Bivalve Aquaculture Associated Plastic Pollution in South Puget Sound

Haley/Taylor Shellfish/Seattle Shellfish Geoduck Proposal
Shoreline Hearings Board, March 3, 2015

ALGALITA

Marine Research & Education

INSPIRING SOLUTIONS TO PLASTIC POLLUTION

Captain Charles Moore, PhD (hon)

Haley/Taylor Shellfish/Seattle Shellfish Specific Site Information

(Taken from Pierce County Hearings Examiner Decision)

Proposed farm will be 11 acres and located in the intertidal zone between tidal elevations -4.5 to +2, as measured at mean lower low water (MLLW). I have visited this site which is located on the west shoreline of the Key Peninsula and east shoreline of Case Inlet, approximately 3/4 miles south of Dutcher's Cove.

Plastic Gear: Proposed farm will use solid plastic PVC tubes and/or mesh nursery tubes. The solid plastic tubes will be planted 1 foot intervals, when fully planted, approximately 480,000 tubes. A small net is placed over each solid plastic tube or a larger net is placed over multiple tubes. The small nets are secured with bands and the larger nets are secured with metal rebar pins. For mesh nursery tubes, netting is not necessary. The larger nets also help prevent the escape of dislodged plastic tubes. Nursery tubes are removed 1-2 years after planting and the canopy nets are removed up to 2 1/2 years later.

Rotational planting: Year 1-solid plastic tubes/canopy nets in Northwest quarter of farm as well as solid plastic tubes/ individual net caps in the Southeast quarter of the farm. Year 2-solid plastic tubes/canopy nets and/or flexible mesh tubes in the Northeast quarter of the farm and plastic tubes/individual net caps in the Southwest quarter of the farm.

PVC TUBES

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.

Polyethylene Canopy Nets and PVC Tubes

Canopy Nets Held With Rebar

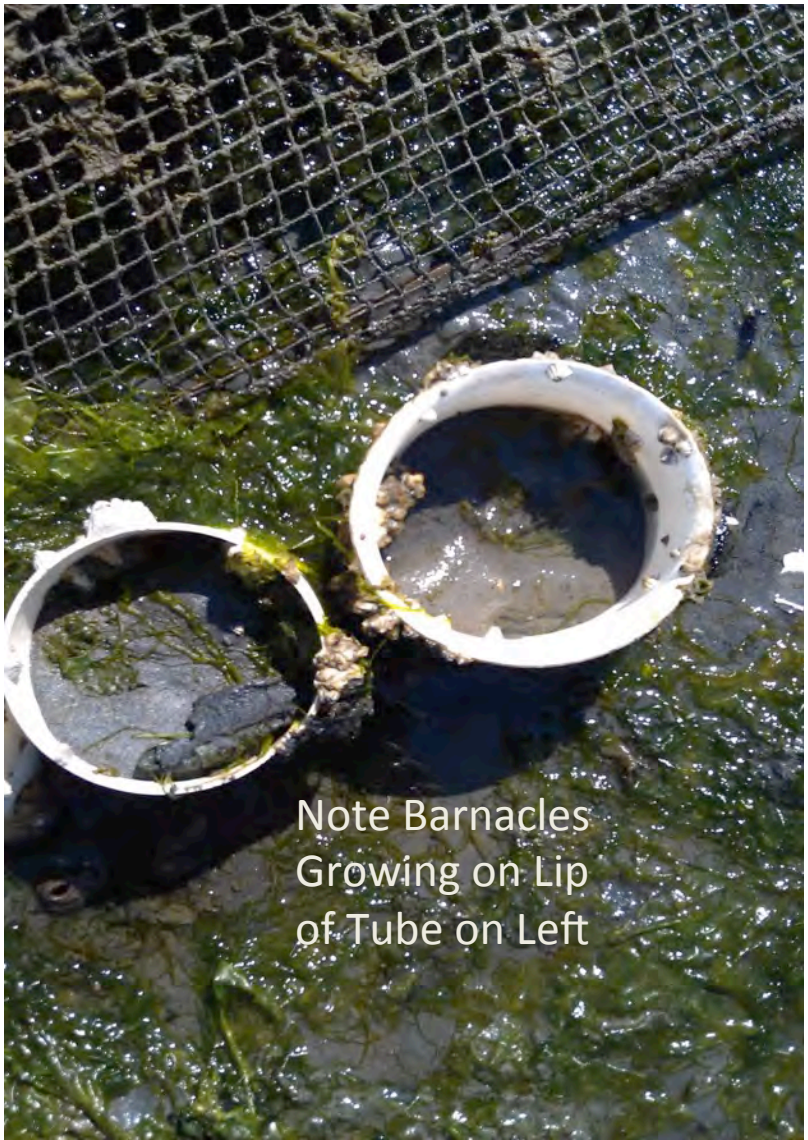
C. Moore
Photo 8-10-13

Approx. 1 Meter Spacing for Rebar

Some PVC Tubes Left Uncovered

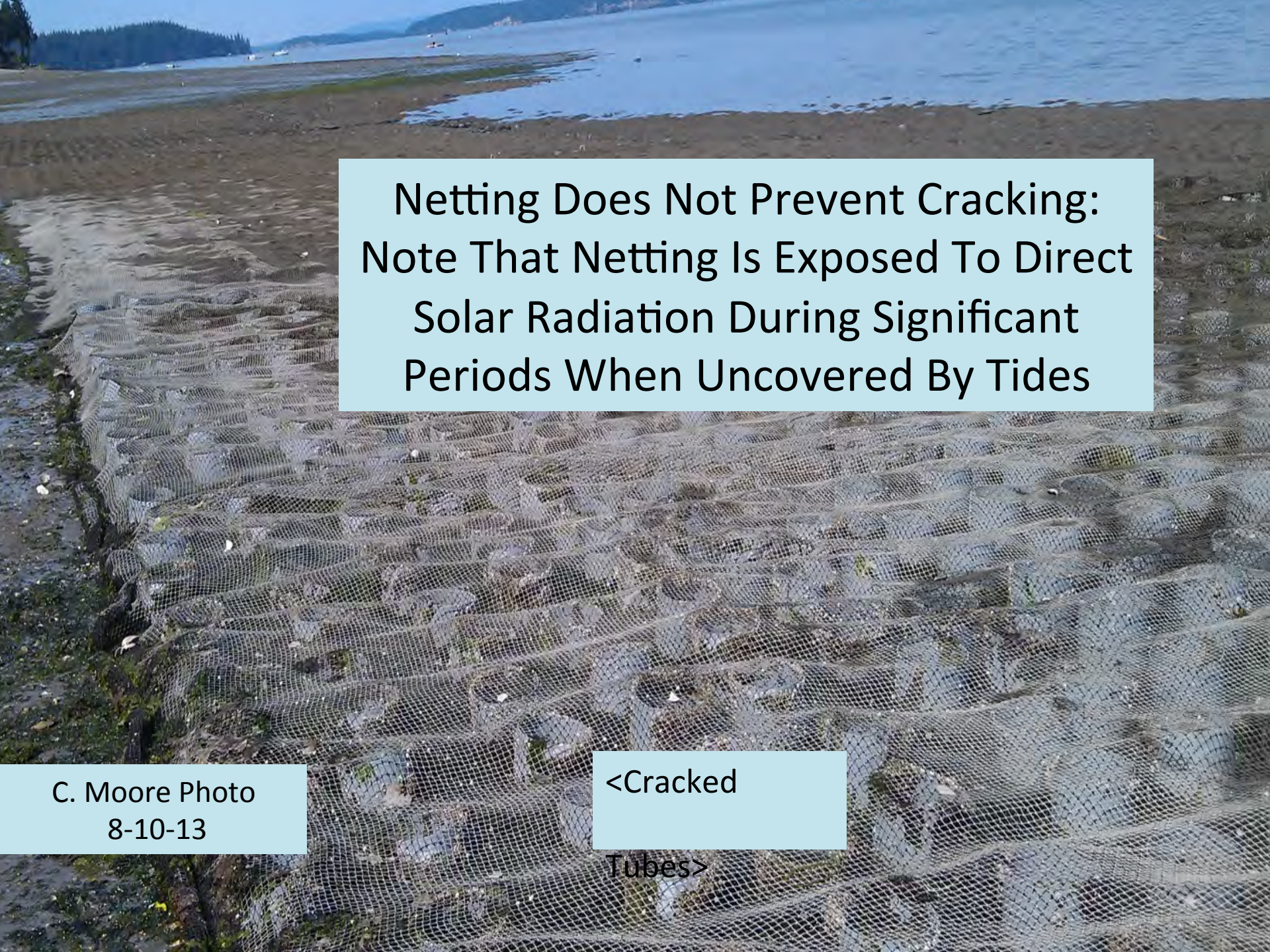
C. Moore
Photo
8-10-13

These Two Tubes of Particular Interest



C. Moore Photo
8-10-13

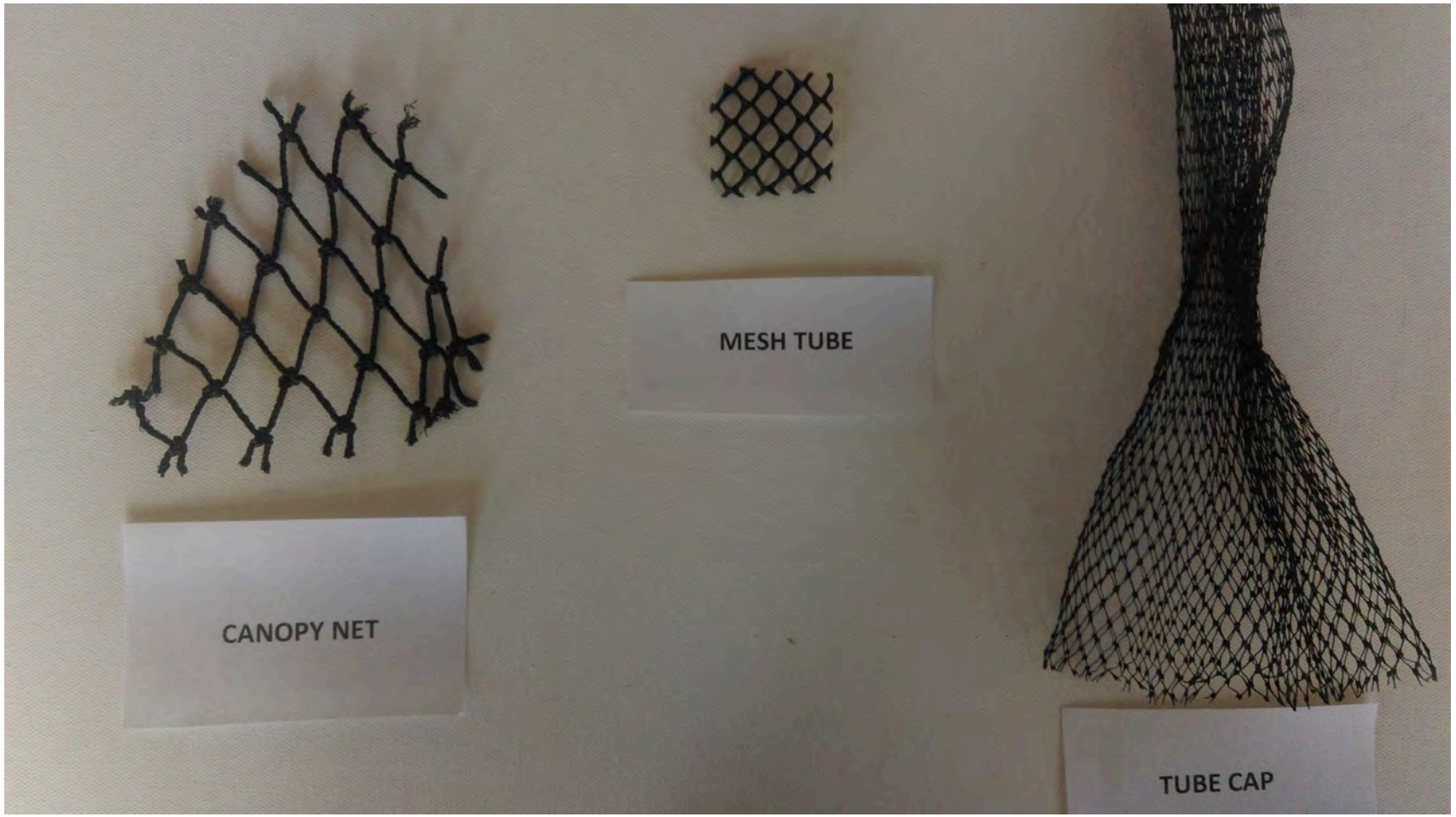
Removal of Barnacles Revealed Fragmenting Plastic Slivers


Netting Does Not Prevent Cracking: Note That Netting Is Exposed To Direct Solar Radiation During Significant Periods When Uncovered By Tides
C. Moore Photo 8-10-13
<Cracked
Tubes>

PVC Tube With Barnacles Was Also Cracked

C. Moore
Photo 8-10-13

Examples of High Density Polyethylene (HDPE #2) Geoduck Materials Used



Andrady Polymer Field Test Results

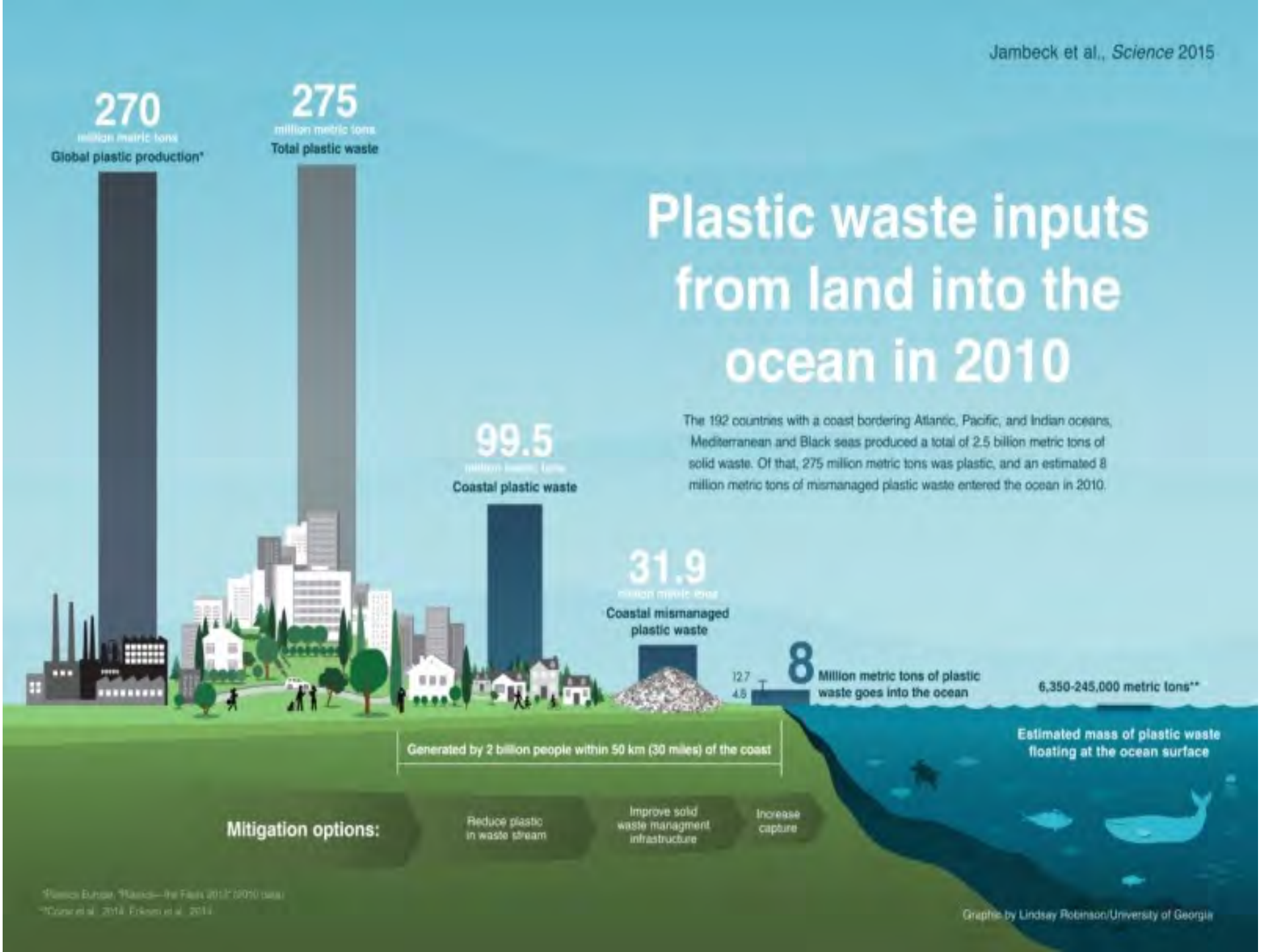
Taylor Shellfish Farms Geoduck Materials						
Chain of Custody Item Number	Description	Test Date	Time	Andrady Polymer Test (Polymer Type)		
1	Mesh Net 25' x 50'	2/2/2015	15:10	HDPE		
2	Mesh Geoduck Tube	2/2/2015	15:13	HDPE		
3	TSF Zip tie	2/2/2015	15:14	HDPE		
4	Blue Rubber Band	2/2/2015		Not Tested		
5	Black Band	2/2/2015		Not Tested		
6	Tube Cap	2/2/2015	15:18	HDPE		
7	Pre Geoduck Tube	2/2/2015	15:22	PVC		
Testor	Gwen Lattin		Witness	Charles Moore		
Date	2/2/2015		Date	2/2/2015		
Time	15:25		Time	15:25		

Floats or Sinks?

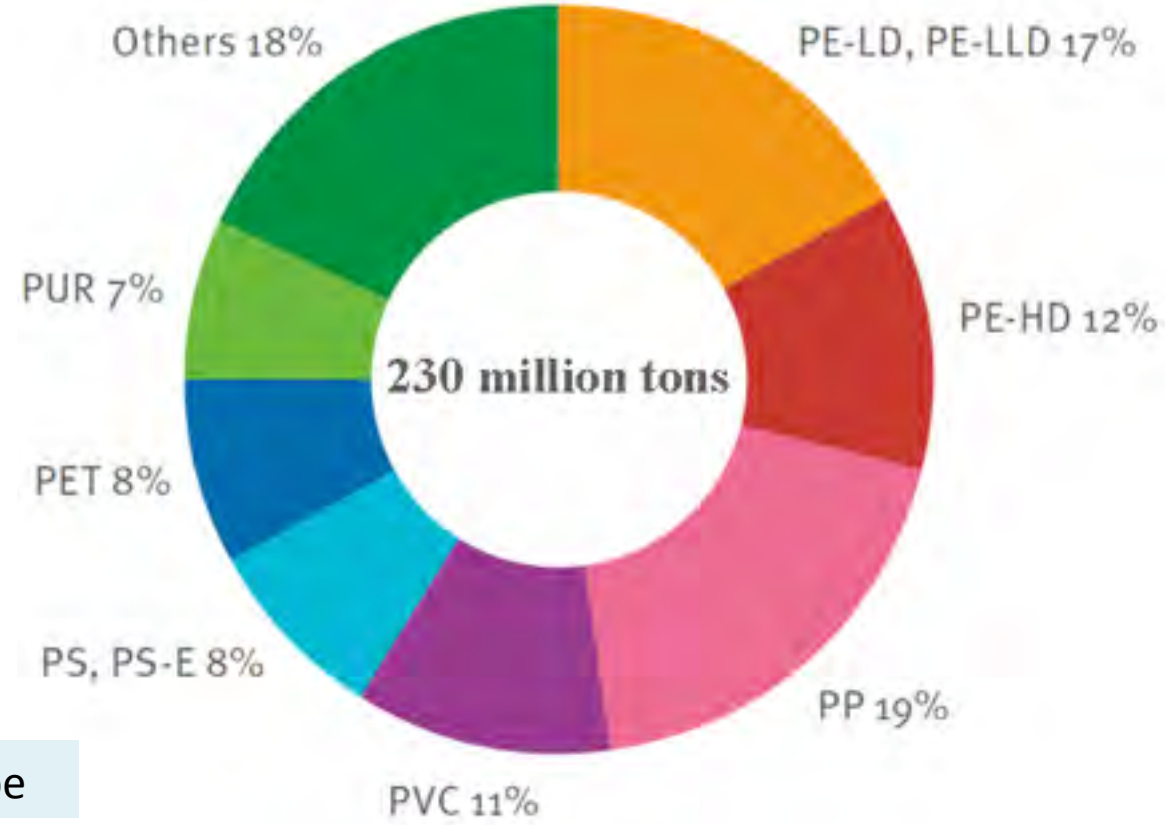
Plastic Density Chart

Density of: Sea water 1.02-1.03g/ml, Fresh water <1.015g/ml

			Polymer Density grams/cubic cm.	
1 PETE	**Thermoplastic polyester – polybutylene terephthalate (PET and PBT)** Fizzy drink bottles and oven-ready meal trays.		(PET) 1.29-1.40 (PBT) 1.30-1.38	SINKS
2 HDPE	**High-density polyethylene (HDPE)** Bottles for milk and washing-up liquids.		0.94-0.96	FLOATS
3 V	**Polyvinylchloride (PVC)** Food trays, cling film, bottles for squash, mineral water and shampoo.		1.30-1.58	SINKS
4 LDPE	**Low-density polyethylene (LDPE)** Grocery bags and bin liners.		0.89-0.94	FLOATS
5 PP	**Polypropylene (PP)** Margarine tubs, microwaveable meal trays.		0.89-0.91	FLOATS
6 PS	**Polystyrene (PS)** Yoghurt cups, foam meat or fish trays, egg cartons, vending cups, plastic cutlery, and packing material.		1.04-1.08	SINKS
7 OTHER	**Polycarbonate** CDs and DVDs, tail lights on cars, hard plastic canteens.		1.2	SINKS


Jambeck et al., Science 2015
270
million metric tons
Global plastic production*
275
million metric tons
Total plastic waste
Plastic waste inputs from land into the ocean in 2010
The 192 countries with a coast bordering Atlantic, Pacific, and Indian oceans, Mediterranean and Black seas produced a total of 2.5 billion metric tons of solid waste. Of that, 275 million metric tons was plastic, and an estimated 8 million metric tons of mismanaged plastic waste entered the ocean in 2010.
99.5
Coastal plastic waste
31.9
Coastal mismanaged plastic waste
12.7
4.8
8
Million metric tons of plastic waste goes into the ocean
6,350-245,000 metric tons**
Estimated mass of plastic waste floating at the ocean surface
Generated by 2 billion people within 50 km (30 miles) of the coast
Mitigation options:
Reduce plastic in waste stream
Improve solid waste managment infrastructure
Increase capture
*Plastics Europe, "Plastics—the Facts 2013" (2010 data)
**Cózar et al., 2014; Eriksen et al., 2014
Graphic by Lindsay Robinson/University of Georgia

Plastic Production Total 2010

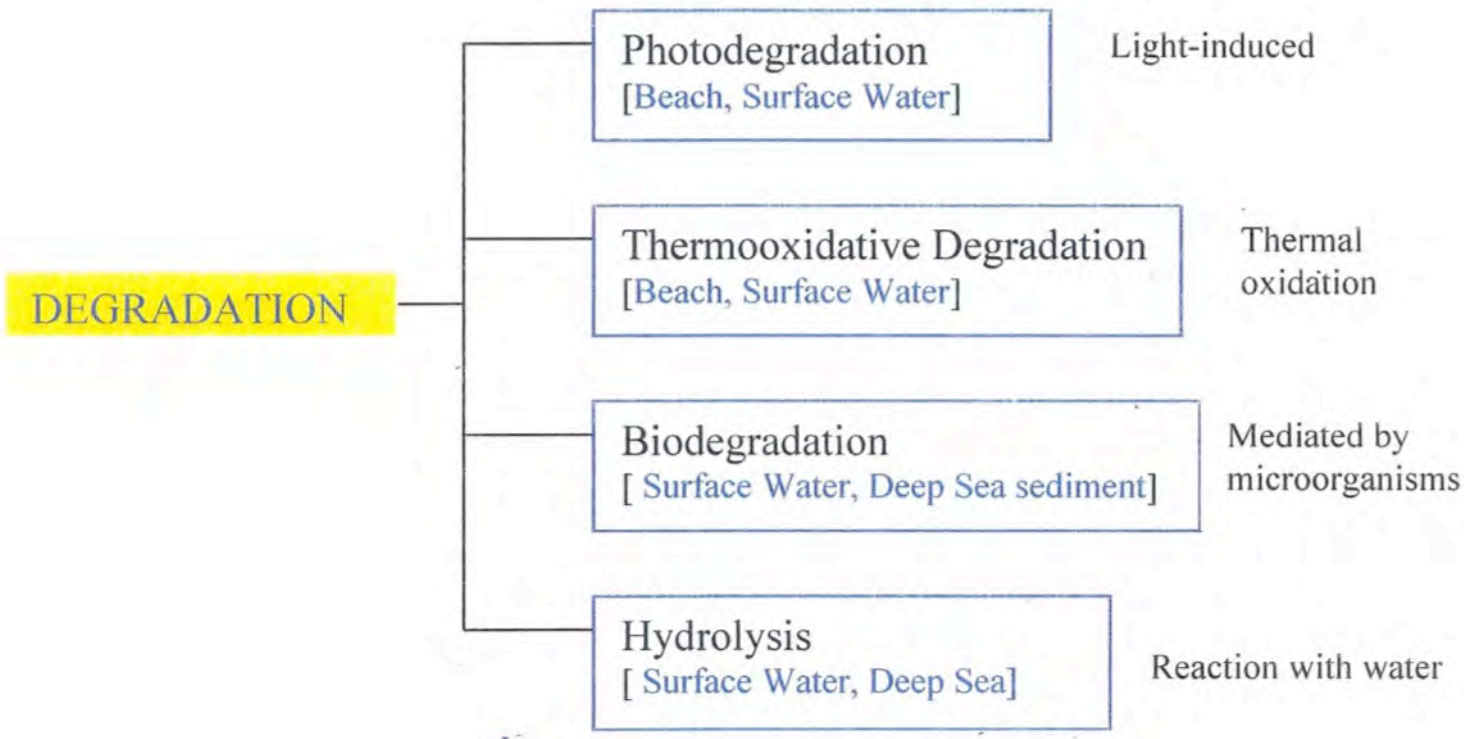


Plastics Europe

Degradation of Polyolefins

- Andrady et. al. compared the loss of mechanical integrity of the thermoplastic materials (Andrady and Pegram 1990; Andrady, et al. 1993); (Andrady and Pegram 1989) particularly polyethylene, polypropylene and polystyrene weathered floating in surface water in Biscayne Bay, FL and Puget Sound, WA with adjacent air exposures. In these studies the tensile properties of plastic materials were used to quantify the extent of degradation process. The findings agreed that in general the plastic material exposed in surface sea water showed marginal or no reduction in its extensibility even after 12-month of exposure. Exposure at the same location on land, however, resulted in severe loss in mechanical integrity over a 6 month period of exposure. This was true of polyolefin trawl webbing, polyethylene, strapping tape, and latex rubber materials studied.
- Weatherabiltiy of Plastics in the Ocean Environment—Andrady 2009
- Note That Geoduck Aquaculture Gear Experiences Both Surface Water And Land Characteristics Depending On Tide And Daylight

PLASTIC DEGRADATION TYPES



The Preceeding Figure Does Not Mention Mechanical Degradation As Seen Above, Which Concerns Us In The Case Of Geoduck Aquaculture Caused By:

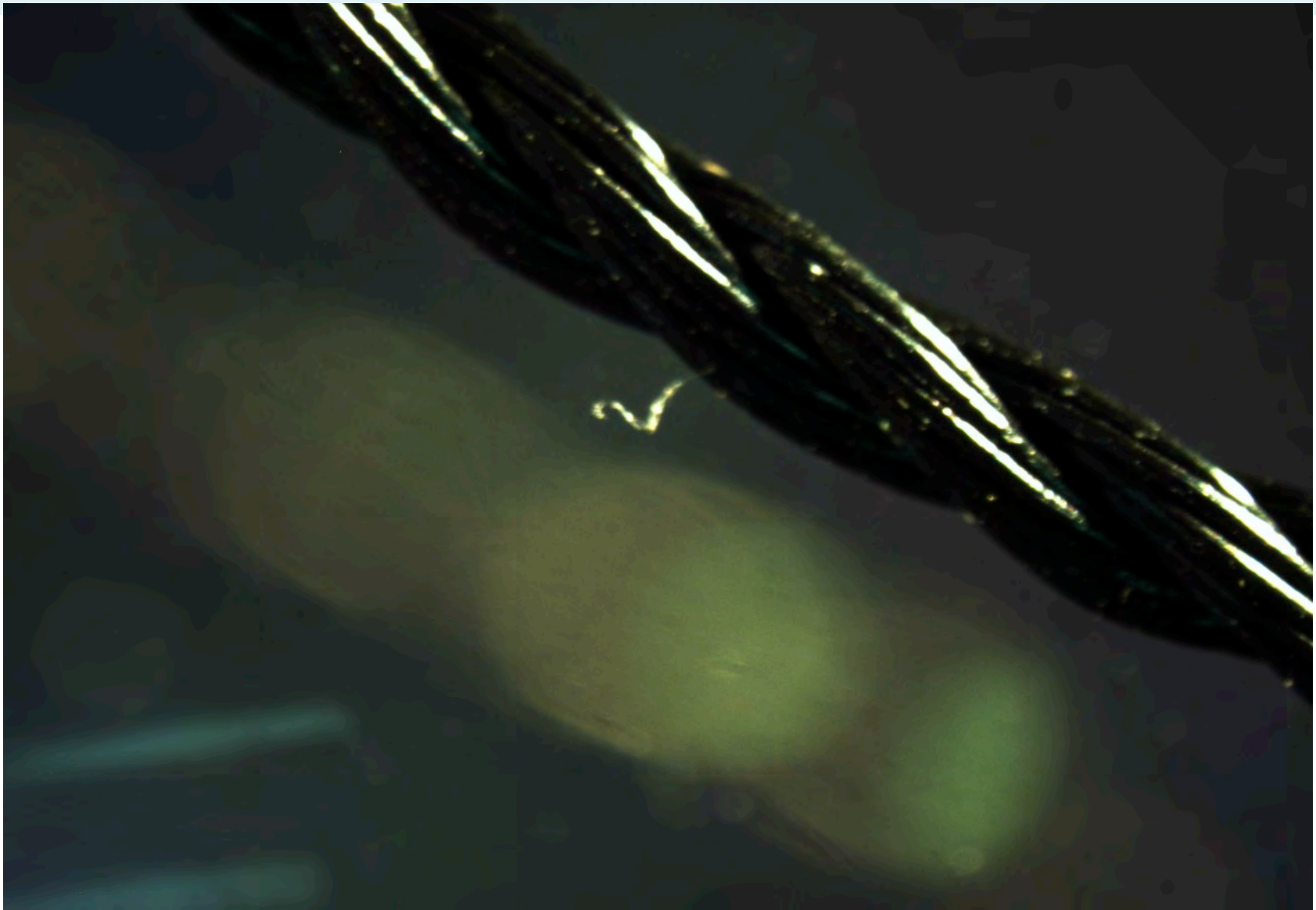
1. Impacts By Logs And Large Debris
2. Impacts By Boaters and Paddlers
3. Impacts By Removal of Barnacles And Other Invertebrates By Feeding Marine Life
4. Impacts By Stones and Sediments

Log Impacts Canopy Net

Normal Production And Preparation For Use Of Geoduck Aquaculture Gear Results In Production Of Plastic Fragments

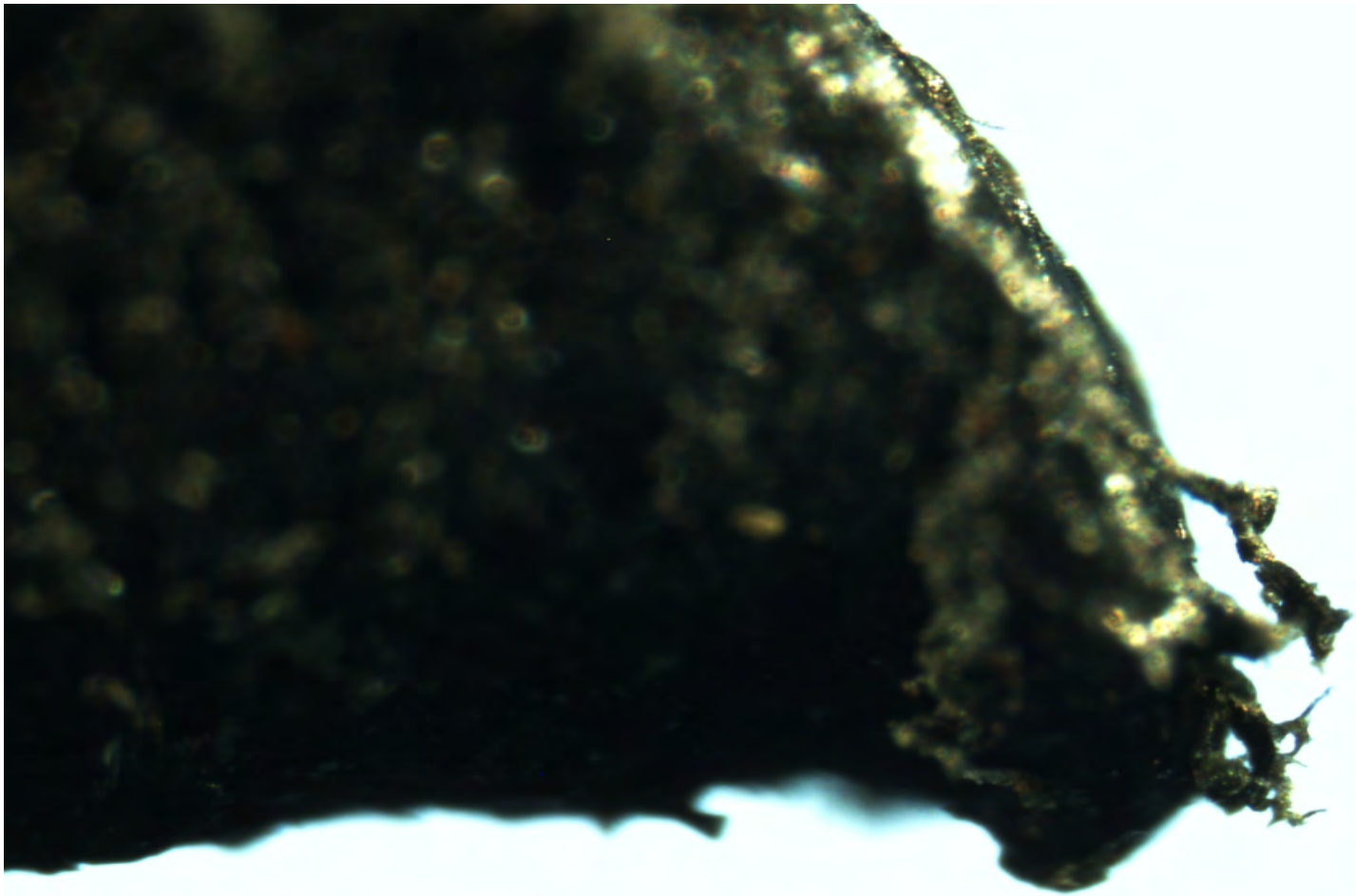
Canopy Net Fragment: C.Moore Photo 2-15

Canopy Net Fragment: C.Moore Photo 2-15

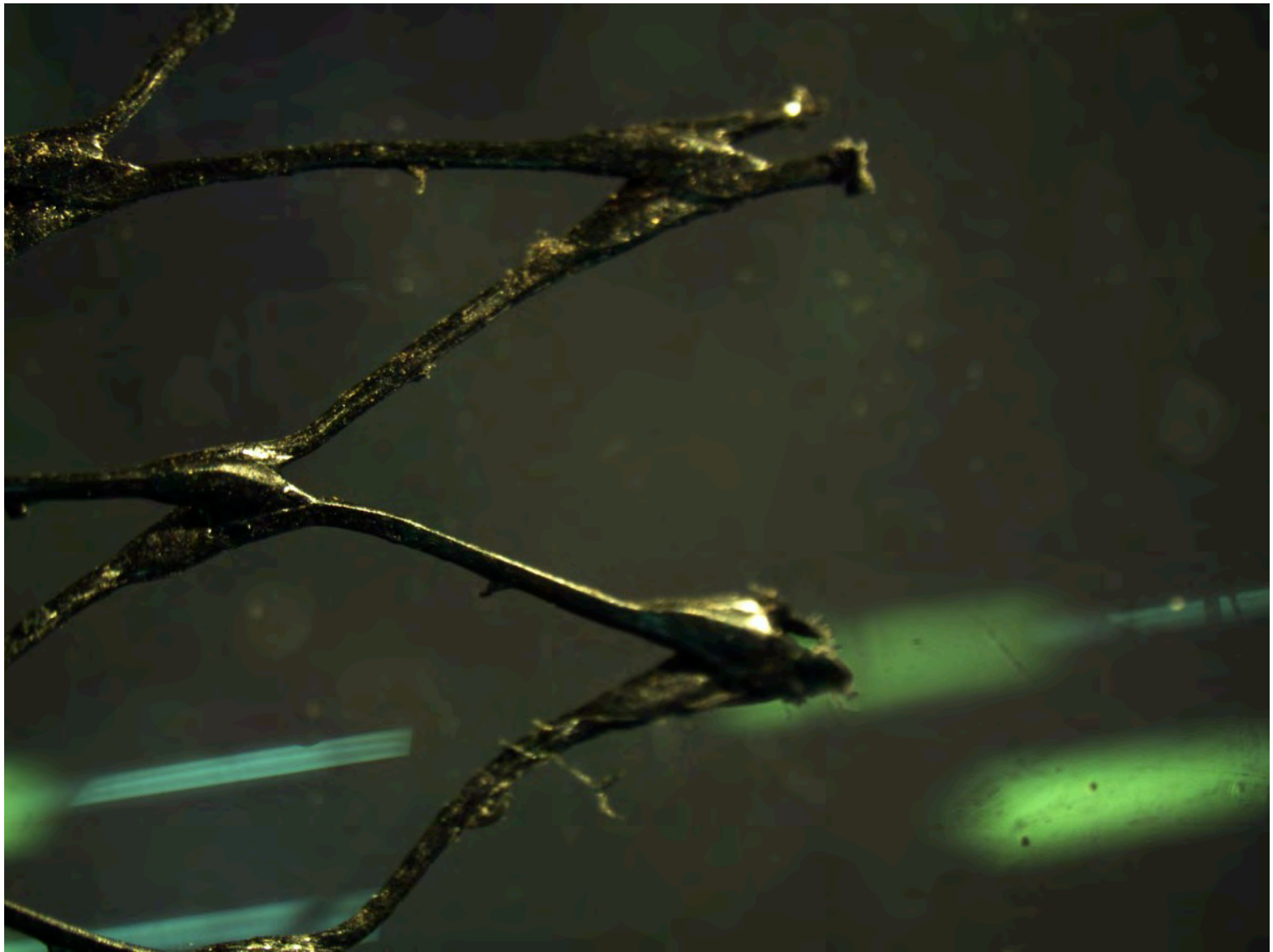


Canopy Net Melted Cut End Fragments: C.Moore Photo 2-15

Mesh Tube Fragmentation At Cut End



Tube Cap Fragments C. Moore Photo 2-15



As Olefin Plastics Age, More And More Fragments Are Created And Enter The Marine Environment

½ mile beach clean up after storm, Haley Park, Case Inlet, 2008

Polyolefin 3 Strand Rope Used in Oyster Aquaculture

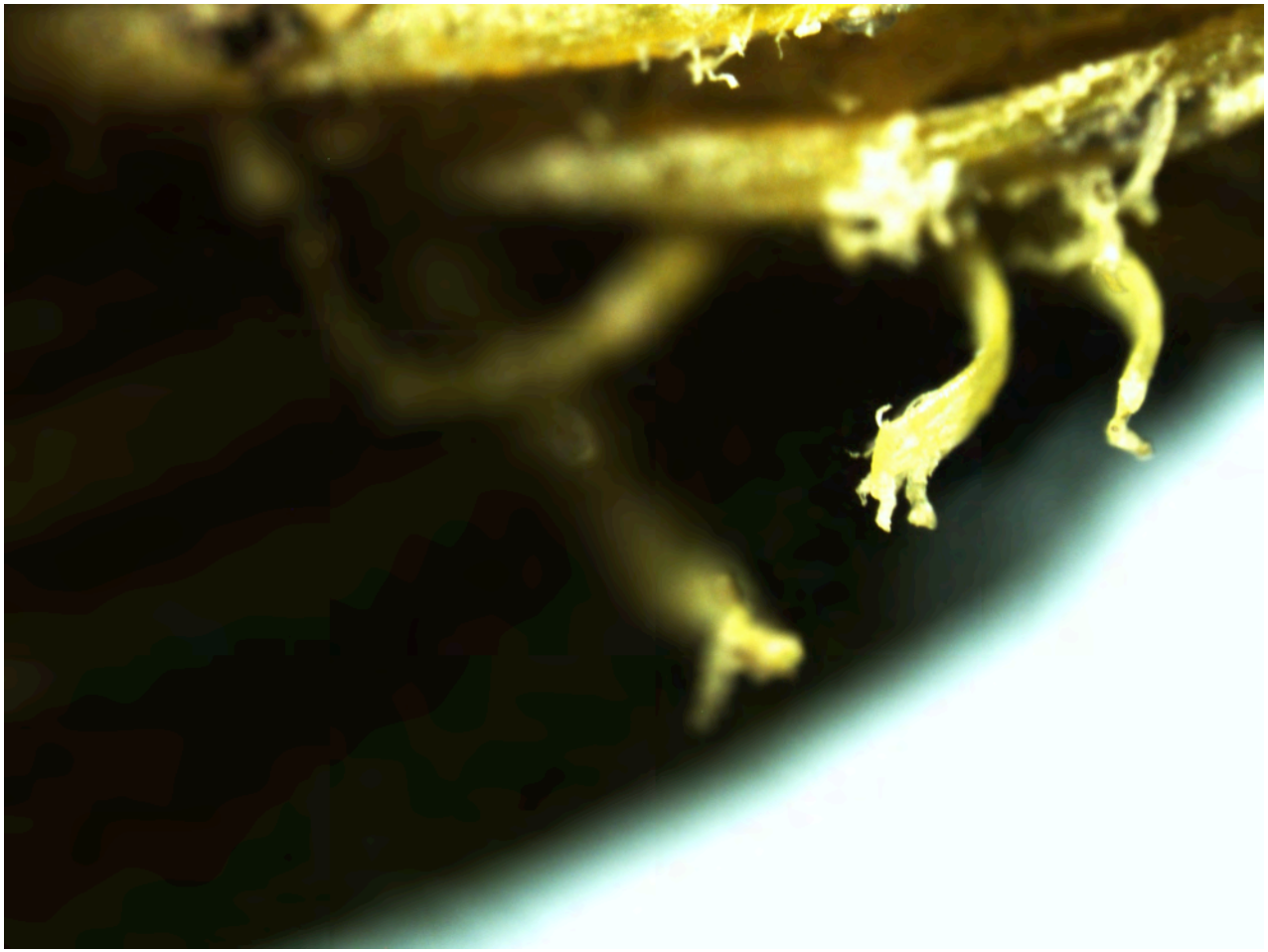
Oyster Shell Has Grown Around Rope

All yellow rope photos by C. Moore

Fragmentation Beginning to Occur

Fragmentation Apart from Shell Contact

Closeup of Microplastic Formation



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

THE PREY IN THIS CASE IS HDPE PLASTIC

ARTICLE INFO

Keywords:
Fishes
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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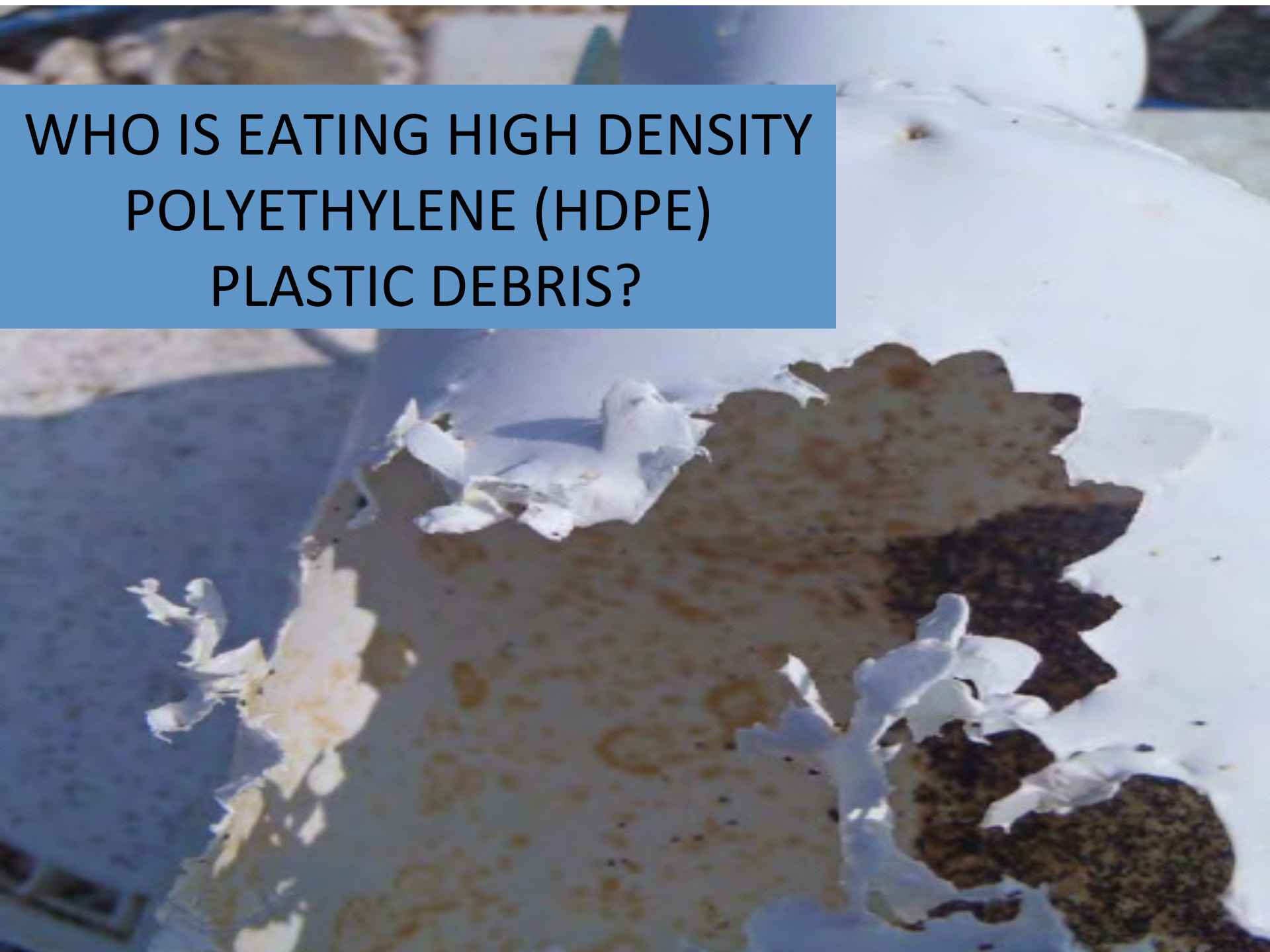
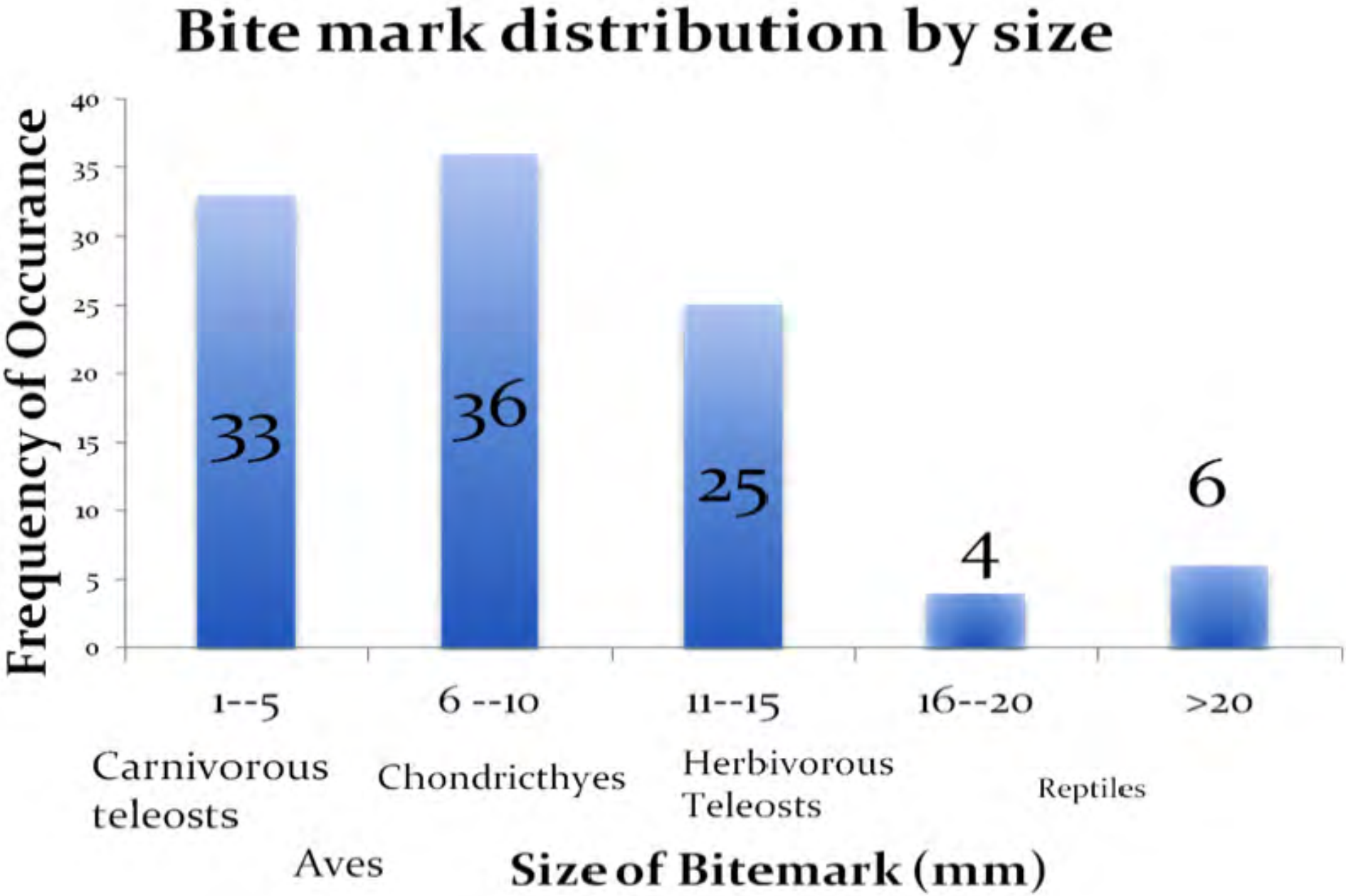

WHO IS EATING HIGH DENSITY POLYETHYLENE (HDPE) PLASTIC DEBRIS?

STUDY BY HANK CARSON OF KAMILO BEACH DEBRIS



Plastic ingestion by planktivorous fishes….

Boerger and Moore et al., 2010

Pacific Saury and Lanternfish Found in Puget Sound

Total Fish = 670 (46% immature)

35% had plastic in the stomachs

6 Species:	Count	% with Ingested
Astronesthes indopacifica	6	16
Cololabis saira	51	16
Hygophum reinhardii	43	23
Loweina interrupa	26	8
Myctophum aurolanternatum	460	37
Symbolophorus californiensis	74	56

Boerger and Moore et al., 2010, Marine Pollution Bulletin

Scientific Reports, November, 2013

Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress

•Chelsea M. Rochman et al.

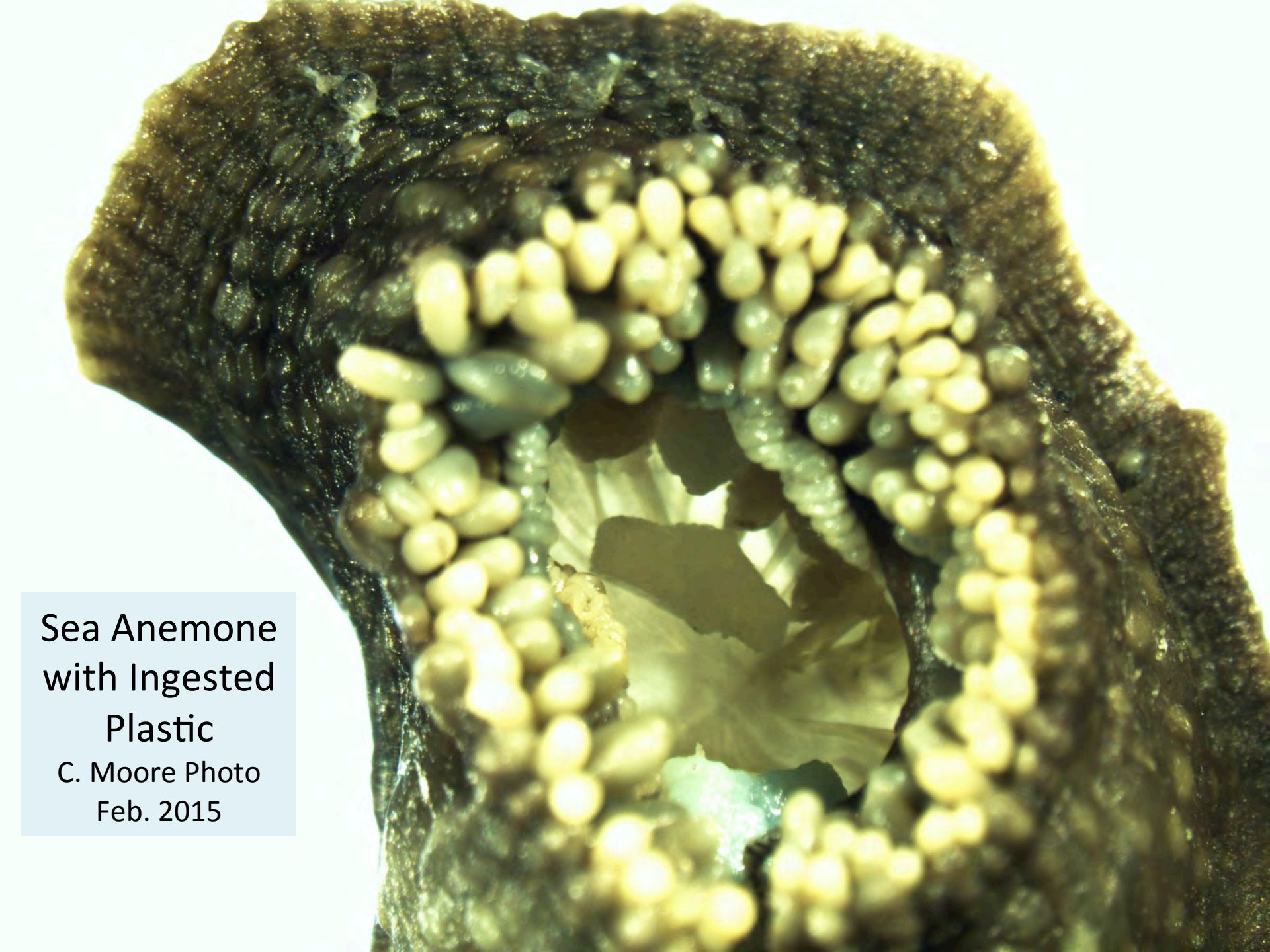
The authors show that fish, exposed to a mixture of polyethylene with chemical pollutants sorbed from the marine environment, bioaccumulate these chemical pollutants and suffer liver toxicity and pathology

Species group	Total number of species worldwide	Number and % of species with entanglement records	Number and % of species with ingestion records
Sea turtles	7	6 (86%)	6 (86%)
Seabirds	312	51 (16%)	111 (36%)
Penguins	16	6 (38%)	1 (6%)
Grebes	19	2 (10%)	0
Albatrosses, petrels, shearwaters	99	10 (10%)	62 (63%)
Pelicans, boobies, gannets, cormorants, frigatebirds, tropicbirds	51	11 (22%)	8 (16%)
Shorebirds, skuas, gulls, terns, auks	122	22 (18%)	40 (33%)
Other birds	-	5	0
Marine mammals	115	32 (28%)	26 (23%)
Baleen whales	10	6 (60%)	2 (20%)
Toothed whales	65	5 (8%)	21 (32%)
Fur seals and sea lions	14	11 (79%)	1 (7%)
True seals	19	8 (42%)	1 (5%)
Manatees and dugongs	4	1 (25%)	1 (25%)
Sea otter	1	1 (100%)	0
Fish	-	34	33
Crustaceans	-	8	0
Squid	-	0	1
Species total		136	177

Figure 14. Number and percentage of marine species with documented entanglement and ingestion records from Mudgal *et al.* (2011) Plastic Waste in the Environment p114 (adapted from Laist, 1997)

Invertebrates, Which Are Food For Vertebrates Also Ingest Plastics

Salp with ingested plastic C. Moore photo Feb. 2015



Sea Anemone with Ingested Plastic

C. Moore Photo
Feb. 2015

Gray Whale in Burley Lagoon 2013

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

PVC TUBES WOULD BE POTENTIALLY ON THIS MENU OF HEAVIER THAN WATER PLASTICS CONSUMED BY BOTTOM FEEDING COASTAL GRAY WHALES

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 seabirds, fish and sea 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.

NMFS Weighs In Against Canopy Nets

- National Marine Fisheries Consultation as of November 15, 2013 that states on page 5:
- "Minimize alteration to the substrate as much as practical (e.g., use predator exclusion nets that attach to individual tubes instead of canopy nets to reduce alteration of the intertidal substrate and habitat; use flow-through mesh type tubing.)

Canopy Net Trapped Bird Carcass

Favored use of anti-predator netting (APN) applied for the farming of clams leads to little benefits to industry while increasing nearshore impacts and plastics pollution.

L.I. Bendell Mar Pollut Bull. 2015

The Author Found That Canopy Nets :

1. Attract clam predators
2. Increase sediment temperature which degrades habitat
3. Present hazards to fish and wildlife
4. Are sources of plastic to marine environment

Summary of Probable Significant Adverse Impacts from Plastic Marine Debris From Proposed Haley/Taylor Shellfish/Seattle Shellfish Site

- Ingestion of non-nutritive and non-digestible toxic plastic particles
- Entanglement in aquaculture gear
- Fragmentation and Degradation of HDPE, Creating Plastic Particles from canopy nets, mesh tubes, and mesh net caps
- Cracking, Fragmentation and Slow Sanding of PVC
- Raising of Sediment temperature from Canopy netting
- Attraction of Predators to recruited vegetation and invertebrate “hitch-hikers” on nets and tubing
- Pollution of Puget Sound with vagrant plastics escaped from site and borne away on tidal currents

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11

DEPARTMENT OF ECOLOGY State of Washington

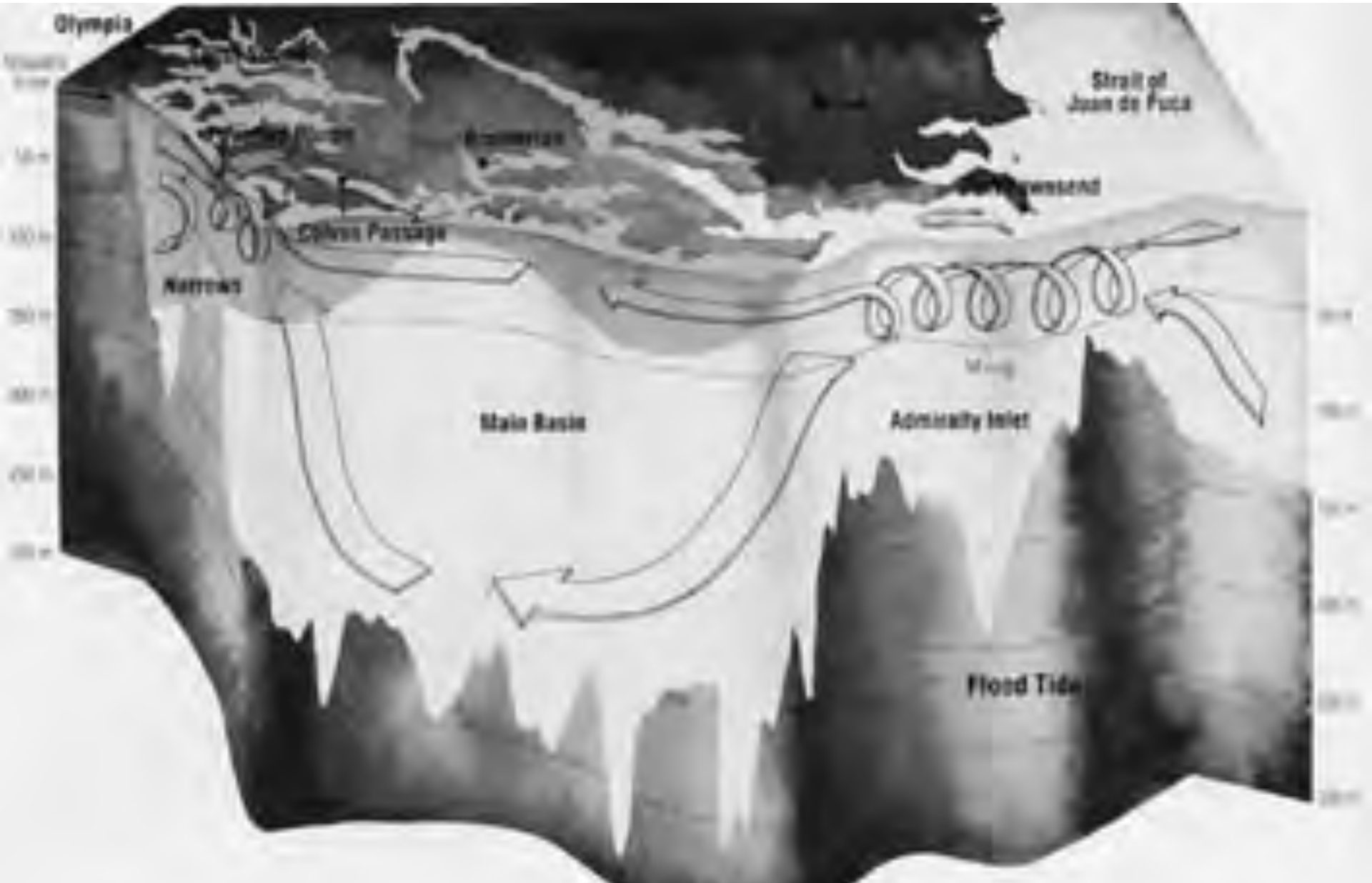
Aerial photography 5-14-2012

Navigate

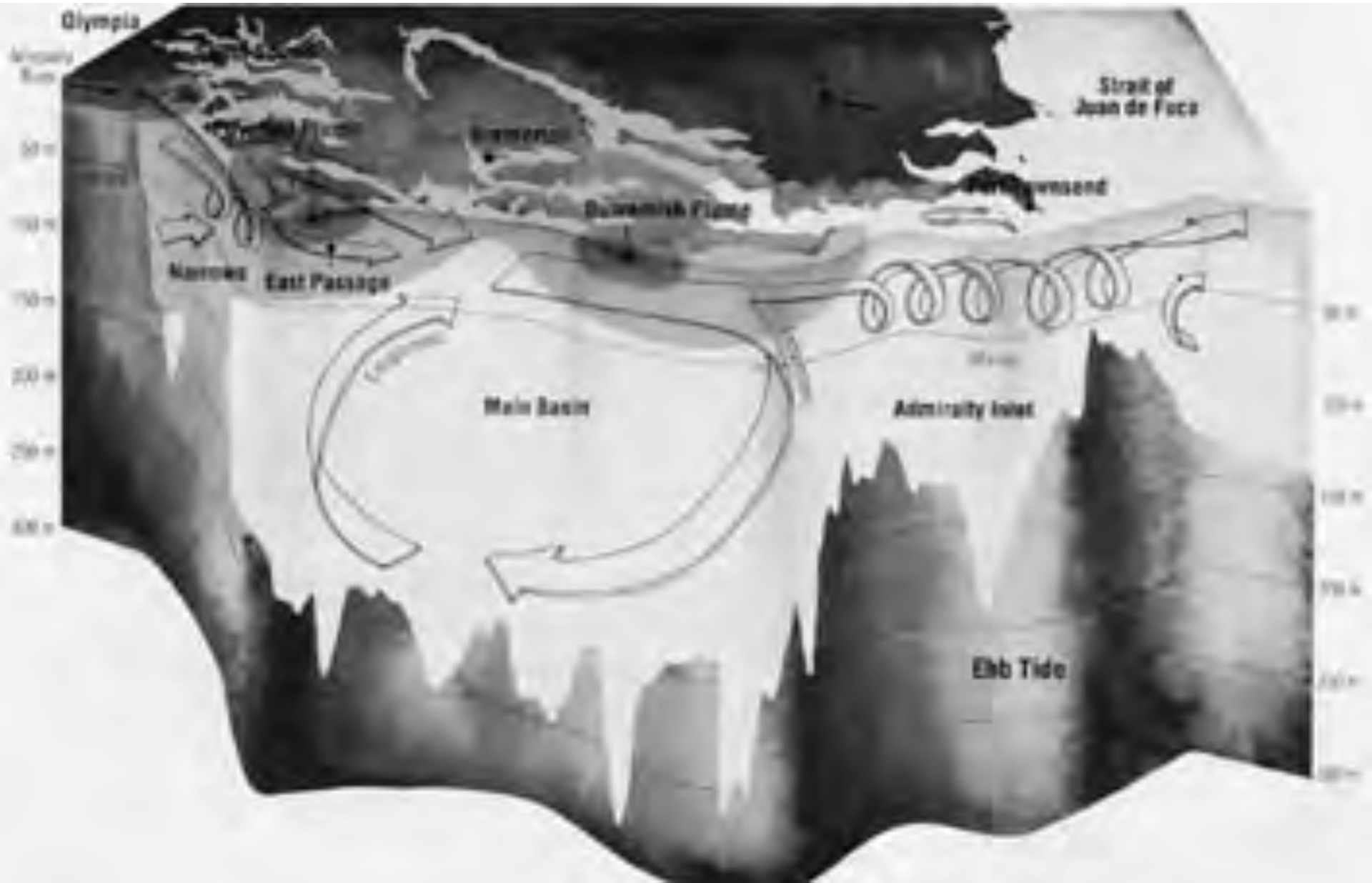
Field log | Weather | Water column | Aerial photos | Ferry and Satellite | Moorings

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

Flood Tide in Puget Sound



Ebb Tide in Puget Sound



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

PVC Tubes Will Sink in Seawater
Some Will Roll into Deeper Water.
At the proposed site, the water is 85 deep within 440 feet.
Nets and net fragments with growth on them, in spite of originally being able to float, will eventually sink into deeper water

Email from Wayne Palsson, WDFW, September 27, 2007

----- Original Message -----
From: Wayne Palsson
To: JfJohannes4@msn.com
Sent: Thursday, September 27, 2007 11:33 AM
Subject: South Sound Questions
Jerry,
Great talking with you today. Here is the information you requested:
Bottom Trawl Survey Estimates of Aquaculture Debris in South Sound, based upon our 2005 survey:
Netting: 61,600 items
Tubes: 21,600
Total: 83,500
The website for the WDFW Priority Habitats and Species is:
http://wdfw.wa.gov/hab/phspage.htm
The website for the Puget Sound Nearshore Restoration Program is:
http://www.cev.washington.edu/lc/PSNERP/
Thanks for your call.
Wayne
****

Wayne A. Palsson
Research Scientist
Washington Department of Fish and Wildlife
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Mill Creek, WA 98012-1296
USA
office (425) 379-2313
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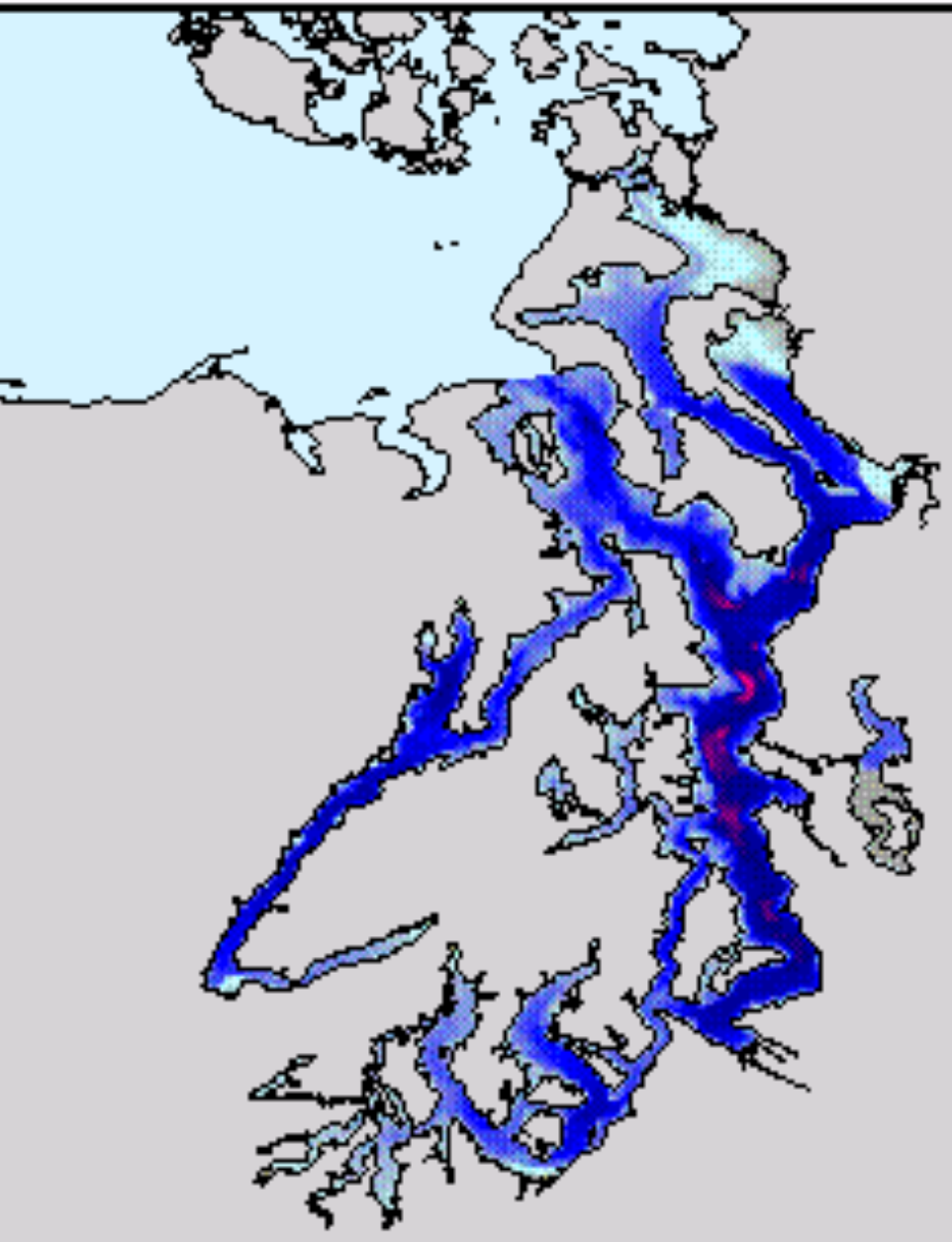
TDD (360) 902-2207
e-mail palsswap@dfw.wa.gov

Washington Department of Fish and Wildlife
Survey of Epibenthic Aquaculture Debris 2005



Puget Sound (P290)

Estuarine Bathymetry

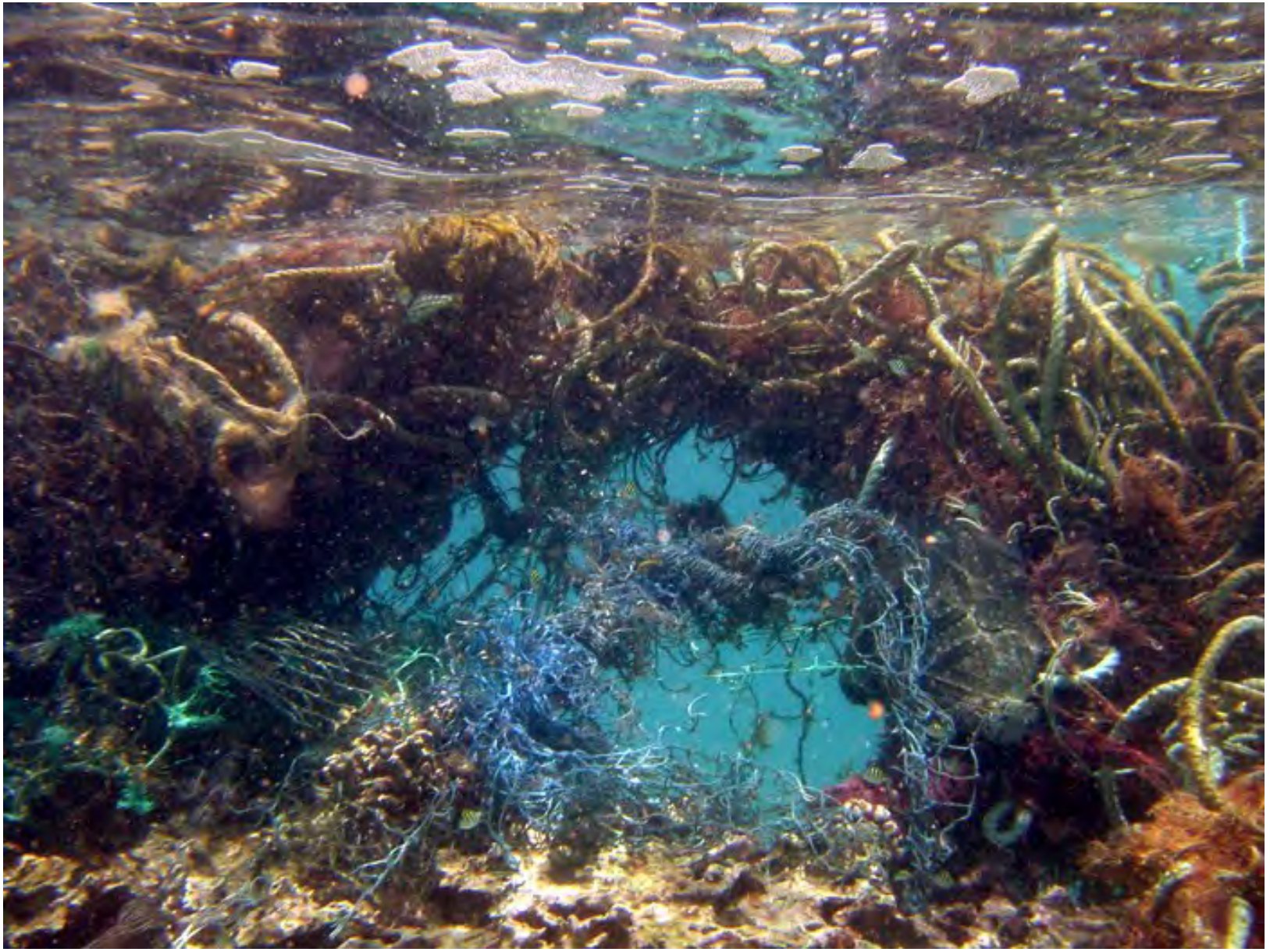
Color Gradient Values

- 3 m
- 0 m
- -5 m
- -10 m
- -20 m
- -100 m
- -200 m
- -290 m

0 25 50

Kilometers

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



Plastic Pollution Degrades Intertidal and Nearshore Marine Habitat

- Plastic becomes embrittled and fragments into small pieces that are ingested by fish, birds and invertebrates
- Plastic tubes, nets and zip ties come loose and move with currents where they entangle marine animals and invertebrates
- Plastics absorb and desorb pollutants which enter the marine food web causing toxicological impacts

Mitigation for Macro-Plastics Only
There Are No Micro-Plastic Mitigation Methods

From the Pierce County Staff Report- AE2-14 Environmental Appeal, Page 8:

- "After a consideration of the proposal itself and permits/approvals already required from other agencies, the County determined that the only un-mitigated probable significant adverse environmental impact would be with regards to marine debris. Therefore the MDNS (Mitigated Determination of Non Significant) imposed mitigation to reduce the impact of marine debris to a non-significant level. Staff finds that this mitigation is capable of being accomplished."

“THE ROLE OF THE INFINITELY SMALL IS INFINITELY LARGE”

—LOUIS PASTEUR

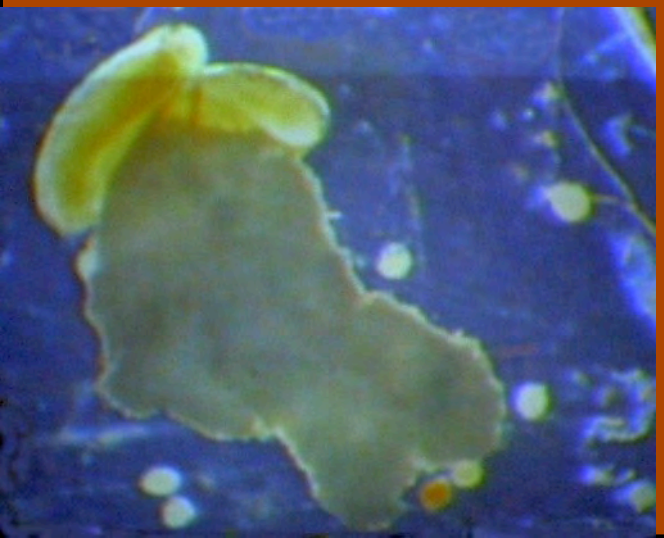
Founder of the science of microbiology and creator of vaccines to prevent diseases caused by germs

Plastic Concerns in Paris - 2010

- **UNESCO-IOC**
  - United Nations Educational Scientific and Cultural Organization –
    - Intergovernmental Oceanographic Commission
- **GESAMP**
  - Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection

UNESCO GESAMP 2010
Paris Workshop Title

"Micro-plastic particles as a vector in transporting persistent, bio-accumulating and toxic substances in the oceans."



28-30th June 2010, UNESCO-IOC, Paris

GESAMP International Workshop

www.gesamp.org

GESAMP Executive Summary **Highlights**

Algalita invited to attend, participate, be on panel making final recommendations, and edit publication.

- "Marine plastic litter and thereby micro-plastics ***will inevitably increase***"
- "Smaller fragments, i.e. microplastics…are considered to ***contribute to bioaccumulation*** through swallowing, extraction in the gut and absorption"
- "Micro-plastics are also considered seen to potentially provide a specific route by which ***additives in the plastics can enter the marine environment***"

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

Per Army Corp (2007)

Shellfish Farm Sites	**Farm Acreage**	**Acres of Tidelands**	%
Willapa Bay	25,562	45,000	56.8%
Grays Harbor	3,995	34,460	11.5%
South Sound	4,748	27,520	17.3%
Hood Canal	1,677	unknown	
North Puget Sound	2,345	unknown	

Total 38,327

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

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

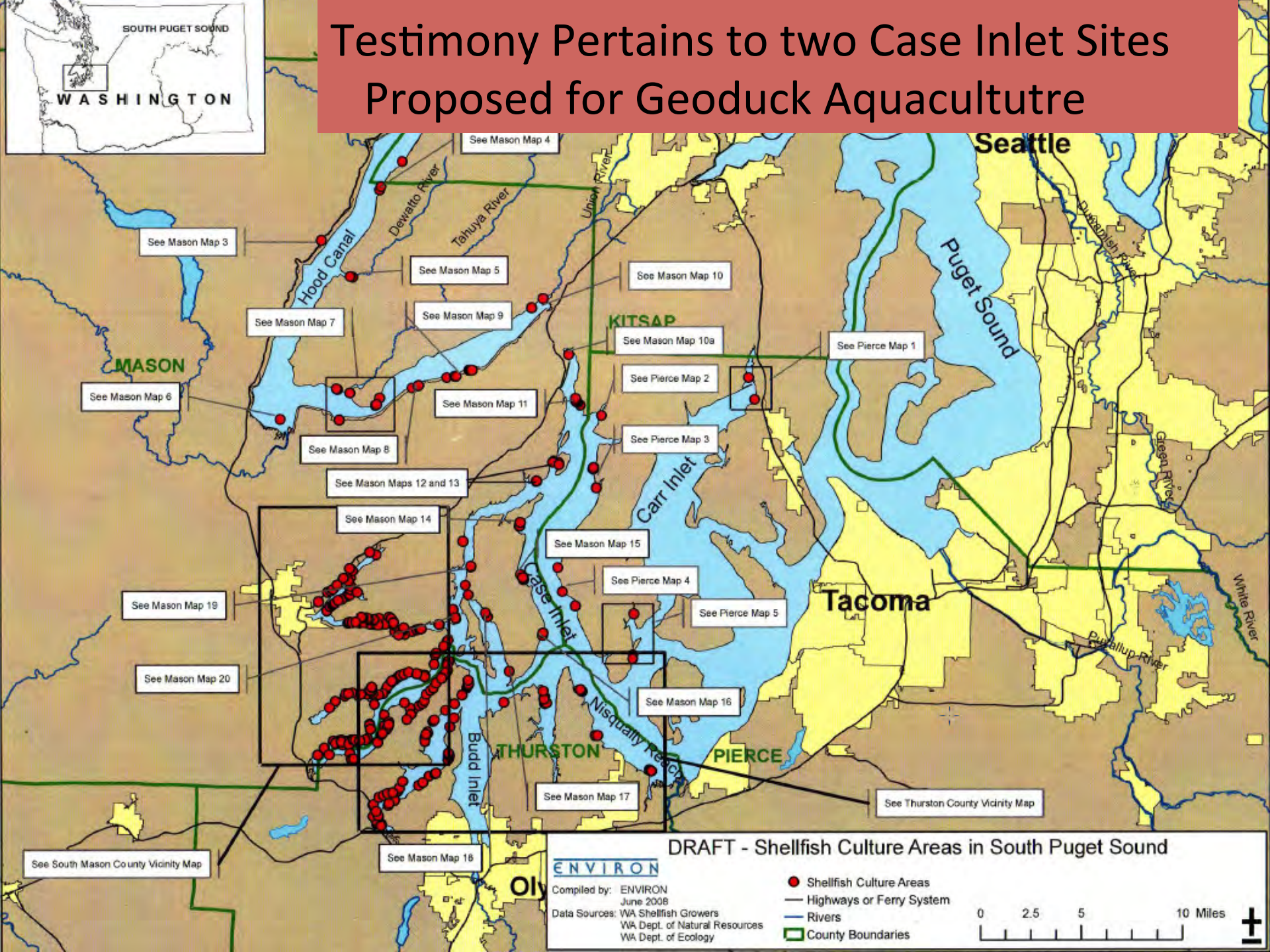
The states will identify marine debris baselines, established by assessing data collected by clean-up programs, state and federal agencies, and nonprofit organizations. The states will then identify a target reduction level to achieve by various prevention and coastal clean-up measures, and will partner 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.

Since Plastic Biodegrades Extremely Slowly, Any Losses To The Marine Environment Add To What Is Already There. This Makes For An Increased Cumulative Effect. The 11 Acre Sight That Has Been Permitted Will Eventually Use 480,000 PVC Tubes And Associated Gear, Over And Over Again. Even If Less Than ½ Of 1% Of This Gear Is Lost To The Marine Environment, Thousands Of Tubes, Associated Netting and Fragments Will Be Lost

Testimony Pertains to two Case Inlet Sites Proposed for Geoduck Aquacultutre



Coalition to Protect Puget Sound Polymer Test

Chain of Custody Item Number	Description	Test Date	Time	Andrady Polymer Test (Polymer Type)		
1	Geoduck 30' x 30" Net	2/2/15	15:00	HDPE		
2	Geoduck Mesh Tube Sample	2/2/15	15:02	HDPE		
3	Oyster Bag Sample	2/2/15	15:04	HDPE		
4	Clam Large Canopy Net	2/2/15	15:05	HDPE		
5	Other Shellfish Netting - Blue Netting	2/2/15	15:07	HDPE		
6	Other Shellfish Netting - Black Netting	2/2/15	15:09	HDPE		
7	Black Disk	2/2/15	15:10	HDPE		
8	Larger White Mesh	2/2/15	15:12	HDPE		
9	Smaller White Mesh	2/2/15	15:14	HDPE		
10	Blue Mesh	2/2/15	15:15	HDPE		
11	Black Mesh - Other #1	2/2/15	15:16	HDPE		
12	Black Mesh - Other #2	2/2/15	15:17	HDPE		
13	Light Yellow Line	2/2/15	15:18	PP		
14	Orange Line	2/2/15	15:15	PP		
15	3 Black Bands			Not Tested		

Testor	Gwen Lattin
Date	2/2/15
Time	15:26

Witness	Charles Moore
Date	2/2/15
Time	15:26

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).

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).

Latest Southern California Bight Survey "Bight 13" Looked at Plastic in Benthos

- Also looked at ingestion of plastic by pelagic and demersal (near the bottom) fishes

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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EPA—Marine Debris Impacts

Environmental Impacts

- Ingestion-In fact, some plastic particles have even been determined to contain certain chemicals up to one million times the amount found in the water column (Moore, C., 2002).
- Entanglement-For example, volunteers participating in the 2008 International Coastal Cleanup event discovered 443 animals and birds entangled or trapped by marine debris (2008 ICC Report, Ocean Conservancy).

Economic Impacts

- Navigation-Floating marine debris is a navigational hazard that entangles propellers and clogs cooling water intake valves.

Human Health and Safety Impacts

- Marine debris impacts humans by endangering health and safety. Similar to marine organisms, swimmers and divers can also become entangled in abandoned netting and fishing lines.

http://water.epa.gov/type/oceb/marinedebris/md_impacts.cfm

5GYRES

Date: Feb 8, 2015

The Coalition to Protect Puget Sound Habitat,

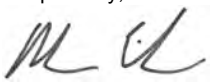
Our recent research published in the journal Plos One estimated 260,000 tonnes of plastic waste in the world's oceans from 5.25 trillion particles. What this shows us is that plastic waste is shredding into microplastics that distributed widely. Over 92% of those trillions of particles are smaller than a grain of rice.

The documented impacts of these microplastics are pouring in. Recent research shows that bivalves can translocate plastic particles into their circulatory system through the gut wall. Lug worms experienced slowed metabolism due to ingested microplastics and the toxins that leach from them. The Convention on Biological Diversity recently published a review of all studies of species impacts with plastic marine pollution, counting 663 species in total.

Though microplastics make up the majority of the count of particles in our study, it only accounts for less than 7% of the weight. The bulk of the weight is from larger objects, especially those designed for persistence in the marine environment. Fishing buoys and derelict nets and line account for more than 70% of our estimated weight of plastic in the world's oceans. It is very common to find lost fishing equipment at sea, and almost a certainty on remote beaches. When recovering nets from the sea, often your hands are left with a confetti of microplastics on them.

Aquaculture is responsible for contributing to the problem of plastics in the marine environment. Only producer responsibility toward 100% net/line/buoy recovery, or 100% environmentally benign materials, is acceptable moving forward.

Respectfully,



Marcus Eriksen, PhD
Research Director
5 Gyres Institute
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THE PLASTIC GEAR USED ON THE 11 ACRE SIGHT AND THE GEAR AND PARTS OF GEAR THAT LEAVE THE SIGHT ARE A SIGNIFICANT ADVERSE IMPACT. 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 AND IGNORES MICROPLASTIC POLLUTION.

FOR THESE REASONS THE PERMIT IN QUESTION SHOULD BE INVALIDATED.

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153. Net Ventures Shorelines Hearings Board Pre-Hearing Brief-August 2013
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179. Plastic Beach Debris Identification Scheme
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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

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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