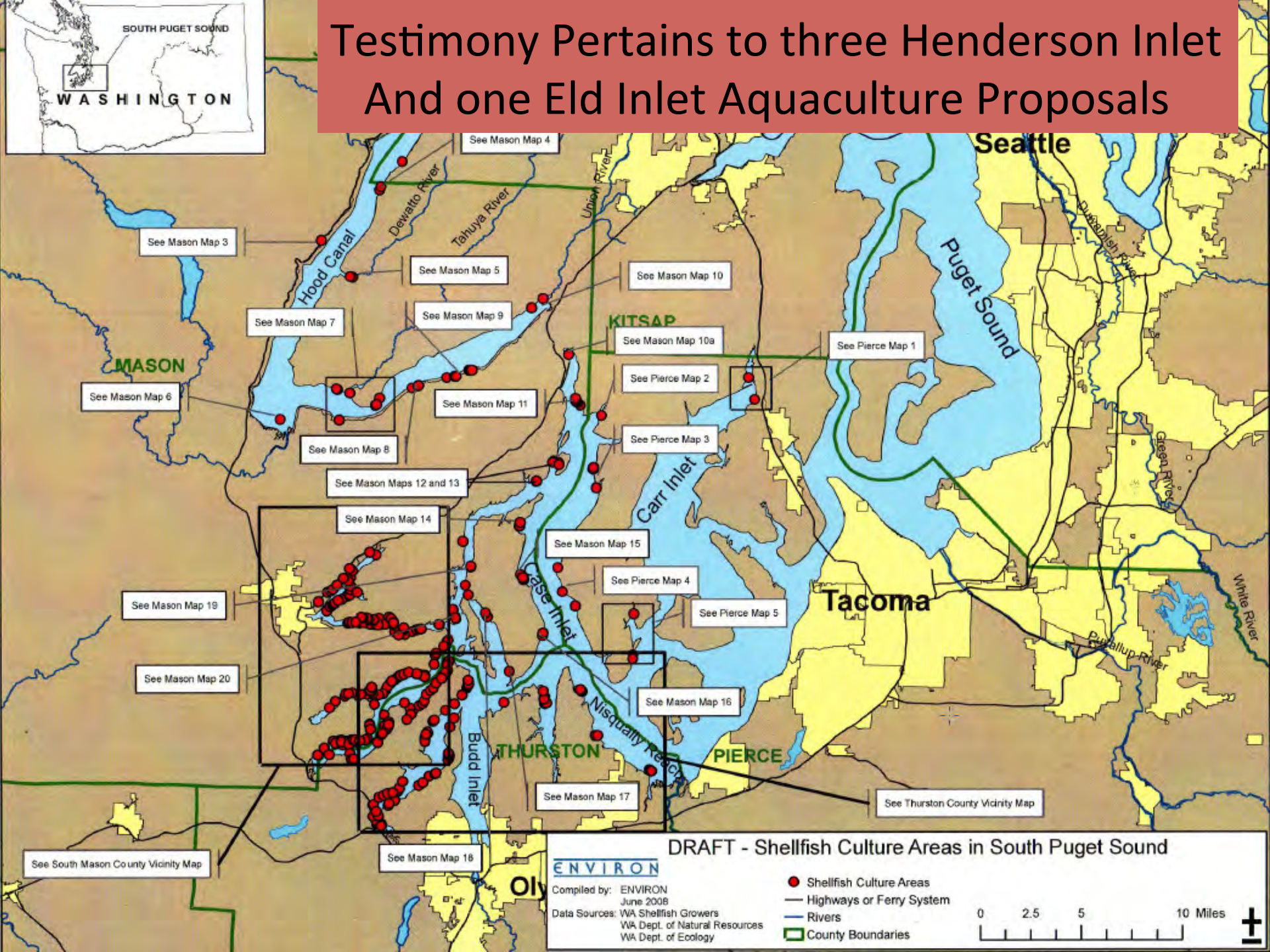
Effects of Plastic Pollution from Bivalve Shellfish Aquaculture in South Puget Sound

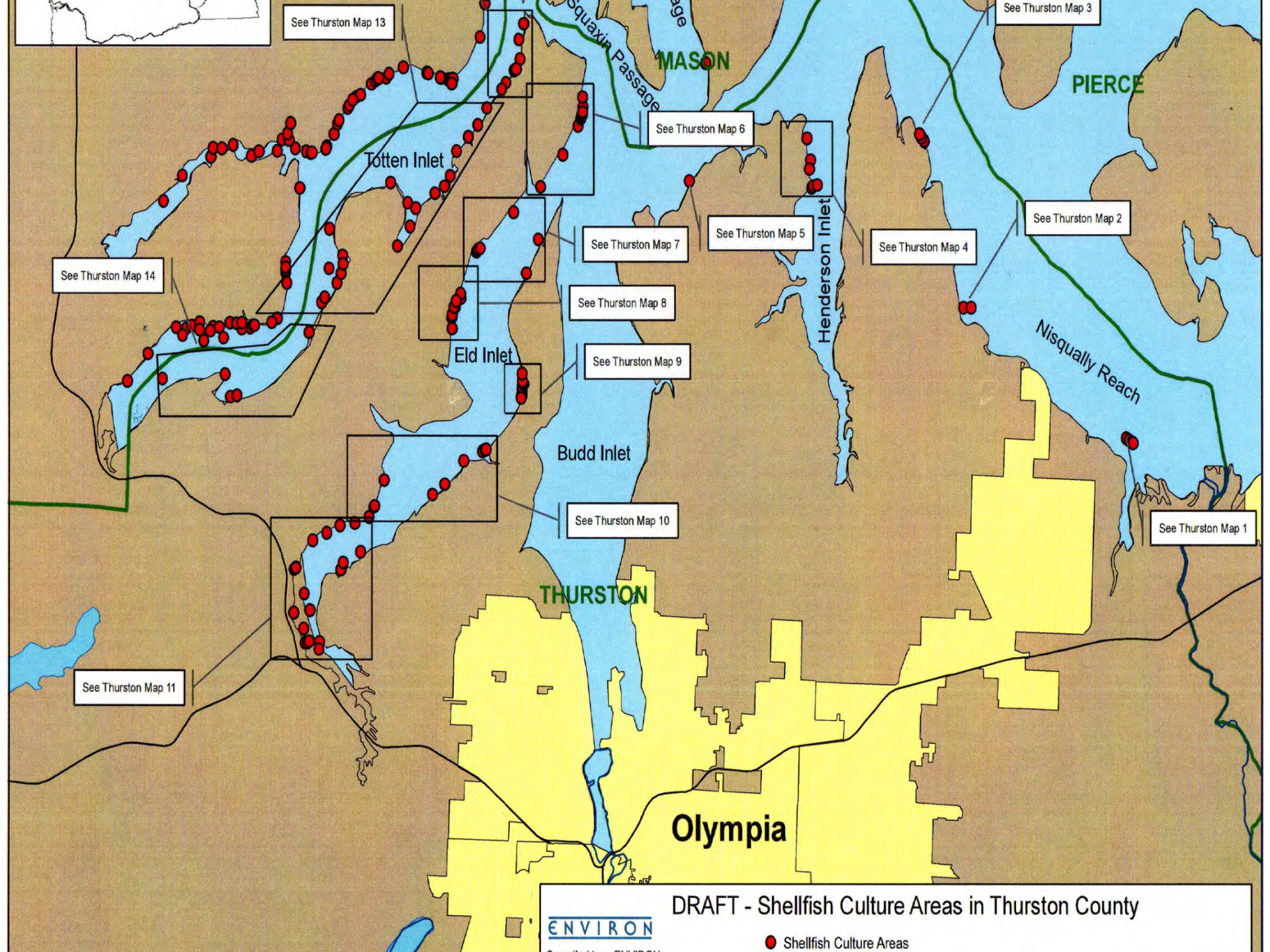
Shoreline Hearings Board August 12 Presentation

CAPTAIN CHARLES MOORE

ALGALITA MARINE RESEARCH INSTITUTE
www.algalita.org

Testimony Pertains to three Henderson Inlet And one Eld Inlet Aquaculture Proposals




See Thurston Map 13
See Thurston Map 3
MASON
PIERCE
Squaxin Passage
See Thurston Map 6
Totten Inlet
See Thurston Map 7
See Thurston Map 5
See Thurston Map 4
See Thurston Map 2
See Thurston Map 14
See Thurston Map 8
Henderson Inlet
Eld Inlet
See Thurston Map 9
Nisqually Reach
Budd Inlet
See Thurston Map 10
See Thurston Map 1
THURSTON
See Thurston Map 11
Olympia
DRAFT - Shellfish Culture Areas in Thurston County
ENVIRON
Shellfish Culture Areas

Nearshore Intertidal Geoduck Aquaculture

EVINRUDE
E-TEC

Geoduck aquaculture canopy nets

SHELLFISH AQUACULTUE IS BEING CONDUCTED ON AN INDUSTRIAL SCALE IN PUGET SOUND

- INDUSTRIAL AQUACULTURE USES OF THE INTERTIDAL ZONE ARE ONLY PERMITTED IF THEY DO NOT DEGRADE THE MARINE ENVIRONMENT.

Derelict PVC

WEST COAST GOVERNORS' AGREEMENT on OCEAN HEALTH

WASHINGTON OREGON CALIFORNIA

Marine Debris

Finding 1D

Marine debris is a significant threat to the health of the marine environment and is increasing along the West Coast and in the North Pacific Gyre.

Derelict Gear Prevention

Employing the assistance of fishermen and other industry experts may help prevent derelict gear. Debris location and source identification could be included in regional and cooperative fishery research programs (see *Finding 6A*), as well as mapping programs *(Priority Area 6)*.

Densities of small plastic pieces have tripled during the last decade in the North Pacific Gyre, a clockwise-circulating area that encompasses a majority of the northern Pacific Ocean and which encompasses the California Current on its eastern boundary. Preliminary data from the Algalita Marine Research Foundation show a five-fold increase in the last 10 years. There is currently no method for removing the estimated 3.5 million tons of plastic debris in the gyre. It is now believed that most marine debris comes from land-based sources, much of which is composed of plastic and lasts hundreds of years or longer without biodegrading. Wildlife species, some of which are threatened or endangered species under state or federal law, can ingest and may become trapped or entangled in marine debris. In addition, organisms attach to plastic and can float to distant habitats and become harmful invasive species.

Marine Debris

Action 1.4

★ *Establish baseline estimates of marine debris and derelict gear off the West Coast and set reduction goals. Support state and federal policies for achieving marine debris reduction goals, including debris prevention through expanded recycling, improved trash maintenance, public education, and enforcement of litter laws.*

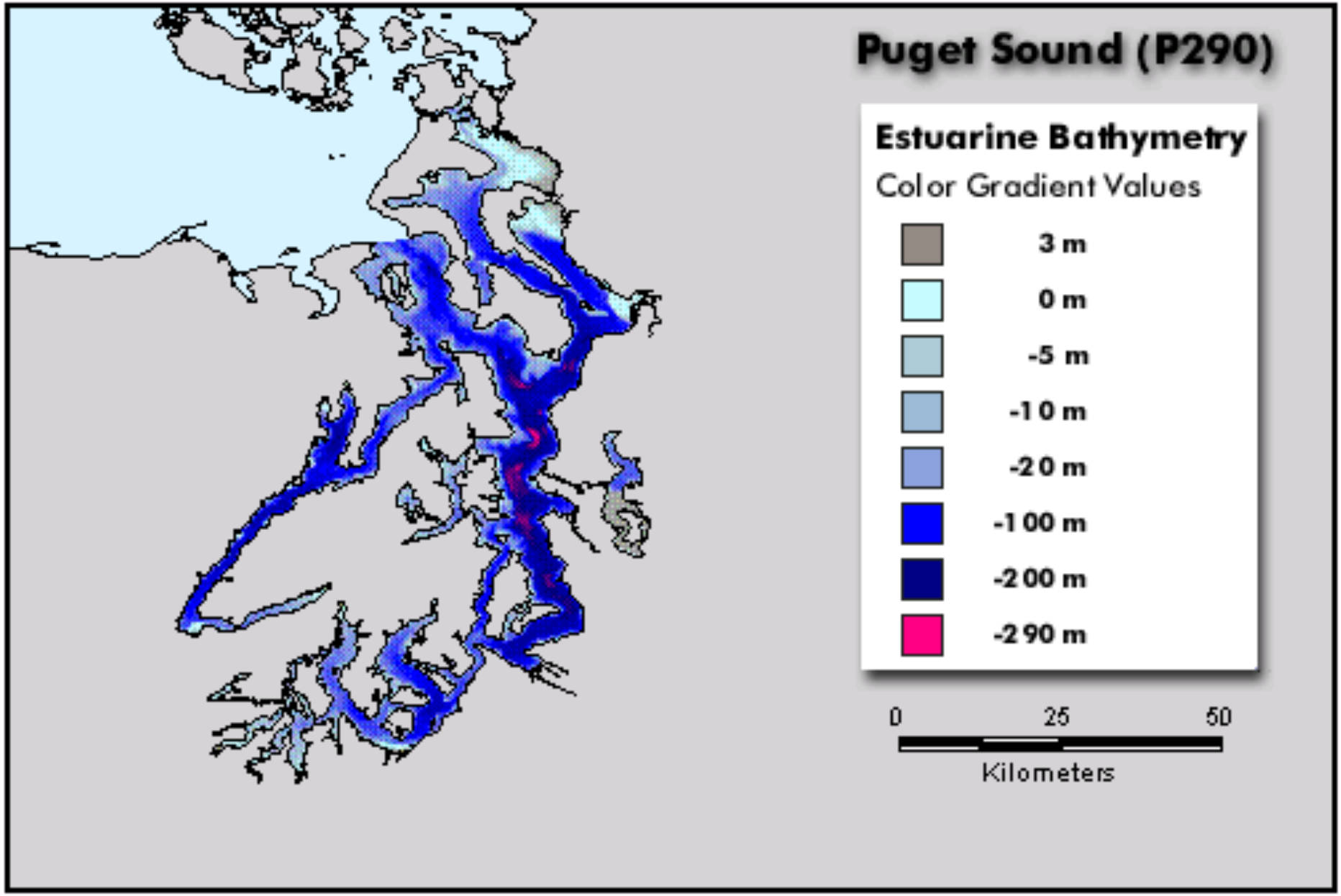
Marine Debris on the beach
Photo Credit: Craig Shuman

The states will identify marine debris baselines, established by assessing data collected by clean-up programs, state and federal agencies, and nonprofit organizations. The states will then identify a target reduction level to achieve by various prevention and coastal clean-up measures, and will partner with and pursue resources from the NOAA Marine Debris Prevention and Removal Program. The states will share lessons learned from existing and emerging state and federal programs and guidelines to pursue safe and effective debris and gear removal. The states will evaluate existing activities such as the annual coastal clean-up day and litter prevention programs and identify ways to effectively expand marine debris reduction efforts.

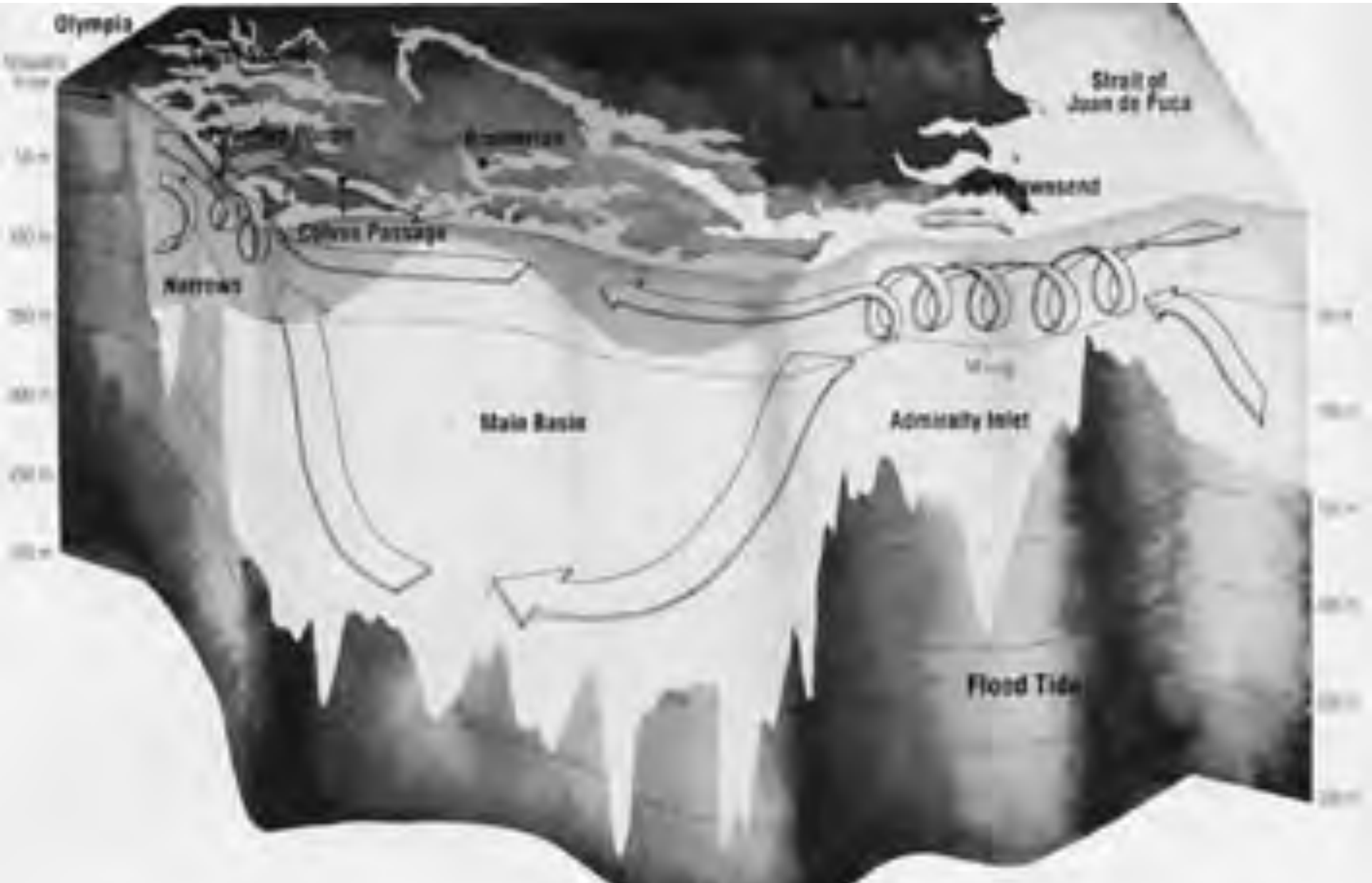
Several recent initiatives across the West Coast have called for a significant reduction in marine debris and the institution of prevention measures. Based on the efforts of existing committees and programs, the states will work together to pursue improvements in public sanitation and maintenance, increased public education and outreach to fishing industries, enforcement of litter laws, and the expansion of recycling programs for plastic materials and fishing line and nets.

Timeframe: Initiated within 18 months of release of the final action plan.

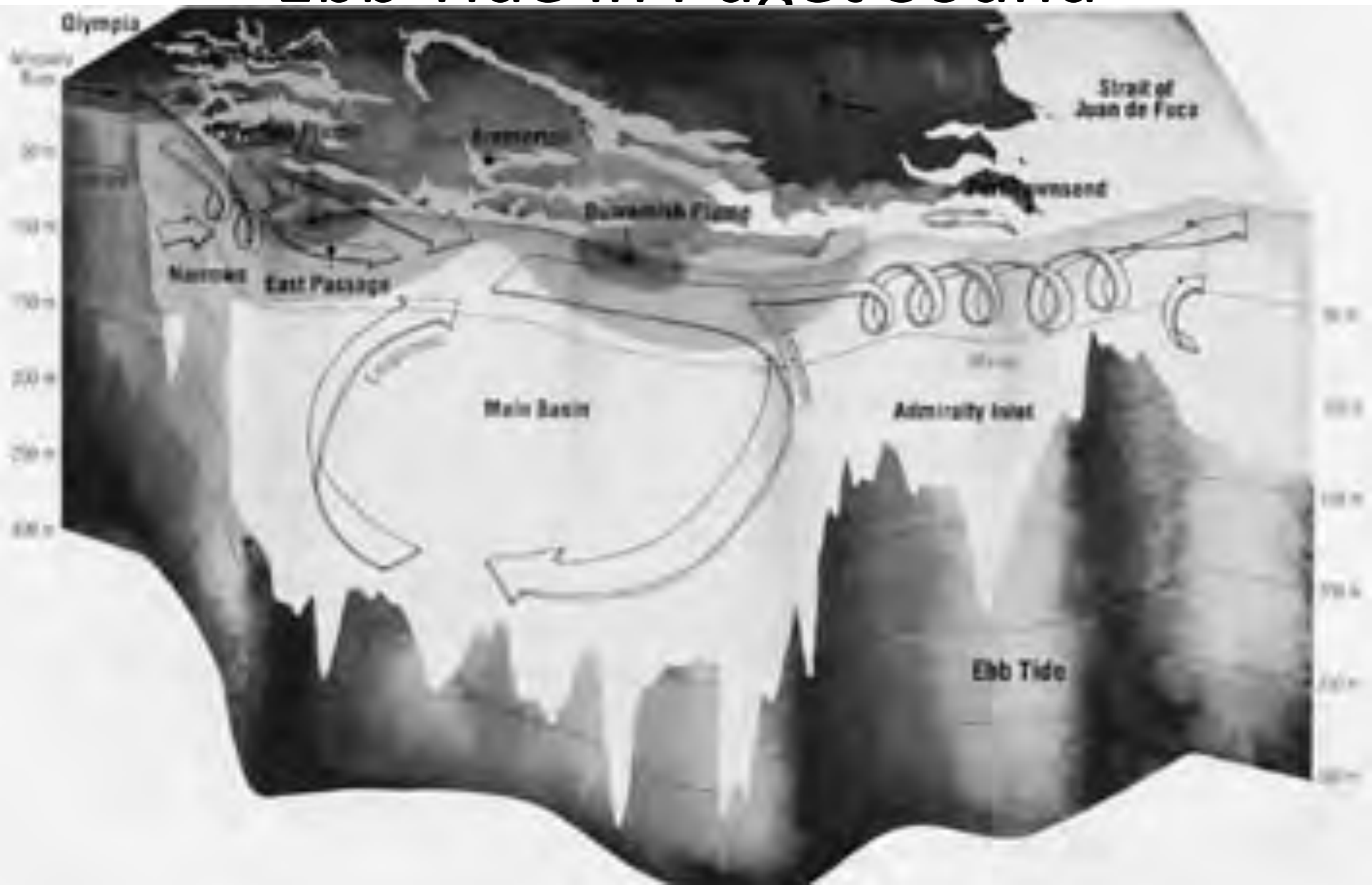
Whale in Puget Sound outside of Seattle


Puget Sound (P290)
Estuarine Bathymetry
Color Gradient Values
3 m
0 m
-5 m
-10 m
-20 m
-100 m
-200 m
-290 m
0
25
50
Kilometers

Flood Tide in Puget Sound



Ebb Tide in Puget Sound



California Seafloor Mapping Reveals Hidden Treasures

“The Ocean Protection Council recognized early on that seafloor habitats and geology were a fundamental data gap in ocean management,” said California’s Secretary for Natural Resources and Ocean Protection Council Chair John Laird. “After an impressive effort by many partners to collect and interpret the data, the maps being produced now are providing pioneering science that’s changing the way we manage our oceans.”

“Our collaboration with the state and more than 15 other partners is critical to the success of this program. We've come together to make the maps, and then to use them. We all like to say that you can't manage it, monitor it, or model it if you don't know what the ‘it’ is, and our seafloor mapping gives that important ‘it’ to the entire coastal management and research community," said the USGS’ lead researcher on this project, Sam Johnson.

Deep sea litter

Depth 992m, 20 km offshore, Mediterranean coast, 3255 feet

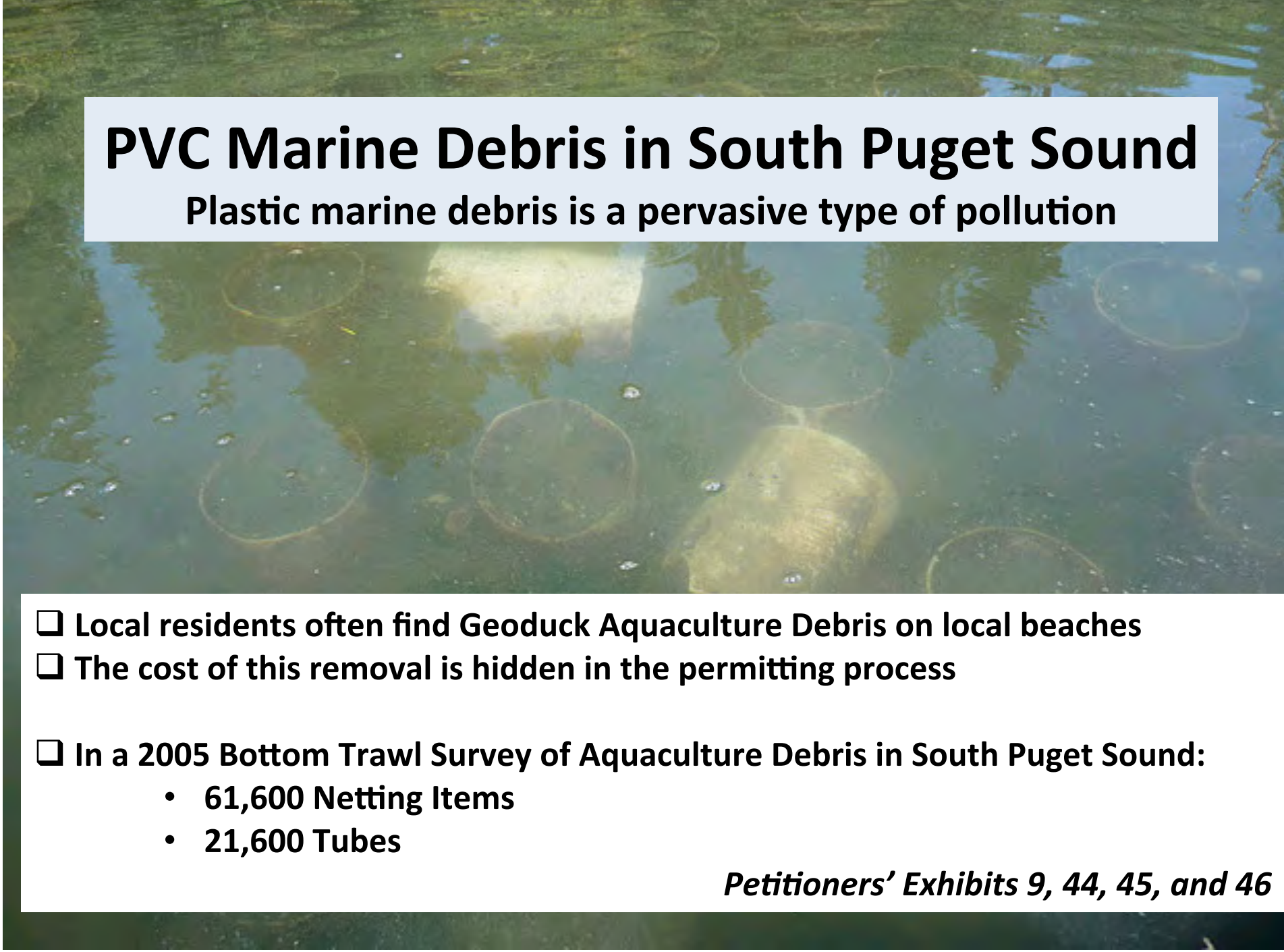
ifremer www.ifremer.fr

Gray Whale in South Puget Sound,
Pierce County/Burley Lagoon, 2013

Gray Whale at risk of ingesting plastic PVC shards from nearby geoduck aquaculture site when sifts thru sediments for food

Derelict PVC tubes scattered on beach

Nets and plastic bands missing from PVC tubes
PVC tubes broken and displaced



PVC Marine Debris in South Puget Sound

Plastic marine debris is a pervasive type of pollution

- ❑ Local residents often find Geoduck Aquaculture Debris on local beaches
- ❑ The cost of this removal is hidden in the permitting process

- ❑ In a 2005 Bottom Trawl Survey of Aquaculture Debris in South Puget Sound:
  - 61,600 Netting Items
  - 21,600 Tubes

Petitioners' Exhibits 9, 44, 45, and 46

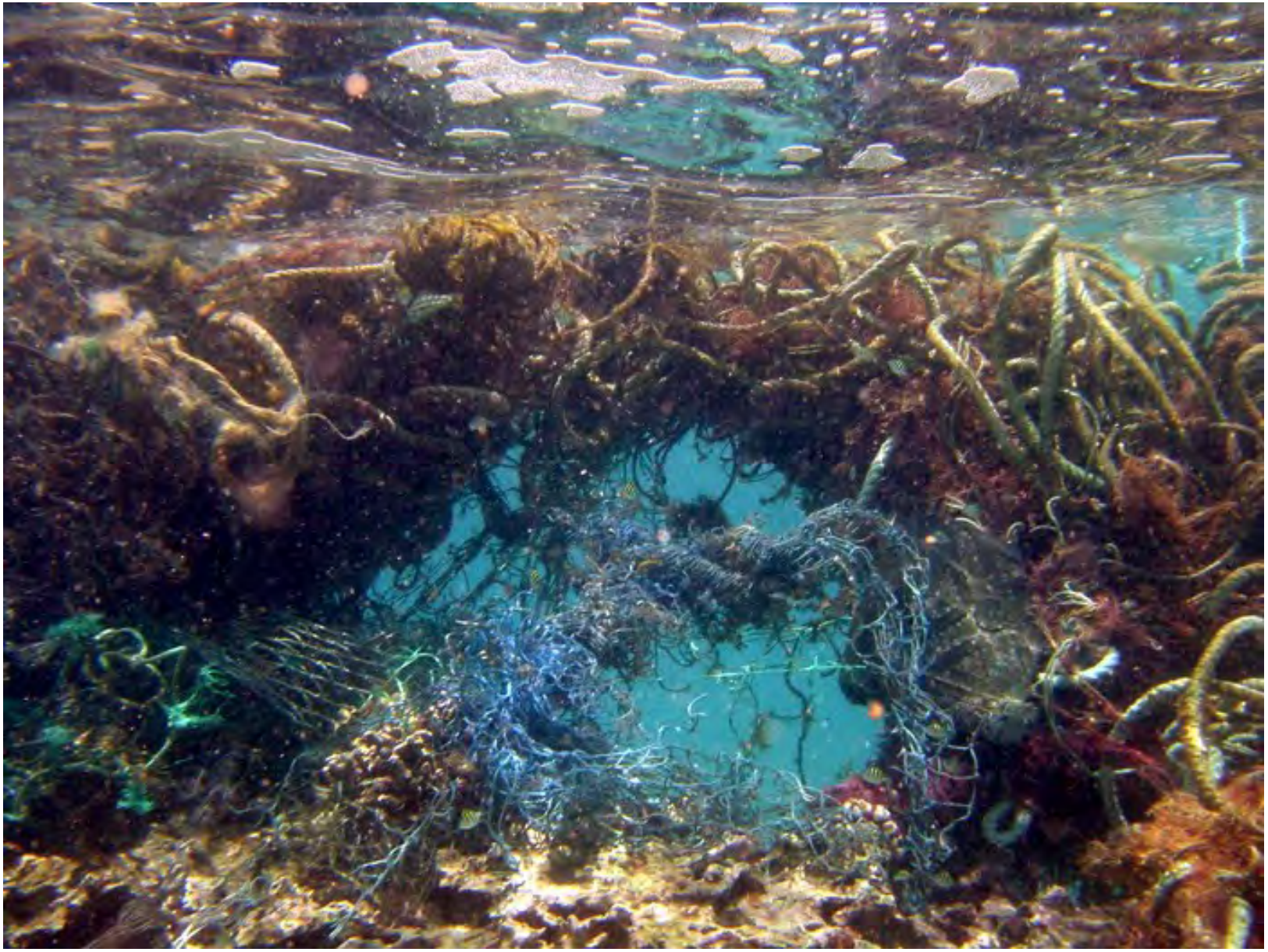
The Center for Biological Diversity

- In August, 2012, The Center petitioned the USEPA to initiate a rulemaking pursuant to the Clean Water Act to address threats posed specifically by plastic pollution.
- Because plastic particles are prevalent….marine animals such as birds, fish and turtles mistake plastic particles for food…Larger plastic debris also entangles and traps marine mammals…Curious seals get plastic straps, rubber bands and rope wrapped around their necks or flippers, which can cut into their flesh and asphyxiate them. Lost fishing nets, traps, and lines made of plastic are a pervasive problem because they haunt the oceans capturing and drowning marine species. Plastic pollution is also known to attract and concentrate toxic chemicals. These chemicals can further accumulate as they pass up the marine food chain.

Stomach Contents of Gray Whale on West Seattle Beach, 2010

- Pair of Sweat Pants
- Golf Ball
- 20 Plastic Bags
- Small Towels
- Duct Tape
- Surgical Gloves

Ropes, Nets and Gear on Seafloor Are Not an Artificial Reef!



Dead Seal-Canada-Clam Aquaculture Predator Net Complaint

Canopy Net Trapped Bird Carcass

Shellfish Aquaculture derelict gear-1/2 mile beach clean up after storm, Haley Park, Case Inlet,

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11

DEPARTMENT OF ECOLOGY State of Washington

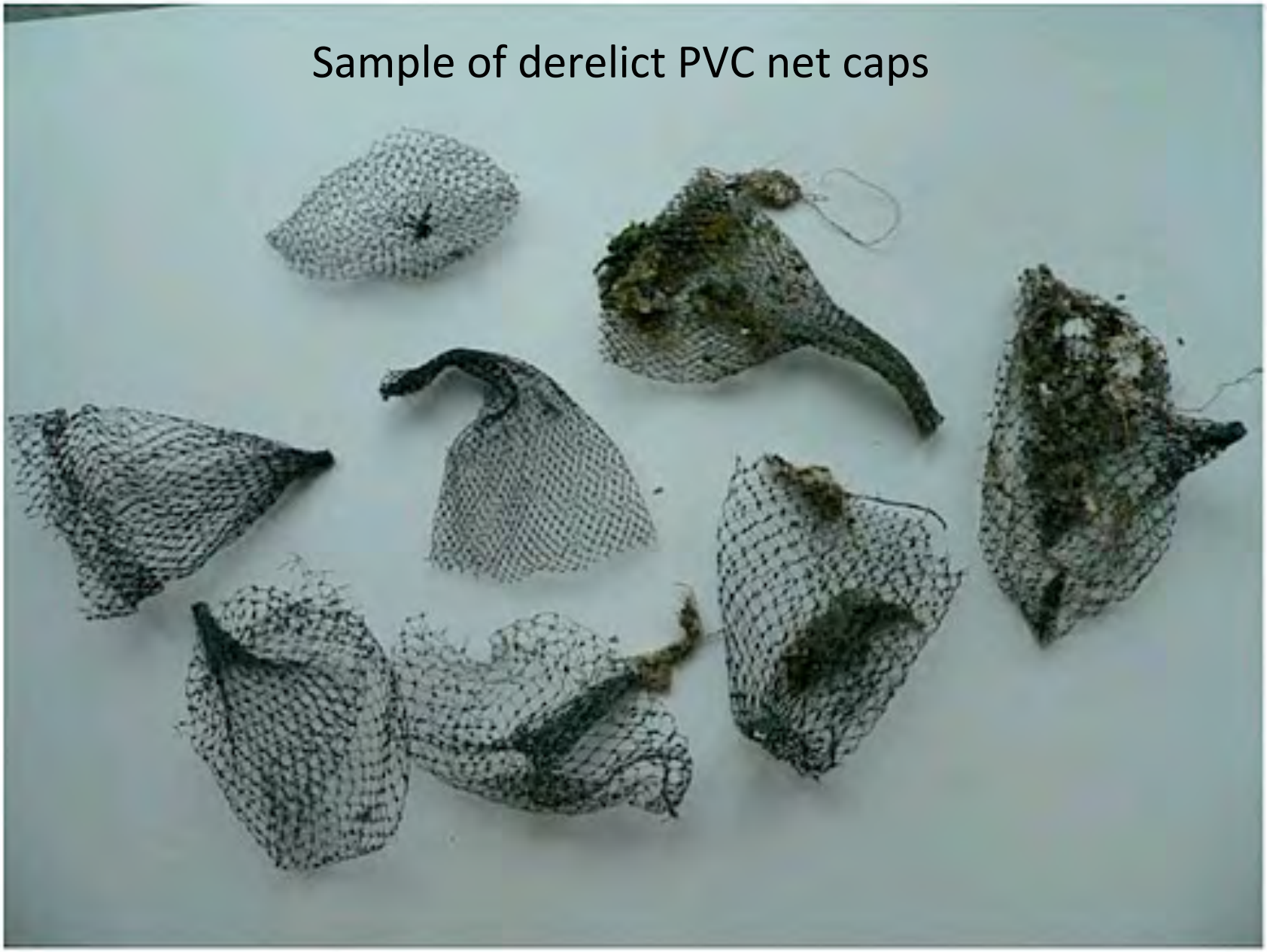
Aerial photography 5-14-2012

Navigate

Field log | Weather | Water column | Aerial photos | Ferry and Satellite | Moorings

Fronts and debris lines between Tacoma Narrows and Colvos Passage. Location: Central Sound, 2:48 PM

Sample of derelict PVC net caps



“Plastic debris ingestion by marine catfish: An unexpected fisheries impact”

Possatto et al., Marine Pollution Bulletin, 2011

23% of 182 estuarine catfish sampled had eaten nylon net pieces from fishery applications

The seasonal and spatial patterns of ingestion of polyfilament nylon fragments by estuarine drums (Sciaenidae)

Dantas et al., Environmental Science Pollution Research, 2012

8% of 569 estuarine drum had eaten blue nylon rope pieces used in fishery applications

Contents lists available at SciVerse ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

The incidence of plastic ingestion by fishes: From the prey's perspective

Henry S. Carson *

Marine Science Department, University of Hawai'i, Hilo, 200 W. Kawili St., Hilo, HI 96720, USA

ARTICLE INFO

Keywords:
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Sharks
Plastic ingestion
Marine debris
Bite marks
Hawai'i

ABSTRACT

One of the primary threats to ocean ecosystems from plastic pollution is ingestion by marine organisms. Well-documented in seabirds, turtles, and marine mammals, ingestion by fish and sharks has received less attention until recently. We suggest that fishes of a variety of sizes attack drifting plastic with high frequency, as evidenced by the apparent bite marks commonly left behind. We examined 5518 plastic items from random plots on Kamilo Point, Hawai'i Island, and found 15.8% to have obvious signs of attack. Extrapolated to the entire amount of debris removed from the 15 km area, over 1.3 tons of plastic is attacked each year. Items with a bottle shape, or those blue or yellow in color, were attacked with a higher frequency. The triangular edges or punctures left by teeth ranged from 1 to 20 mm in width suggesting a variety of species attack plastic items. More research is needed to document the specific fishes and rates of plastic ingestion.

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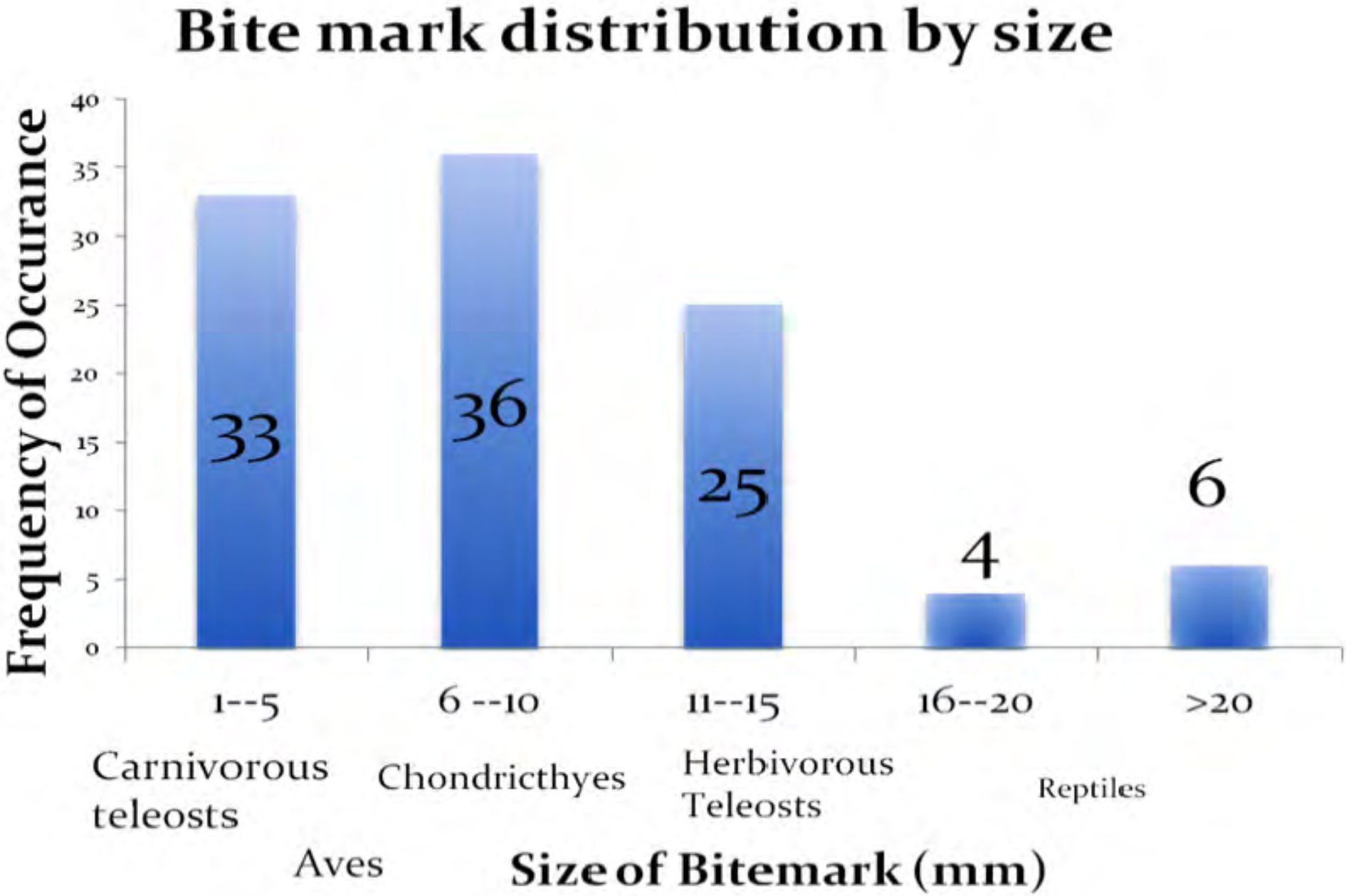
WHO IS EATING
PLASTIC DEBRIS?

Who is biting it?
Parrotfish

Albatross

STUDY BY HANK CARSON OF KAMILO BEACH DEBRIS



Final Environmental Impact Statement Drakes Bay Oyster Company Special Use Permit, November, 2012

p. 403 “Offshore structures are subject to deterioration and damage by weather events which may result in dispersal of items such as Styrofoam floats, treated lumber displaced from racks, and PVC piping and separators.”

p. 404 ….”direct adverse impact to central California steelhead could result from the presence of small fragments of synthetic debris in Drakes Estero. This could occur through the ingestion of debris by steelhead, which could inhibit their digestion and remain in the stomach for long periods of time. This could affect the steelhead through a reduction in appetite, injury to the stomach, or by provision of a potential source of toxic material (Laist 1987). These effects from mariculture debris could adversely impact central California steelhead by decreasing energy or health that may make the fish more susceptible to predation disease, and reduced breeding success (Laist 1987).

POLYVINYL CHLORIDE (PVC) AND CHLORINATED PVC (CPVC) WHETHER USED FOR POTABLE WATER OR SEWAGE:

1. Has no after market. Used PVC is not recycled.
2. Releases Dioxins when burned at trash to energy plants.
3. Releases toxic smoke during accidental fires in buildings or at landfills containing PVC.

PVC Tube Shard Pollution on Beach

Broken, worn PVC polluting the nearshore

Broken PVC polluting the nearshore

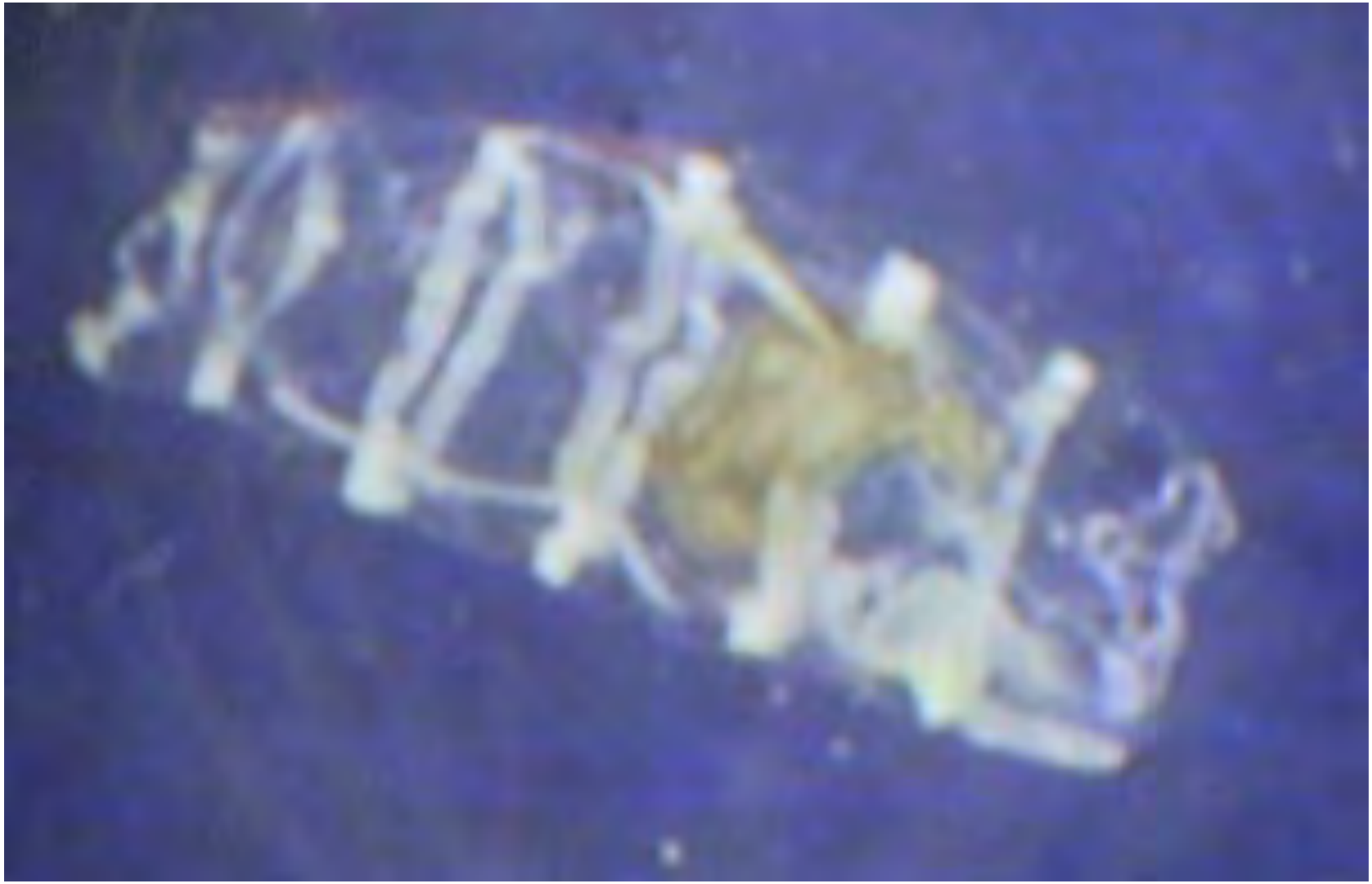
”THE ROLE OF THE INFINITELY SMALL IS INFINITELY LARGE”

LOUIS PASTEUR

FOUNDER OF THE SCIENCE OF MICROBIOLOGY AND CREATOR OF VACCINES TO PREVENT DISEASES CAUSED BY GERMS

Three Salps--Two appear to have ingested Styrofoam

Ingested plastic particle appears to be near maximum possible size



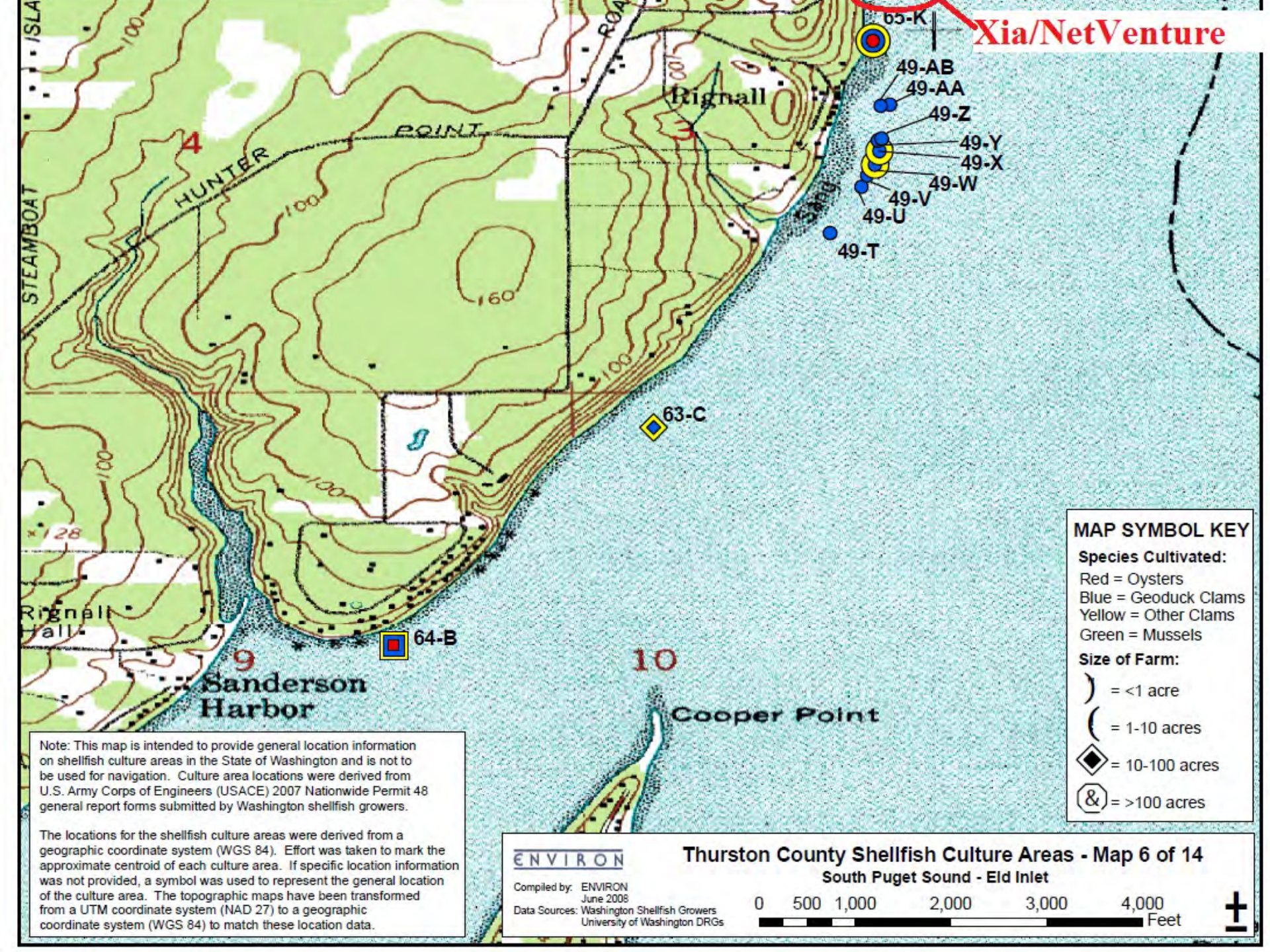
Experimental Techniques (eg. plastic drink cups) should be vetted before implementation

THIN WALLED POLYSTYRENE DRINK CUPS CRACK EASILY ARE NOT SUITABLE FOR AQUACULTURE APPLICATIONS

Derelict PVC
06/22/2013

Derelict PVC
06/22/2013

Otter Entangled in Tube Net Cover Retaining Rubber Band


Xia/NetVenture
65-K
49-AB
49-AA
49-Z
49-Y
49-X
49-W
49-V
49-U
49-T
63-C
64-B
Rignall
HUNTER POINT
STEAMBOAT
Sanderson Harbor
Cooper Point
MAP SYMBOL KEY
Species Cultivated:
Red = Oysters
Blue = Geoduck Clams
Yellow = Other Clams
Green = Mussels
Size of Farm:
= <1 acre
= 1-10 acres
= 10-100 acres
= >100 acres
Note: This map is intended to provide general location information on shellfish culture areas in the State of Washington and is not to be used for navigation. Culture area locations were derived from U.S. Army Corps of Engineers (USACE) 2007 Nationwide Permit 48 general report forms submitted by Washington shellfish growers.
The locations for the shellfish culture areas were derived from a geographic coordinate system (WGS 84). Effort was taken to mark the approximate centroid of each culture area. If specific location information was not provided, a symbol was used to represent the general location of the culture area. The topographic maps have been transformed from a UTM coordinate system (NAD 27) to a geographic coordinate system (WGS 84) to match these location data.
ENVIRON
Compiled by: ENVIRON
June 2008
Data Sources: Washington Shellfish Growers
University of Washington DRGs
Thurston County Shellfish Culture Areas - Map 6 of 14
South Puget Sound - Eld Inlet
0 500 1,000 2,000 3,000 4,000
Feet

Monitoring of Aquaculture Debris is Anecdotal and Incomplete in Puget Sound

Only volunteer beach cleanups have been used to assess the amount of aquaculture debris in the marine environment of the Sound.

Per Letter in evidence from Margaret Pilaro Barrette dated 3-16-2011: Of 61 thousand items collected from over 1000 miles of beach from 2004 to 2010, 17% was shellfish aquaculture related.

A 2011 beach cleanup produced a newspaper article which had no reportable data. “Dale Hall, a Hammersley Inlet shellfish grower and “captain” of the Manke Lumber boat, estimated his load from beaches in his inlet was about 75 percent debris that had nothing to do with growing oysters, clams and geoducks. Read more here: http://www.bellinghamherald.com/2011/03/18/1922477/south-sounds-cleaning-crew.html#storylink=cpy”

COMPREHENSIVE AND MEANINGFULL MONITORING WILL REQUIRE EPIBENTHIC SAMPLING

Southern California Coastal Water Research Project

Seafloor debris was surveyed in July-August 1994, where 113 trawl stations on the mainland shelf of the SCB were sampled at depths of 10 to 200 m. Trawl sites were selected using a stratified random design, with strata defined by three subpopulation categories: depth — inner shelf (10-25 m), middle shelf (26-100 m), and outer shelf (101-200 m); location — northern region (Point Conception to Point Dume), central region (Point Dume to Dana Point), and southern region (Dana Point to the United States-Mexico international border); and proximity to POTW monitoring areas.

Trawl sampling was conducted using standardized methods described in the field operations manual prepared by the Southern California Bight Pilot Project. Trawl samples were collected with 7.6-m head-rope and 8.8-m foot-rope semiballoon otter trawls with a 1.25-cm cod-end mesh. Otter boards were 76.2 cm wide and 40.8 cm tall, and bridles were 22.9m long. Deviations within 10% of these dimensions were acceptable. Trawls were towed along isobaths for 10 min at 0.8-1.2 m/sec (1.5-2.4 kn).

Debris Workplan
February 15, 2013

Prepared by:
Bight''13 Debris Committee
Prepared for:
Commission of Southern California Coastal Water Research Project
3535 Harbor Blvd, Suite 110

Costa Mesa, CA 92626

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THE PERMIT DOES NOT ADDRESS ADEQUATELY THE IMPACTS I HAVE NOTED AND NO BASELINE IS AVAILABLE TO DETERMINE CURRENT LEVELS OF AQUACULTURE DEBRIS IN THE SUBJECT INLETS OR SOUTH SOUND AQUACULTURE SITES. THE MITIGATION OF BEACH CLEANUPS IS ONLY A VERY PARTIAL SOLUTION TO THE IMPACT PROBLEM. FOR THESE REASONS THE PERMIT IN QUESTION SHOULD BE INVALIDATED.

How BIG is your plastic footprint?

Algalita Marine Research Foundation
Graphic by Raybird Design Copyright 2010

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29	Georgia Strait Alliance. 2013. Artificial Reefs and Fish Habitat; What the experts say
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Captain Charles James Moore PhD

Curriculum Vitae

Professional Experience

Titles: Founder, Algalita Marine Research Institute
Captain, ORV *Alguita*
Research Coordinator, Algalita Marine Research Institute
Doctor of Laws, Honoris Causa, Thompson Rivers University

In this capacity, Captain Moore:

- Led the first expedition to the North Pacific Central Gyre for the purpose of sampling zooplankton and measuring the relative abundance of plastic particles, 1999. Groundbreaking study published in Marine Pollution Bulletin 42-12 found 6 times more plastic than zooplankton by weight;
- led a major voter approved (CA Prop 13) non-point source study in cooperation with the Coastal Commission and the California State Water Board to assess and reduce sources of plastic and trash in urban and coastal waters, 2004-2006. Concluded with the first international conference on plastic water pollution, *Plastic Debris, Rivers to* Sea;
- conducted first study to measure the amount of plastic delivered from an urban watershed to the ocean via two major urban rivers as part of the Prop 13 study, published in Integrated Coastal Zone Management;
- conducted research, using samples collected on AMRF trips to the North Pacific Central Gyre, to assess the degree to which marine plastic debris sorbs toxic chemicals, in cooperation with the Department of Chemistry, University of the Pacific. Published results in Marine Pollution Bulletin 54;
- completed his tenth research voyage, in 2009, to the North Pacific Central Gyre to collect zooplankton samples at the surface and at 10 30 and 100 meters depths to test for the presence of plastic;
- conducted the first coastal study comparing the ratio of plastic fragments to zooplankton off the San Gabriel River before and after a rain event, published in MPB 44;
- conducted the first study to determine the quantity of plastic fragments below the surface at 10 and 30 meters depths off Ballona Creek, CA, published in MPB 49;
- helped AMRI begin a kelp restoration pilot project along the Long Beach, California breakwater, using laboratory-grown giant kelp;
- funded and with Mexican scientists aboard *ORV Alguita,* conducted the first multidisciplinary study comparing Ojo de Liebre and San Ignacio Lagoons, Baja California, Mexico, calving grounds of the eastern Pacific gray whale;
- finished phases one and two, with Mexican scientists aboard *ORV*

Alguita, of a three-phase multidisciplinary study documenting the changes in a pristine coastal environment of Baja California, Mexico caused by the building of a marina at Santa Rosaliita. Phase three, which was to monitor the marina after completion and use by vessels has begun has not been completed due to silting up of the marina and failure of the project.

- Worked on the international level to expand monitoring of the coastal ocean through helping to volunteer programs from Australia to Mexico, including the archipelagos of Fiji, Hawaii, and American Samoa.

Additional Professional Activities:

- Lectures worldwide from Japan to Germany, and Canada to Mexico, where he speaks to groups of all kinds, University audiences, plastic industry and recycler meetings, environmental groups, civic organizations, and students about the problem of plastic pollution in the world's oceans;
- Serves as an expert witness in appeals of permits for mariculture and aquaculture farming operations using polluting plastic materials
- Serves as Secretary of the Will J. Reid Foundation, a private charitable foundation that funded the first post doctoral position in marine debris research at the University of Hawaii, Hilo.
- Represents AMRI and speaks at conferences, symposiums, seminars, and government meetings, including UNEP, the IMO and the European Commission;
- Writes for, appears on, and sometimes stars in a wide variety of media formats, including high profile TV and movie shows, representing AMRF, and presenting diverse audiences with information about marine plastic pollution.

Professional Memberships

- American Cetacean Society
- The Explorer's Club
- The Long Beach Power Squadron
- Southern California Academy of Sciences

Awards Received

- Carson BP Environmental Leadership Award 2003
- Orange County Coastkeepers Award for Coastal Protection 2003
- Los Angeles Regional Water Quality Control Board's Water Quality Award for Water Quality Research 2003
- John Olguin Marine Environment Award 2005
- Amigos de los Rios Science Award 2005
- USEPA District 9 Environmental Award 2008
- Smith-Weiss Environmental Champion Award 2009
- Rick Best Environmental Advocacy Award 2011
- Wyland Icon Award 2012
- John Kelly Environmental Lifetime Achievement Award 2012

Publications

C.J. Moore, S.L. Moore, M.K. Leecaster, S.B. Weisberg. A comparison of plastic and plankton in the North Pacific Central Gyre. London. Marine Pollution Bulletin 42, No. 12 (2001) 1297-1300

C.J. Moore, S.L. Moore, S.B. Weisberg, G.L. Lattin, A.F. Zellers. A comparison of Neustonic plastic and zooplankton abundance in southern Califoria's coastal waters. London. Marine Pollution Bulletin 44 (2002) 1035-1038

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Charles James Moore, Synthetic polymers in the marine environment: A rapidly increasing, long-term threat. Environmental Research 108 (2008) 131-139.

C.J. Moore, R.C. Thompson, E.S. vom Saal and S.H. Swan (editors). Plastics, the environment and human health. London, Philosophical Transactions of the Royal Society B (2009) 1969-2166.

C.J. Moore, G.L. Lattin, A.F. Zellers, Quantity and type of plastic debris flowing from two urban rivers to coastal waters and beaches of southern California. Brazil, Integrated Coastal Zone Management (2010).

C.J. Moore, C.M. Boerger, G.L. Lattin, S.L. Moore. Plastic ingestion by planktivorous fishes in the north Pacific central gyre. Marine Pollution Bulletin (2010).

Plastic Ocean, Charles Moore with Cassandra Phillips. Penguin Group, 2011. ISBN 978-1-158333-424-9

Education

Graduated 4.0 with honors, Wilson High School, Long Beach, CA 1965

UC San Diego, major in Chemistry 1965-1968

Doctor of Laws, Honoris Causa, Thompson Rivers University 2012