出國報告（出國類別：其他）

出席「亞太經濟合作（APEC）訓練計畫：海洋垃圾防治和管理之能力建構」

服務機關：行政院環境保護署
姓名職稱：宋欣真簡任技正
派赴國家：韓國麗水
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摘要

有鑑於海洋垃圾除造成海洋污染外，也會對各會員體之海洋生態、漁業及社會經濟環境造成鉅大之影響，韓國於 APEC 海洋及漁業工作小組（OFWG）提出西元 2017 年辦理亞太經濟合作(APEC)計畫「海洋垃圾防治和管理之能力建構(Information and Guidelines of Capacity Building for Marine Debris Prevention and Management in the APEC Region)」，並獲得 APEC 秘書處批准辦理。計畫內容包括：海洋垃圾來源、對海洋環境與生態及人類的影響、進行海灘垃圾現場調查實作及海洋垃圾治理經驗分享。我國講者（全程費用由 APEC 秘書處支應），分享我國海洋垃圾治理經驗。包括推動限塑政策，從海面、海灘到陸地，從國內源頭減量到從國外來的垃圾處理所擬定之執行策略，以面對海洋垃圾的挑戰。參加訓練計畫經濟體，包括香港、智利、泰國、美國等會上及會後有許多提問與討論，各會員體參加者對於我國海漂垃圾治理的努力給予很高的肯定。

目錄

壹、 緣起及目的

「海洋垃圾防治和管理之能力建構（Information and Guidelines of Capacity Building for Marine Debris Prevention and Management in the APEC Region）」是APEC海洋及漁業工作小組（OFWG）項下的工作，由韓國和共同提案國包括智利，中國，日本，秘魯，巴布新幾內亞，泰國和美國提出，並獲得APEC秘書處批准辦理。由韓國的海洋和漁業部（Ministry of Oceans and Fisheries, MOF）和韓國海洋環境管理合作（Korea Marine Environment Management Cooperation, KOEM）辦理。

根據科學研究報告顯示，亞太經合組織發展中經濟體是主要的海洋塑膠垃圾來源，造成全世界海洋污染。因此，在這些區域的海洋塑膠垃圾的預防和管理是迫切需要的，應該要有長遠的污染控制規劃。在這方面，這個工作旨在建立亞太經合組織有關人員對海洋廢棄物的治理能力，透過分享關於海洋廢棄物現況及和負面影響的最新狀況，以及共享從全球，區域，國內至地方各層面的最佳做法中吸取經驗，共同面對處理海洋廢棄物問題。

貳、 出席代表

本工作項目在韓國麗水（Yeosu）舉辦，課程共計7天，自2017年6月12日起至6月18日止。參加人員和講者總計約40人。講者來自聯合國、美國、韓國、中國大陸和我國。參加者來自12國，包括智利、中國大陸、香港、印尼、馬來西亞、墨西哥、巴布亞新幾內亞、秘魯、菲律賓、蘇俄、泰國、越南。

我國講者（全程費用由APEC秘書處支應）參加2日(6月13日及6月14日)活動，分享我國海洋垃圾治理經驗。從我國推動限塑政策，從海面、海灘到陸地，國內源頭減量到從國外來的垃圾處理所擬定之執行策略，以面對海洋垃圾的挑戰。環保署擬定「海漂垃圾處理方案」，涵蓋了各個面向的推動政策與措施，以及2016年在海漂或海底垃圾就珊瑚礁岩及礁岩地區執行淨海作業，清除對海中生物危害較大的漁網及塑膠垃圾，並結合今年更結合世界海洋日，串連19個臨海地方政府共同辦理全國「海底垃圾清除總動員」淨海活動，同時推動各縣市成立環保艦隊，號召漁民或各類船舶加入，宣導將船上的廢棄物攜回岸上，並訂定回收物或廢棄物的兌換機制，提高參與誘因。在淨灘工作上，推動海岸淨灘認養，改變以往一次性之淨灘活動作法。對於金門縣、連江縣及澎湖縣長年受到海漂垃圾之嚴重影響，也藉此機會提出讓APEC會員體成員了解我國的努力。

參、 參與過程

一、主辦單位韓國海洋環境管理法人機構（KOEM Korea Marine Environment Management Corporation）介紹

韓國海洋環境管理法人機構（KOEM Korea Marine Environment Management Corporation）的前身是西元 1997 年成立的 Korea Marine Pollution Response Corp.，主要負責的業務是溢油應變及廢油的收集與處理。在西元 2007 年 12 月韓國發生 Hebei Spirit 事件後，為強化海洋環境管理工作，更名為 Korea Marine Environment Management Corp. 並逐步擴大業務範圍延伸至海洋海岸污染的清理、海洋生態系統與海岸濕地調查、棲地復育、海洋環境管理、海洋事務等，職員約 600 人。該機構積極辦理及參與許多海洋環境相關活動訓練等，本署也曾應邀擔任講者，於 2014 年海洋油污預備、應變與評估（Preparedness, Response and Assessment of Oil Spill , PRAOS）（第 1 階段）計畫分享我國處理海洋污染緊急應變之個案經驗。

二、活動會場

本次活動會場在韓國麗水（Yeosu）舉辦，位於韓國的全羅南道，是一個大約擁有 30 萬人口的城市，主辦 2012 年世界博覽會。在世博會之後，成為舉辦國際會議等的場所。

圖 1 會場

三、參與重點

（一） 美國海洋廢棄物法規及管理現況

由美國環境保護署的 Andrew Horan 說明美國海洋廢棄物法規及管理現況。美國 2006 年簽署海洋垃圾研究、預防及減少法案(Marine Debris Research, Prevention, and Reduction Act of 2006，簡稱海洋垃圾法)，美國大氣及海洋總署(NOAA)海洋垃圾方案(Marine Debris Program)是由國會授權，基於“海洋垃圾法”簽署，據以辦理海洋廢棄物相關工作。海洋垃圾法於 2006 年簽署，並於 2012 年修訂。法案內容要求海洋垃圾方案要能從源頭進行識別、確認，並且對海洋廢棄物要進行評估、防止以及減少和清除，以減少海洋廢棄物對經濟、海洋環境及航行安全的不利影響。

美國在海洋廢棄物的法案，除了前述的海洋垃圾法外，涉及的法令尚包括清淨水法(Clean Water Act)的總量管制、暴雨逕流許可及垃圾捕集技術，以減少垃圾流入河川進入海洋、無柔珠水域法、防止船舶污染國際公約(MARPOL)附錄五有關船舶廢棄物處理、倫敦海拋公約管制海上棄置廢棄物。

上述美國這些相關法規在我國也有相對應的法令從源頭管制廢棄物進入海洋。

美國在處理海漂垃圾的努力包括清除、教育、預防、研究及公私夥伴關係及區域性協調。擴及全國的以社區、團體，包括 NGOs、州政府、地方政府及研究單位為基礎的海洋廢物清除補助自 2006 年以來資助了 130 多個項目，以 2016 年而言，聯邦經費約 112 萬美金。在預防部分包括教育從行為改變，自 2013 年以來資助 40 個計畫，以 2016 年為 68 萬 4,264 美元。至於研究項目側重於塑膠微粒，廢棄漁具影響及對經濟之影響，自 2013 年以來資助了 4 個項目 2016 年經費為 13 萬 7,113 美元。至於公私夥伴的合作關係美國講者提到針對漁網在 9 個州共計 44 個港口設置漁網回收箱，針對漁網可回收的部分回收，無法回收的以焚化處理，迄今已收集處置 1,315 公噸。

NOAA 海洋垃圾應急和行動計畫(Marine Debris Emergency Response and Action Planning)由美國大氣及海洋總署 Tom Barry 說明在法令授權下辦理海洋垃圾來源之確認評估、預防、減少和清除之協調工作，以及減少棄置漁具對海洋的不利影響、辦理宣導教育以及解決“嚴重海洋垃圾污染事件”。

（二） 韓國國家海洋垃圾監測計畫

韓國國家海洋垃圾監測計畫(**Korea National Marine Debris Monitoring Program**)，自 2008 年 3 月～2009 年 12 月在 20 個非人工結構物的海灘進行，每兩個月監測一次，在政府的支持下由非政府組織和志工來進行，每段海灘長度 100 公尺，寬度：從目前的水位到海灘高潮線外，對大於 2.5cm 的垃圾進行計數稱重/體積估算及分類，且辦理定期培訓講習班進行數據的收集和分析。調查方式包括試點調查(每 100 公里 40 站（長 100 米/站）)及主要調查(每 100 公里 382 站（長 100 米）)。

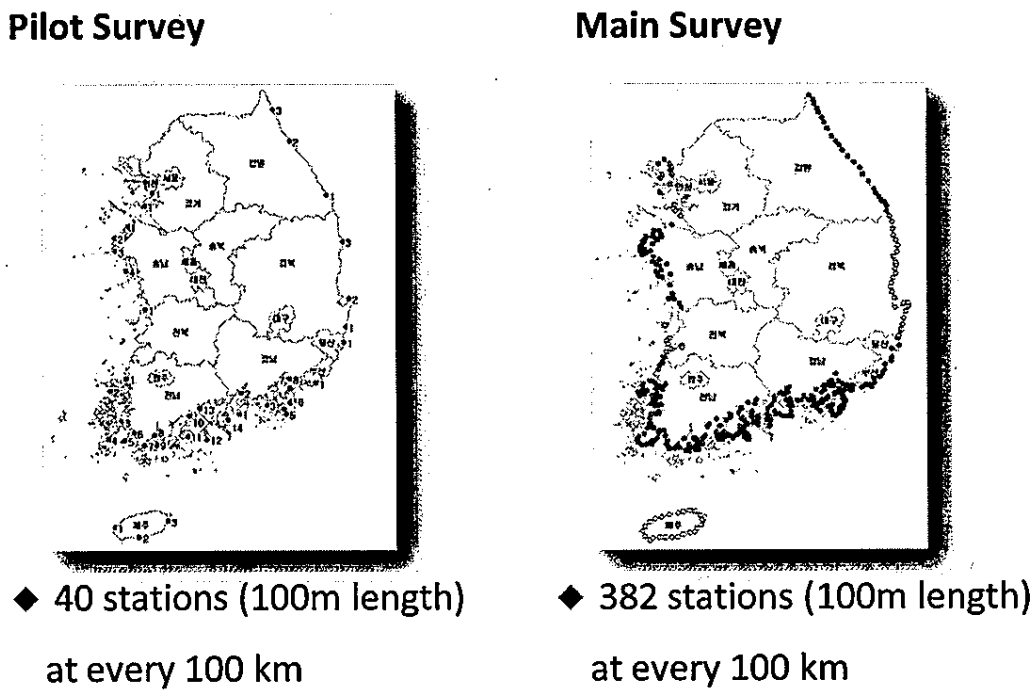


圖 2 韓國國家海洋垃圾監測點

以 2014 年結果為例，就數量而言，塑膠 49.8%與保麗龍 16.9%，合計佔 66.7%，再其次為木頭 8.4%；就體積而言，塑膠 30.7%和保麗龍 31.6%，合計佔 62.3%，再其次為木頭 23.6%；重量是以木頭 37.9%所佔比例最高，其次為塑膠的 30.3%，在其次為保麗龍 12.5%。

該監測計畫經由調查結果分析在不同季節、不同海岸線與各種活動造成海洋垃圾的數量變化。並且分析出在東部、西部及南部海岸主要海洋垃圾問題都是漁業活動造成。也進而發展出，要保護海洋生態系統，唯有避免塑膠及保力龍的垃圾。政

府的計畫就集中在有數據基礎的管理、檢索系統的開發及提升漁民的認知等三大面向。

（三） 麗水海洋垃圾調查實作

由韓國的 NGO 團體 Our Sea of East Asia Network(O.S.E.A.N)，也就是進行韓國國家海洋垃圾監測計畫的 Dr. Sunwook Hong and Mr. Jongmyoung Lee,from Our Sea of East Asia Network(O.S.E.A.N)帶領所有參與工作坊的人，到麗水海岸進行一次海洋垃圾實作調查。在限定的時間範圍、海岸的長度寬度進行。結果顯示就數量而言，以菸蒂最多，由於該調查海岸是遊憩觀光海岸，調查的廢棄物種類以菸蒂、煙火廢棄物、寶特瓶蓋頭為主，甚至還有泳衣。

圖 3 韓國 Dr. Sunwook Hong and Mr. Jongmyoung Lee,
from Our Sea of East Asia Network(O.S.E.A.N)

圖 4　APEC 各經濟體人員進行海灘垃圾撿拾與分類

圖 5 與來自泰國、智利與墨西哥代表同組進行 ICC 分類調查

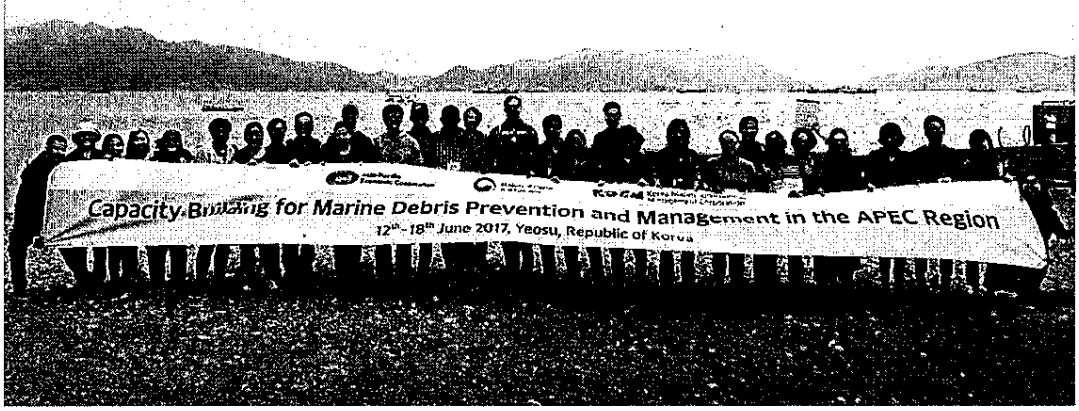


圖 5 參與 ICC 分類調查人員合影

（四） 韓國-斯里蘭卡的海洋垃圾計畫

由於每年有 159 萬噸塑料廢物從斯里蘭卡進入海洋（世界第五名），因此韓國與斯里蘭卡合作執行該項計畫，以應對日益惡化的海洋污染。經費由 2012 年麗水博覽基金會資助，由 KMI（韓國海事研究所），ORI（海洋研究所），MATEC（海洋技術工程）和 USJP（Sri Jayewardedepura 大學）實施，並得到 MEPA（斯里蘭卡海洋環境保護局）支持，以確保可持續的漁業和旅遊業務。

韓國協助斯里蘭卡解決海洋污染惡化，特別是塑料廢物和工業廢水，這些污染物可能會影響漁業和旅遊業。通過對海灘和水下的海洋廢物進行調查，對斯里蘭卡海洋廢物的來源和影響進行研究，有助於製定應對海洋廢棄物的政策，幫助斯里蘭卡科學家利用設備來調查海洋廢棄物，開發教育材料，教育公眾。根據最近的研究顯示，斯里蘭卡每年進入海洋的塑料廢物數量為 24 萬至 64 萬噸，研究也顯示，沿岸水體，如 Negombo 瀉湖和 Bolgoda Lake 的可食用物種的重金屬積累濃度令人震驚，來源是附近的工業區。整個計畫執行期間從 2015 年 7 月 1 日至 2017 年 10 月 30 日，建立斯里蘭卡海洋廢棄物管理能力。

（五） 我國海洋垃圾治理現況

說明我國在海洋廢棄物的治理近年來的作為，包含擬定「海漂垃圾處理方案」，從源頭進行控管，並且就海灘、海面及海底的垃圾，分別採取各種清理作為以為因應。向 APEC 會員體介紹我國在 2016 年及 2017 年在海洋垃圾處理的相關工作重點，包括強化限塑政策（擴大購物用塑膠袋限制使用對象，以及限制含塑膠微粒之化粧品及個人清潔用品（含牙膏）製造、輸入及販賣）、力行資源回收、建立漁業廢棄物收集處理管道等。此外，也加強督導地方政府辦理河川行水區、河岸及海岸垃圾掩埋場封閉、設施維護、廢棄物及堆置物管理工作，巡查取締海岸釣魚行為及海灘地區任意棄置垃圾及其他影響環境衛生行為，加強河面垃圾清理及污水截流站垃圾清疏作業，以減少可能進入海洋的廢棄物。

對於臺灣西南部漁業養殖用（養蚵）蚵棚及保麗龍，由於材質脆弱，易因天然災害及自然損耗而破碎後散置污染海岸。臺南市政府訂有「淺海牡蠣養殖管理自治條例」，強力推動養蚵管理措施，包括「總量管制養蚵棚數」、「蚵棚申報及回收重罰管理」、「7~9 月颱風季禁止養蚵」、「逐年提高蚵農負擔清理費」、「禁用未包覆保麗龍浮具」等措施，以根本解決養蚵保麗龍污染海岸問題，相關作法可提供其他縣市參考。

對於金門縣、連江縣及澎湖縣長年受到海漂垃圾之影響極我們所做的努力也讓 APEC 會員體成員了解。

另外對於今年 4 月 22 日全國推動民間團體及企業認養，成立全國揪團認養淨灘，以及原訂於 6 月 4 日串連 19 個臨海地方政府共同辦理全國「海底垃圾清除總動員」淨海活動(因受豪雨影響延至 7 月 22 日舉辦)，同時推動各縣市成立環保艦隊，號召漁民或各類船舶加入，宣導將船上的廢棄物攜回岸上，並訂定回收物或廢棄物的兌換機制，提高參與誘因，讓民眾了解保護海洋環境永續發展的重要性，並以臉書粉絲團方式經營，擴大海洋環境教育宣傳效果。

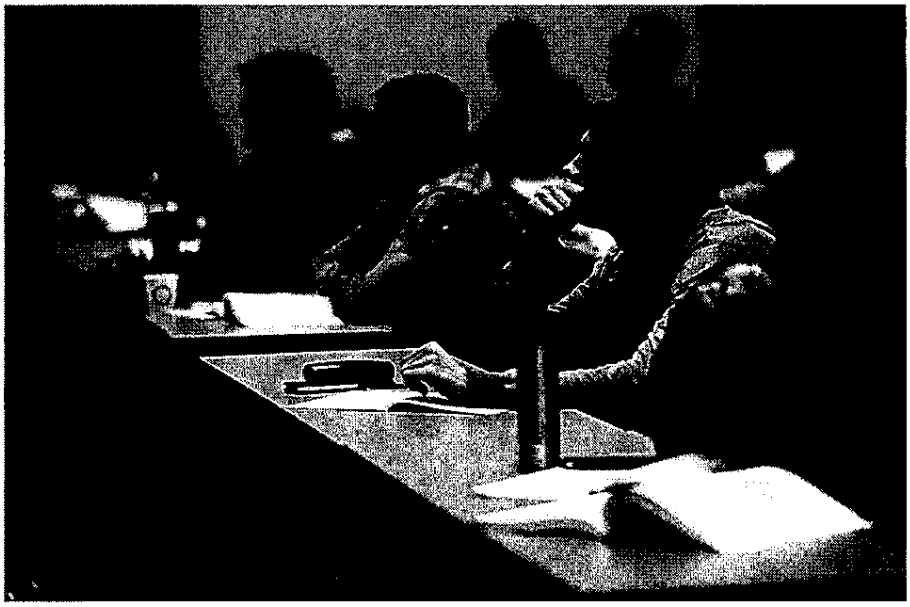


圖 6 APEC 各會員體代表聆聽狀況

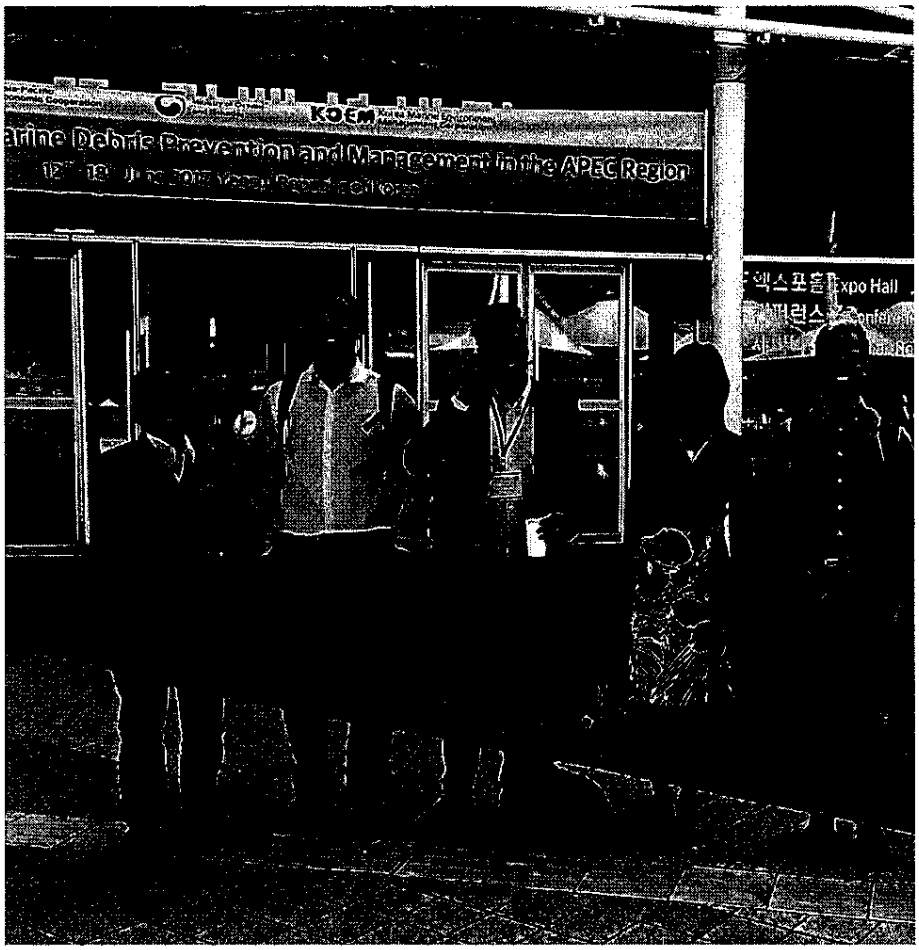


圖 7 與美國 NOAA、EPA 及聯合國環境保護計畫講者合影

（六） 中國大陸海洋塑膠微粒的研究

塑膠微粒是指粒徑小於 5mm 的塑膠粒子，包括初級塑膠微粒(Primary microplastics)，原始塑膠微粒直接使用於產品添加，例如用於去角質劑，化妝品，工業磨料或間接用作生產多種塑料消費品的前體（如原生樹脂顆粒）；次級塑膠微粒(Secondary microplastics) 由於大型塑料材料（特別是海洋垃圾）破碎而成為更小和更小的碎片。是由機械力（例如波浪）和由陽光（尤其是 UVB）觸發的光化學過程的組合引起的。

這項研究包括針對全世界塑膠微粒的研究報告做一彙整分析，包括塑膠微粒的危害在於會和多種化學或重金屬污染物交互作用，成為污染物的雞尾酒，也因此對食物鏈會造成巨大的影響，以及在全世界的分布狀況。

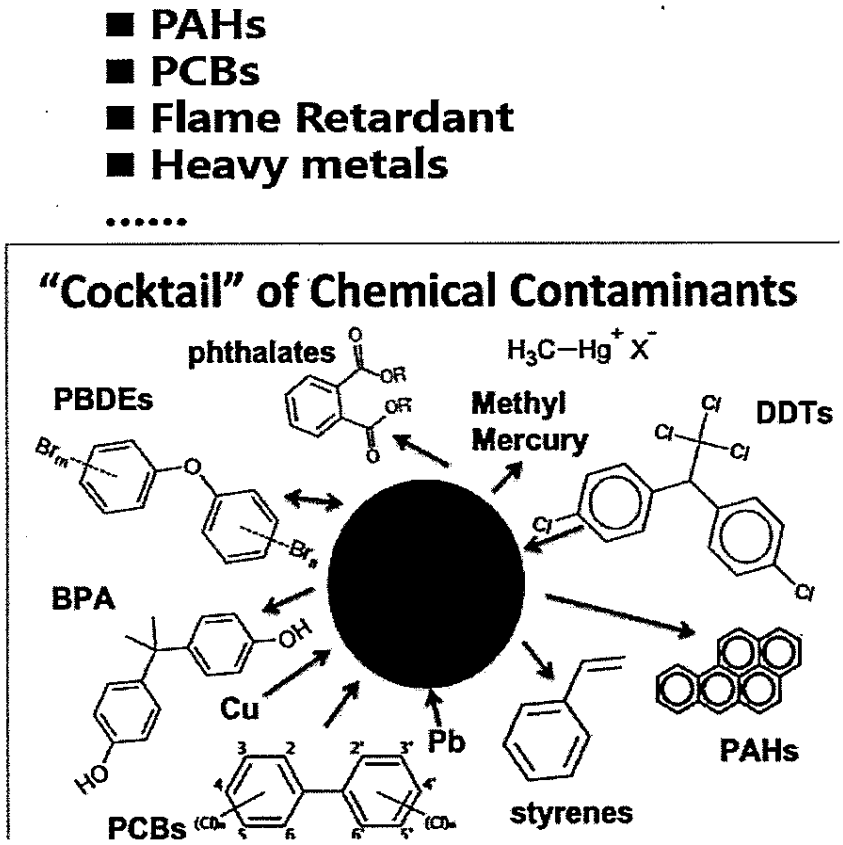


圖 8 塑膠微粒的化學污染物雞尾酒

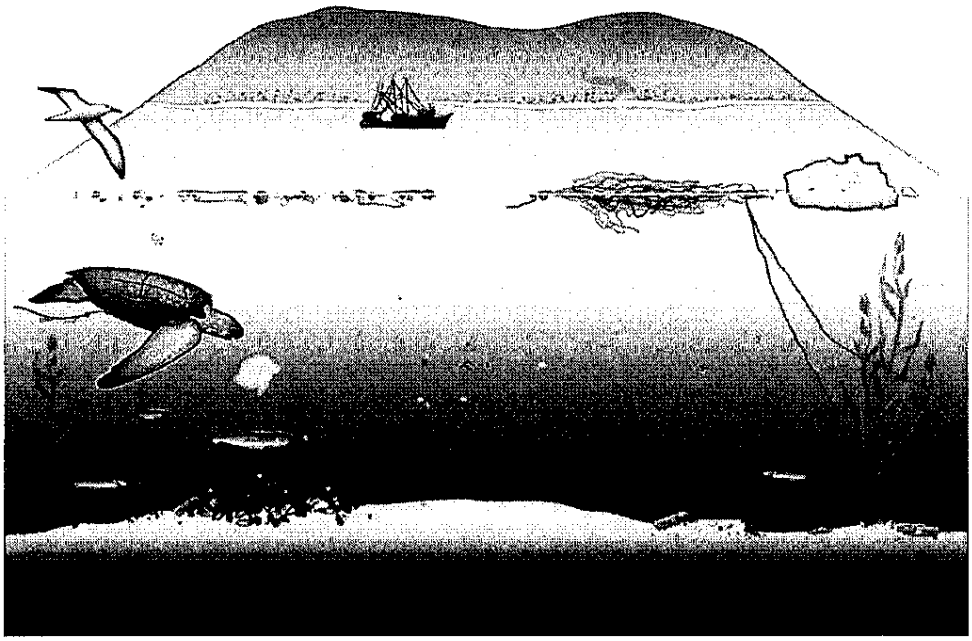


圖 9 塑膠微粒食物鏈的累積作用

塑膠微粒在任何地方都可見，粒徑涵蓋 5mm 至最小可達 10 μm，也發現具有分解塑膠微粒所需的觸酶機制的微生物可以用作環境修復策略以及用於塑膠微粒的生物分解和/或發酵。

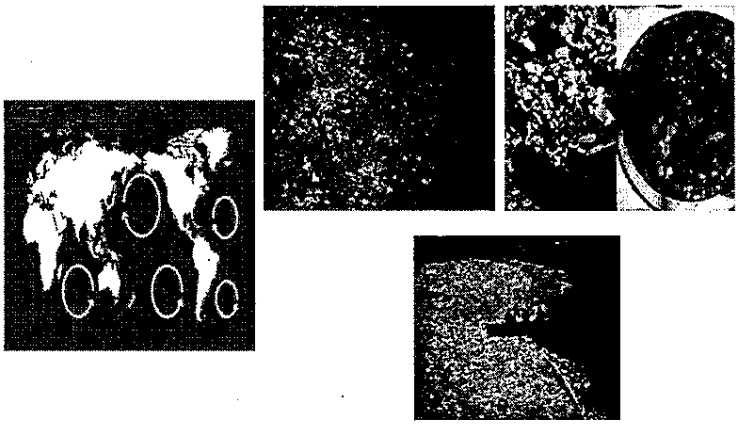


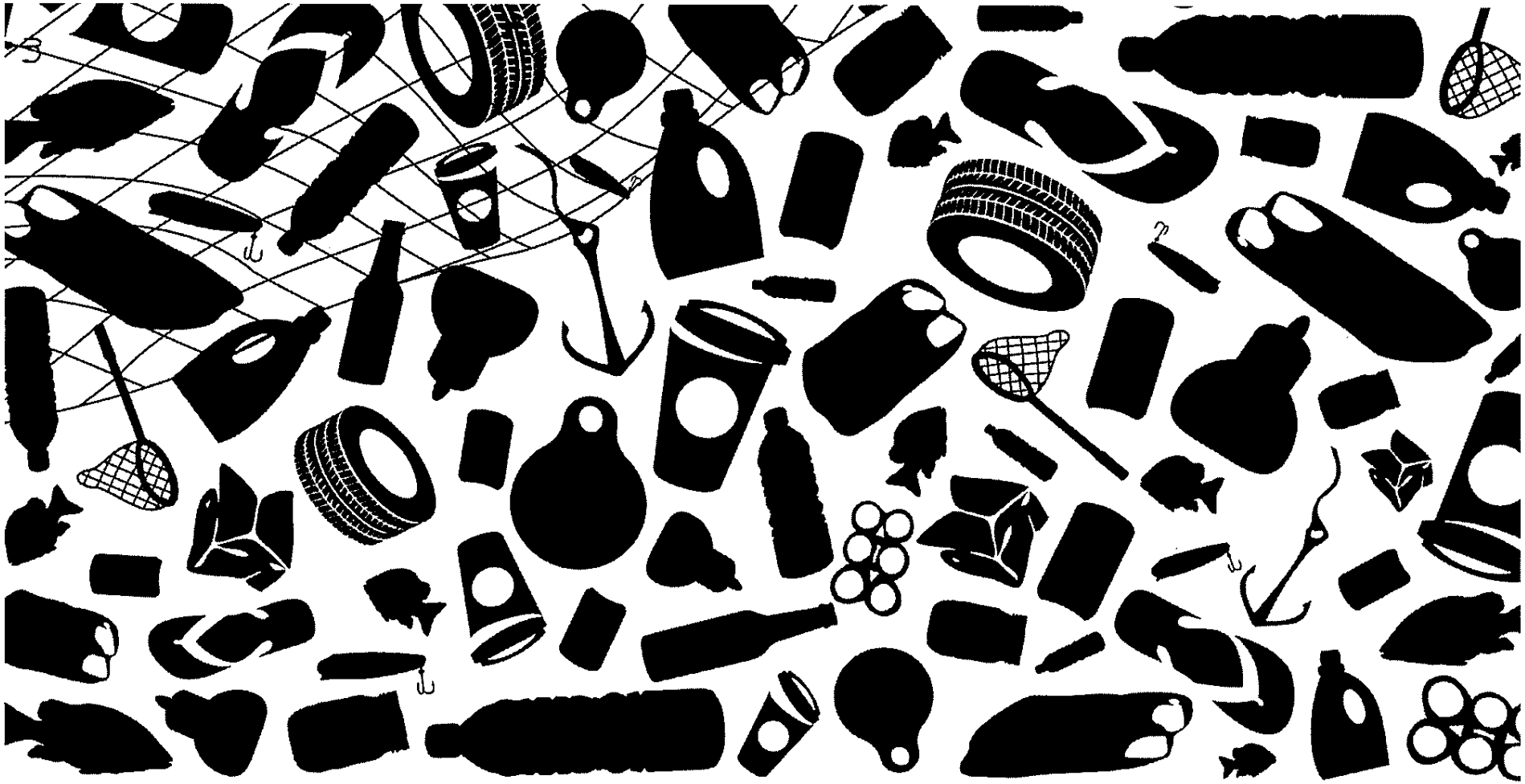
圖 10 全世界五大塑膠垃圾環流帶

肆、 心得及建議事項

一、出席本次 APEC 訓練計畫，分享我國處理海洋垃圾之經驗，並與美國環保署、國家海洋暨大氣總署及太平洋周邊國家交流海洋垃圾治理實務經驗，實屬相當難得機會。

二、建議本署未來積極主動參與國際活動與會議，延伸觸角，擴展視野，藉由類似經驗交流活動，建立國際關係，更有助於海洋環境保護。

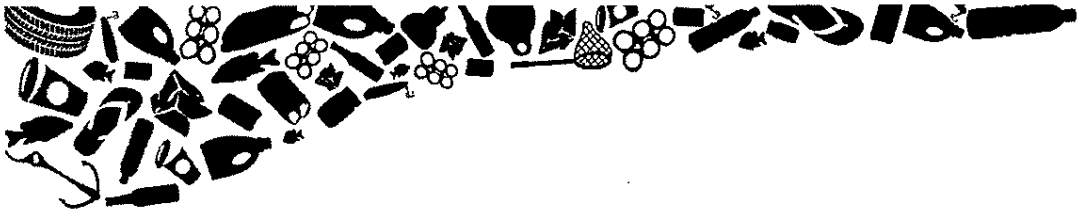
伍、 附件資料



Regulation and Management of Marine Debris in the U.S.

EPA
United States
Environmental Protection
Agency

NOAA



Regulation through National Legislation

Voluntary regulations

State, Local, and Municipal legislation and management

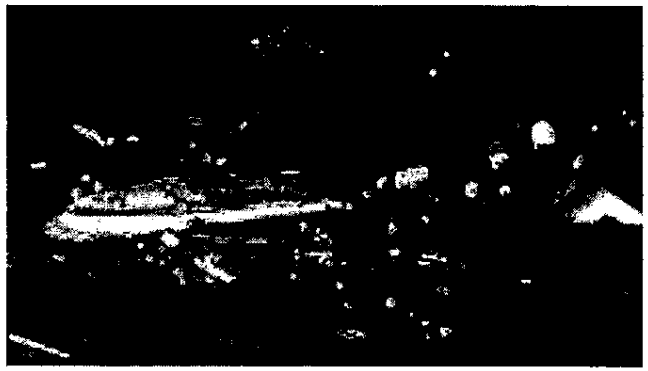
NOAA EPA United States Environmental Protection Agency

National Legislation

Marine Debris Research, Prevention, and Reduction Act of 2006

- The NOAA Marine Debris Program is authorized by Congress to work on marine debris through the Marine Debris Act, signed into law in 2006 and amended in 2012.

- The Act requires the program to "identify, determine sources of, assess, prevent, reduce, and remove marine debris and address the adverse impacts of marine debris on the economy of the United States, marine environment, and navigation safety."



NOAA

EPA United States Environmental Protection Agency

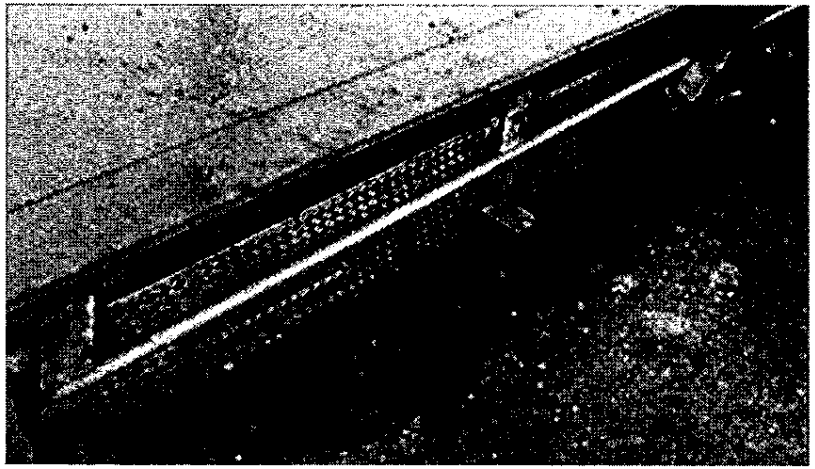
Legislative Mandates

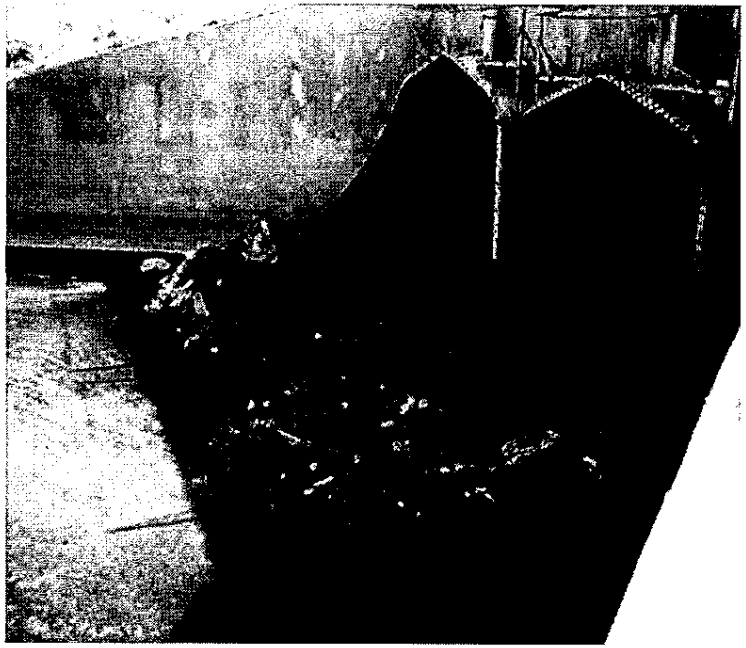
- Identify, determine sources of, assess, prevent, reduce, and remove marine debris
- Provide national and regional coordination
- Reduce adverse impacts of lost and discarded fishing gear
- Conduct outreach and education

Address "severe marine debris events"

Other Legislation pertaining to marine litter and debris

- **Clean Water Act (CWA)** – Used to prevent trash at the source through trash Total Maximum Daily Loads (TMDLs), stormwater permits, and trash capture technologies
  - 303 (d) listings for trash impairment
  - National Pollution Discharge Elimination System (NPDES) stormwater and combined sewer permits
  - TMDL for trash





NOAA

EPA United States Environmental Protection Agency

Other Legislation and Regulatory Tools

- **Superfund (CERCLA)** – Removing threats to human health, including marine debris at EPA's Pacific Southwest Regional Office.
  - Abandoned and derelict vessels removal that harbor hazardous substances and/or oil to mitigate human health risks

- **Pollution Prevention Act (PPA) and Resource Conservation and Recovery Act (RCRA) –** These authorities and tools support EPA's focus on source reduction, reuse and recovery.
  - Used RCRA to generate public-private partnerships to increase recovery and beneficial reuse of packaging waste

Other Legislation and Regulatory Tools

- **Microbead Free Waters Act of 2015 –** To amend the Federal Food, Drug, and Cosmetic Act to prohibit the manufacture and introduction or delivery for introduction into interstate commerce of rinse-off cosmetics containing intentionally-added plastic microbeads by July 2018.

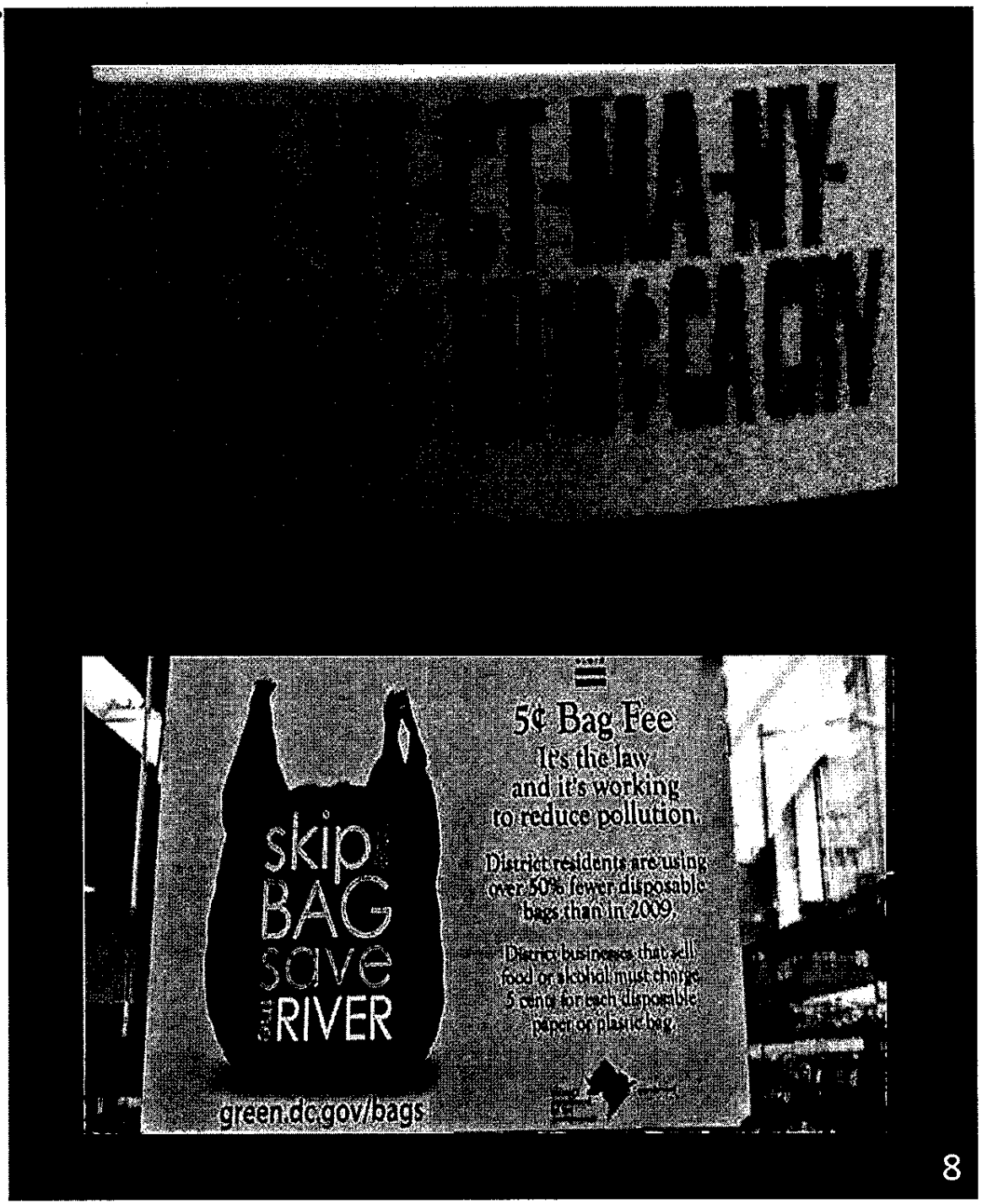
Source: The 5Gyres Institute

NOAA

EPA United States Environmental Protection Agency

State, local and municipal legislation

- Bottle Deposit Bills (State level)
- Plastic bag fees
- Plastic bag bans (mostly at the local or municipal level)
- No EPR laws passed yet



NOAA EPA United States Environmental Protection Agency

Legislation for Sea-Based Litter

- **MARPOL Annex V –** Regulations for the Prevention of Pollution by Garbage from Ships
  - Garbage must be collected by "adequate" Port reception facilities
  - Not all ports have "adequate" reception facilities
  - Coast Guard and EPA both manage enforcement and compliance of port reception facilities
  - Port Authorities take on management role of reception facilites

Source: IMO

NOAA

EPA United States Environmental Protection Agency

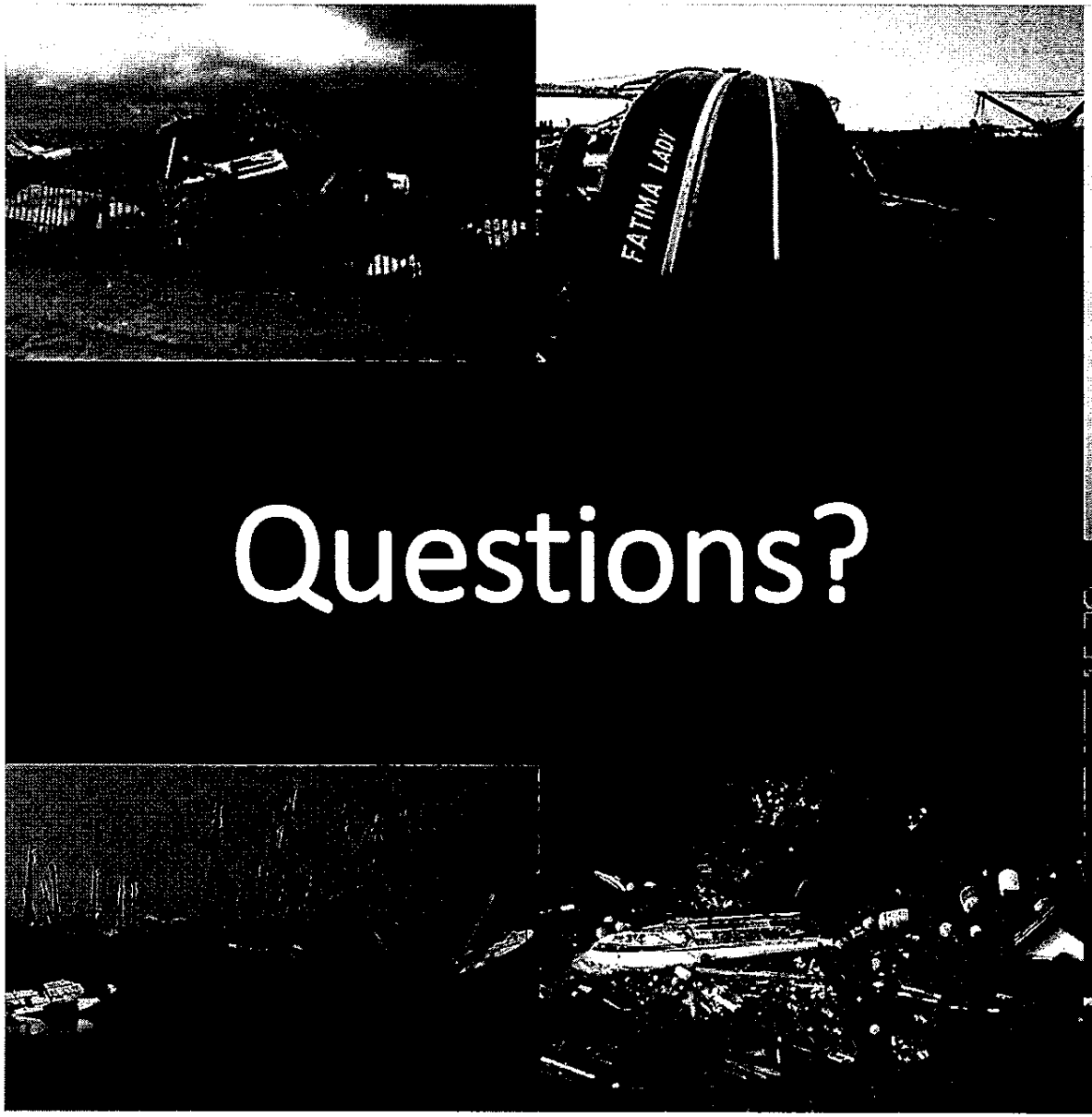
Legislation for Sea-Based Litter

- **London Convention/London Protocol** – Refers to deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms, and other man-made structures at sea
  - Largely focused on dredged material, sewage sludge, fish waste, and inert inorganic material
  - Some of this deliberate material is garbage and other waste from land that is deliberately dumped in open ocean
  - Enforcement and compliance is administered by USEPA and U.S. Coast Guard

NOAA

EPA United States Environmental Protection Agency

Regulation and Management of marine debris in U.S.



Questions?

Andrew Horan

Horan.Andrew@epa.gov

U.S. Efforts to Combat Marine Debris

Grant Programs
- **Removal**
- **Education and Outreach (Prevention)**
- **Research**

Public-Private Partnerships

Regional Coordination

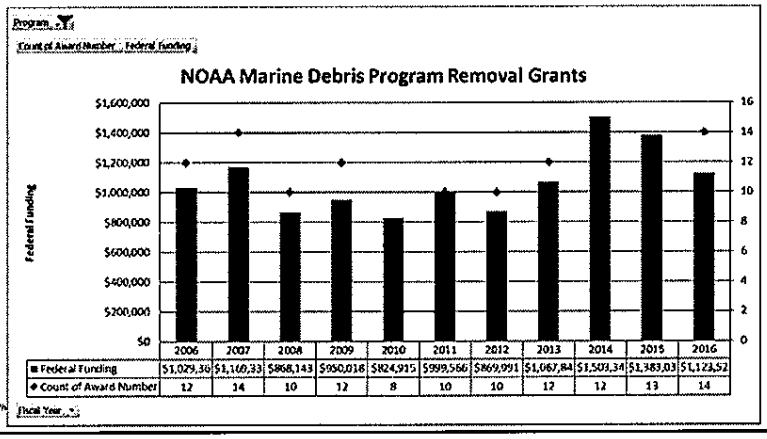
Photo: NOAA CREP

2

Removal

Community-based marine debris removal grants

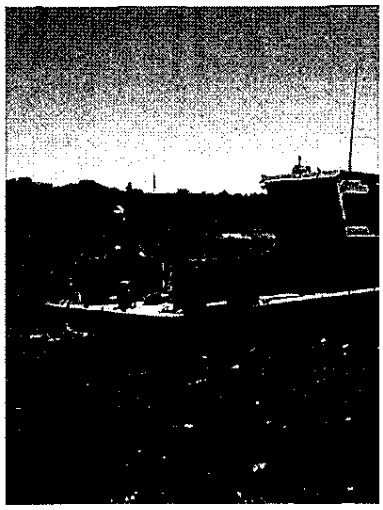
- Grants support removal projects **nationwide**
- Recipients include NGOs, state and local government, and academia
- Funded more than **130 projects** since 2006



3

Removal

Large-scale



Small-scale

Photo: NOAA ORP

4

Removal

Northwest Hawaiian Islands Marine Debris Removal

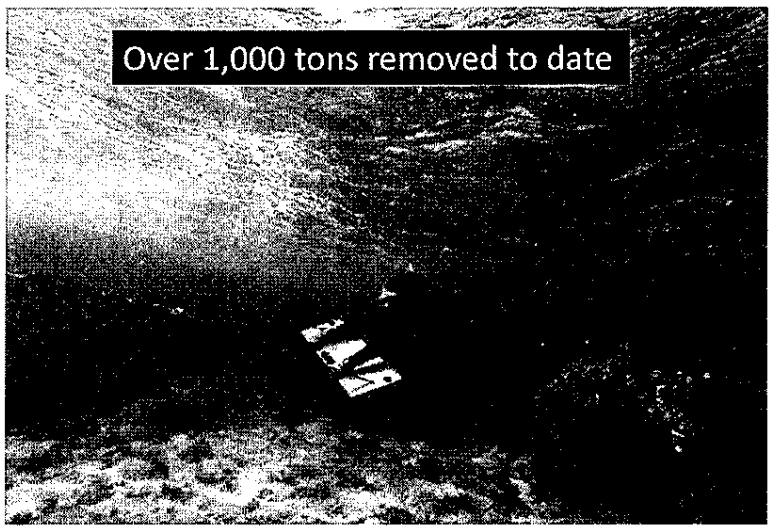


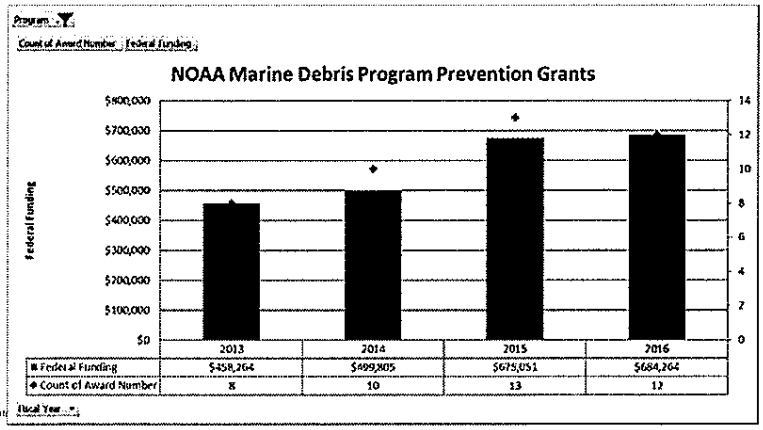
Photo: NOAA CREP

5

Education / Outreach

Prevention grants

- Projects focus on **outreach, education, and behavior change**
- Funded more than **40 projects** since 2013



6

Education / Outreach

Educational Curriculum Development

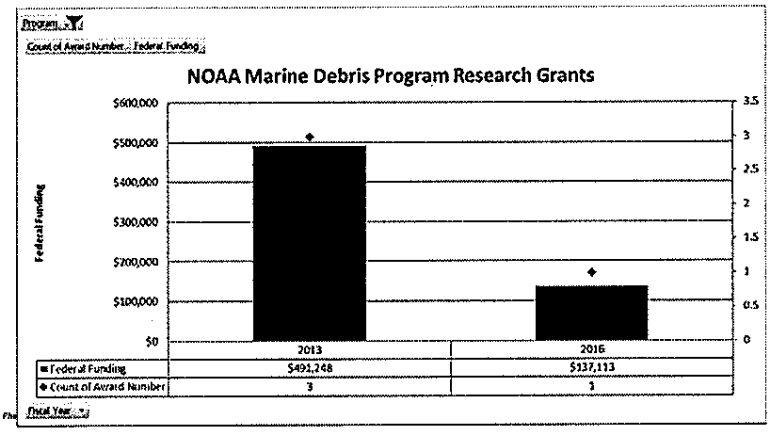
Photo: NOAA CREP

7

Research

Research grants

- Projects focus on **microplastic, derelict fishing gear impacts, and economic impacts**
- Funded **4 projects** since 2013



8

Acceptable Gear

- **Nets** - nylon, polypropylene, monofilament - as dry as possible with organic debris removed
- **Fishing gear rigging** - trawl dragger cookies, cans, rollers, chain – *steel ground cables are accepted but should be separated from other gear for disposal*
- **Traps/Pots** - wood, vinyl-coated wire - crushed with bricks removed
- **Line** - nylon, polypropylene - as tightly coiled as possible

11

All bin locations since 2008

12

Research

- Detection and modeling
- Monitoring
- Economic impacts
- Natural resource impacts
- Microplastics

Photo: NOAA CREP

9

Public / Private Partnerships

FISHING FOR ENERGY

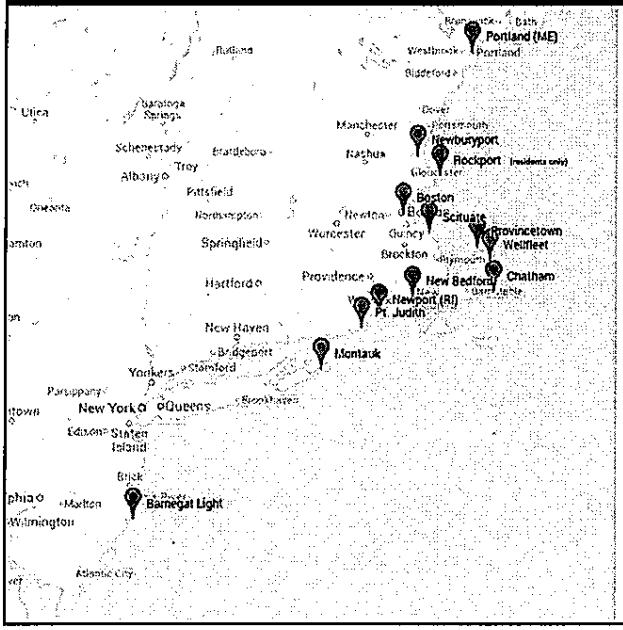
Fishing for Energy Partnership

- Covanta Energy
- Schnitzer Steel
- National Fish and Wildlife Foundation
- NOAA Marine Debris Program

Bin program

- No-cost disposal option for commercial fishermen to dispose of old or unwanted gear.
- Metals and other recyclable materials are removed and recycled.
- Materials that are not recyclable are incinerated at a Covanta Energy facility.
- > 1,315 metric tons to date (~3,000,000 pounds)

10



Garibaldi, OR

Newport, OR

New Hampshire - rotating

Not part of FFE:
Hawai'i Nets-to-Energy Program

13

NOAA Marine Debris Emergency Response and Action Planning

NOAA Marine Debris Program

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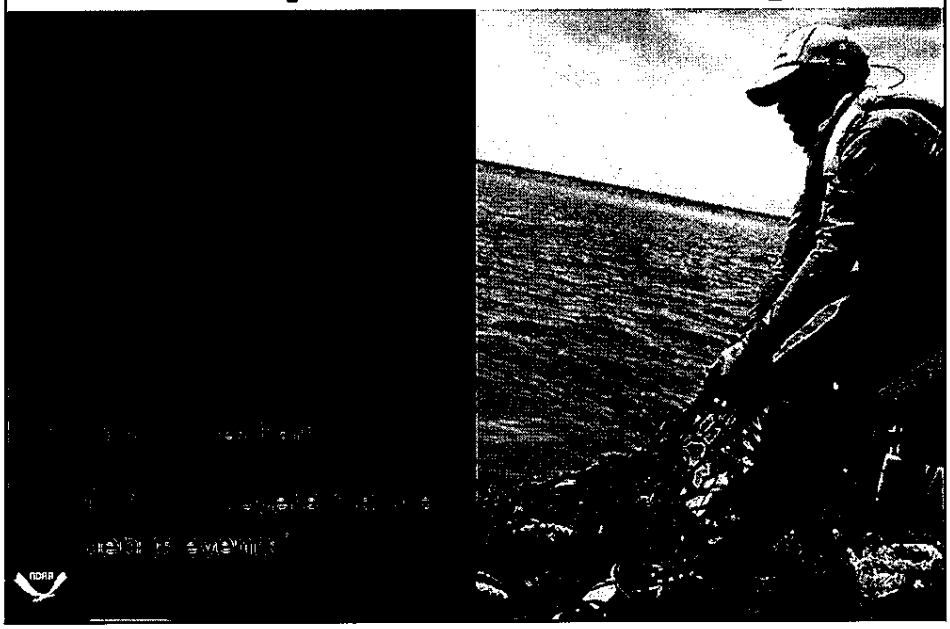
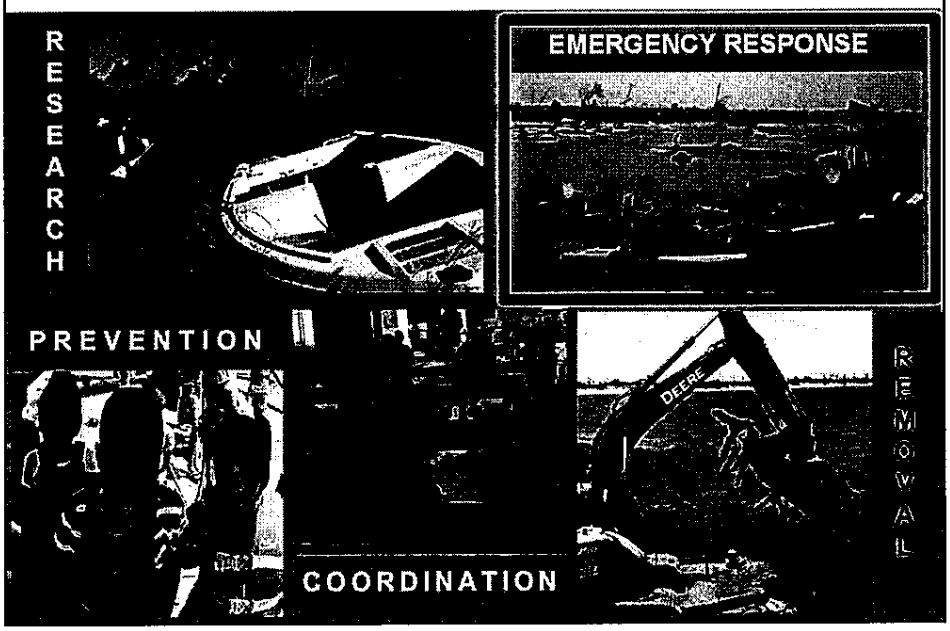
Response Planning



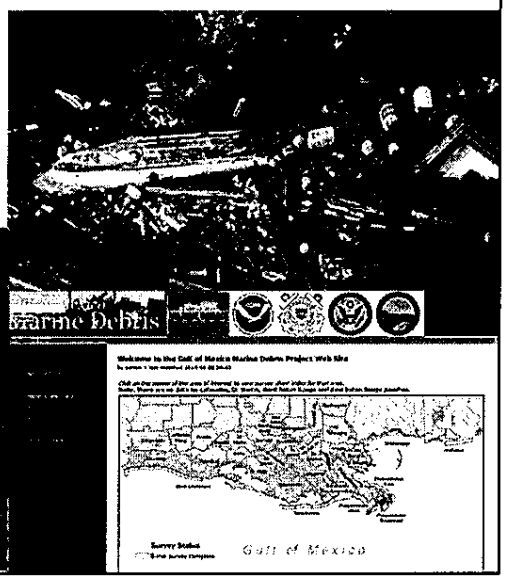
Program Pillars

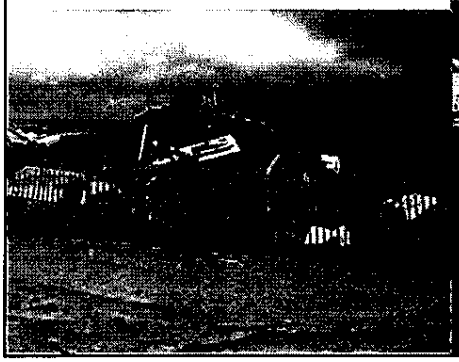


MDP Response History

2005-2012: Case-by-case

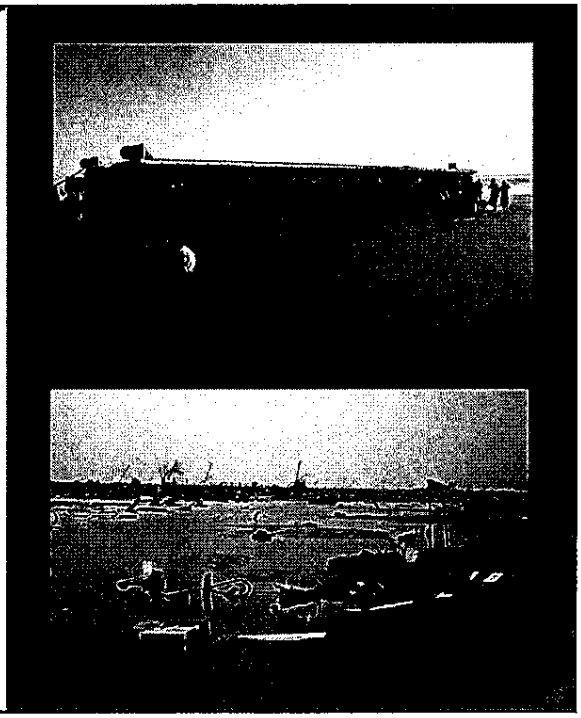
Hurricanes Katrina and Rita (2005)
American Samoa Tsunami (2009)
Japan Tsunami (2011)
Super Storm Sandy (2012)



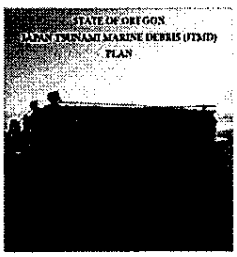


Emergency Response to Marine Debris

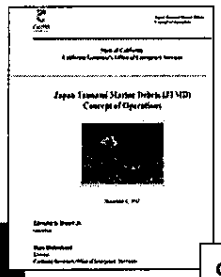
- Every event is different
- Debris can threaten **navigation, natural resources, and human safety**
- 2012 MDP reauthorization included specific language on response mandate
- 2014 began focused effort to conduct response planning
- Internal: Developed a response framework and list of core services
- External: Working with relevant agencies to create Regional Response Plans



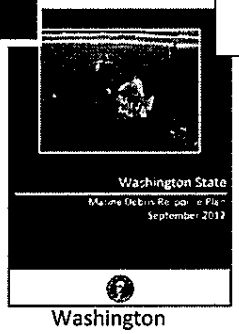
West Coast Plans



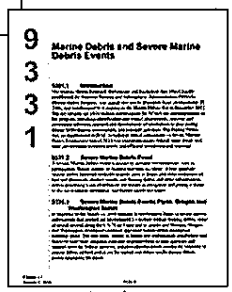
Oregon



California



Washington



Northwest Area Contingency Plan

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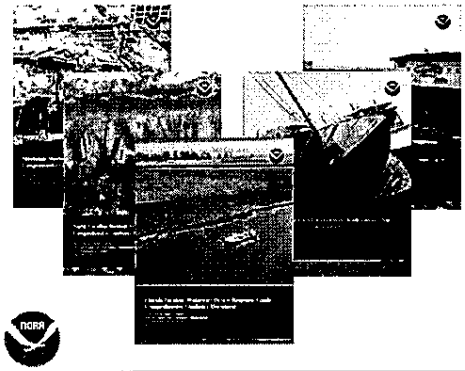
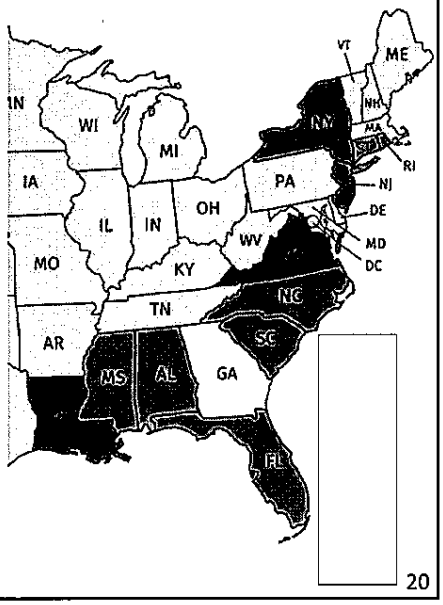
Status of Gulf and East Coast Plans

- Published & Complete
- Written & Under Review
- In Development
- Passive Research Complete





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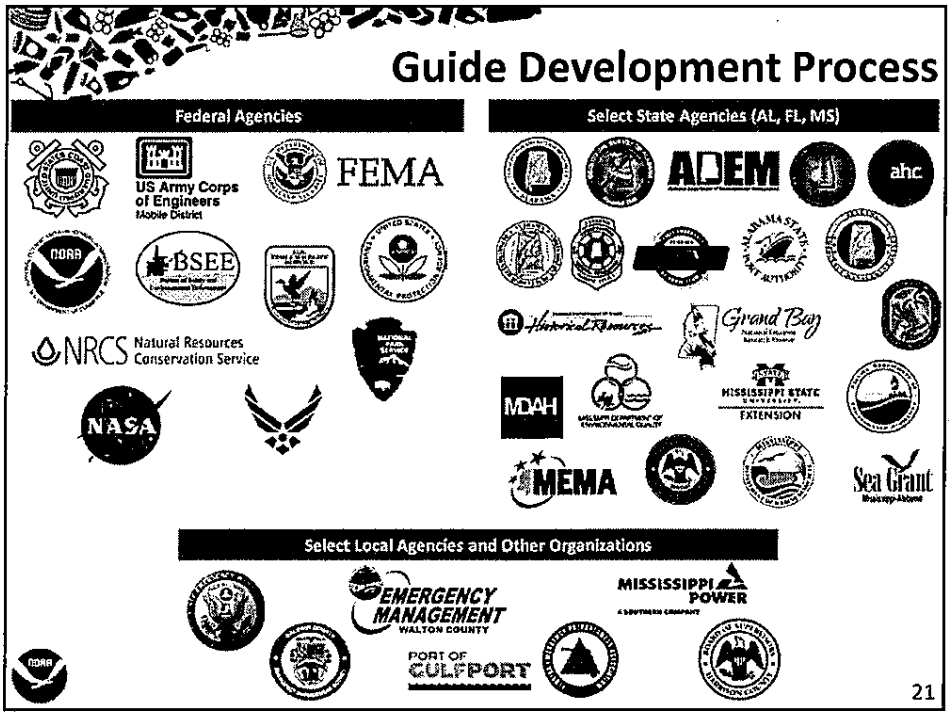

Action Planning

- Coordinated efforts help reduce marine debris
- NOAA MDP provides a roadmap – focused direction
- Plan developed by local stakeholders adds value to issues and actions in the plan and becomes powerful tool to inform decision makers
- Coordinated message among partners can be much more powerful communication tool
- Helps us (NOAA MDP) prioritize projects for funding
- Aligns states with regions, regions with Nation

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Existing Debris Action Plans

- Hawai'i Marine Debris Action Plan
- Great Lakes Land Based Marine Debris Action Plan
- VA Marine Debris Reduction Plan
- FL Marine Debris Reduction Guidance Plan
- Oregon Marine Debris Action Plan





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✓Purpose

✓Scope of Plan: functionally and geographically

✓Plan Maintenance

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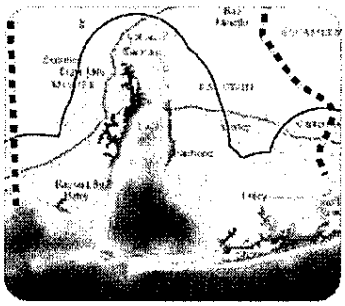

		Risk of Occurrence		
		High	Medium	Low
Natural Hazards	Flooding	H		
	Tornados/Wind Storms	H		
	Hurricanes	H		
	Winter/Ice Storms		M	
	Earthquakes			L
	Landslides/Subsidence			L
	Tsunamis			L
Technological Hazards	Transportation (Air/Sea/Rail)		M	
	Terrorism			L
	Hazmat (Fixed Facility)			L
	Hazmat (Transportation)			L

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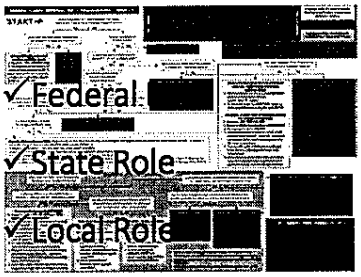

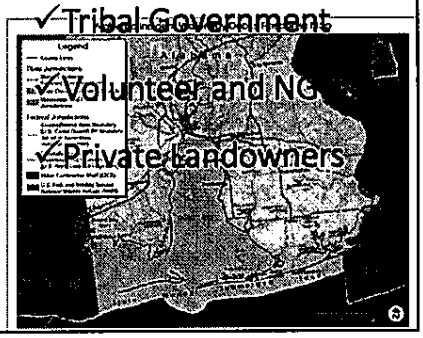

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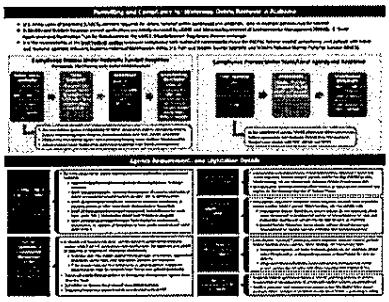

US Army Corps of Engineers Mobile District
ADEM
ahc

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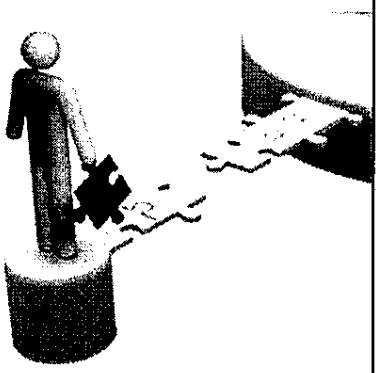

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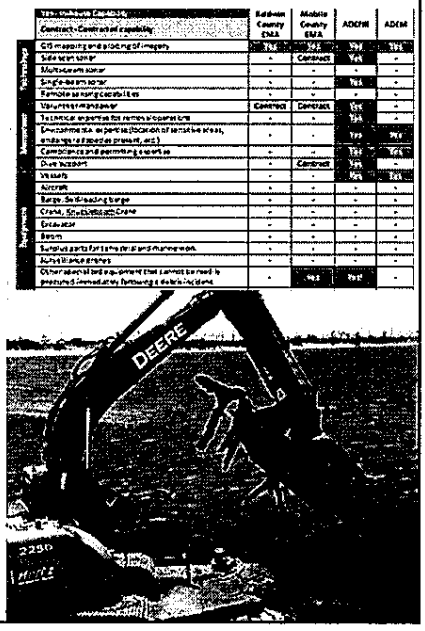

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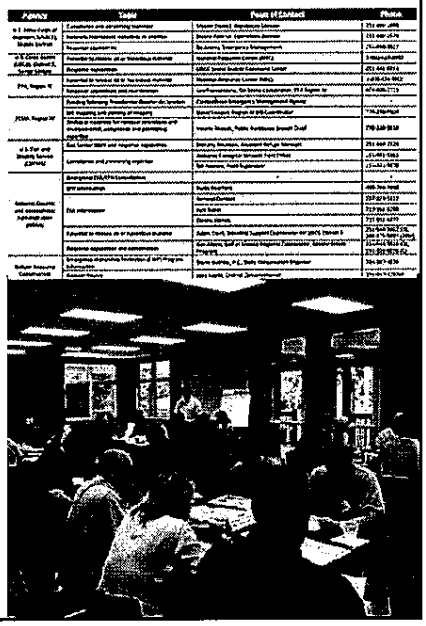

Guide Contents

1. Introduction
2. Background Risk: Foreseeable Incidents and Debris Types
3. Agency Roles, Responsibilities, and Jurisdictions
4. Permitting and Compliance Requirements
5. Gaps and Recommended Actions
6. Agency Response Capabilities
7. Agency Contact Information

Field Reference Guide

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The NOAA Marine Debris Monitoring and Assessment Project

NOAA Marine Debris Program

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Marine Debris Monitoring and Assessment Project (MDMAP)

Sea Grant
National Marine Sanctuaries
U.S. Fish & Wildlife Service
SURFRIDER FOUNDATION
Redfish Rocks Community Team
National Park Service
Heal the Bay
HAPPON
SAVE OUR SHORES
COASTWATCH A PROGRAM OF OREGON SHORES
OREGON COAST AQUARIUM NEWPORT
HUMBOLDT STATE UNIVERSITY
California Coastal National Monument

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MDMAP Goals

- Provide tools to partners
- Promote standardization
- Address research questions, detect JTMD arrival
- Raise awareness
- **Guide prevention**

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Program Development

- CitSci program launched in 2012 w/response to JTMD
- **General question:** Is the amount and composition of marine debris changing in a given area?
- **Specific Question:** What is the total marine debris load at a 100 m site over a 28 day (± 3d) period?

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Methods Overview

- Sites are self-selected by partners
- Partners conduct monthly shoreline surveys
- Data upload to online database
- Only items larger than 2.5 cm

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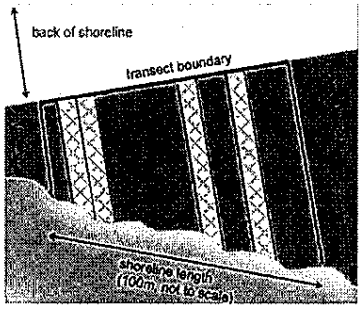
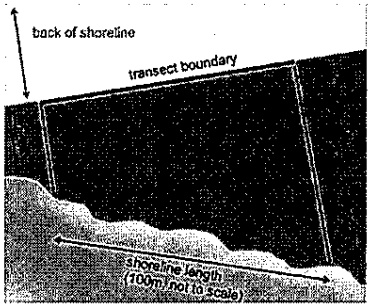
Methods

- Counts of debris items per m^2 of shoreline
- Emphasis on debris material type

Standing-Stock
(no debris removal)



Accumulation
(beach cleanup)



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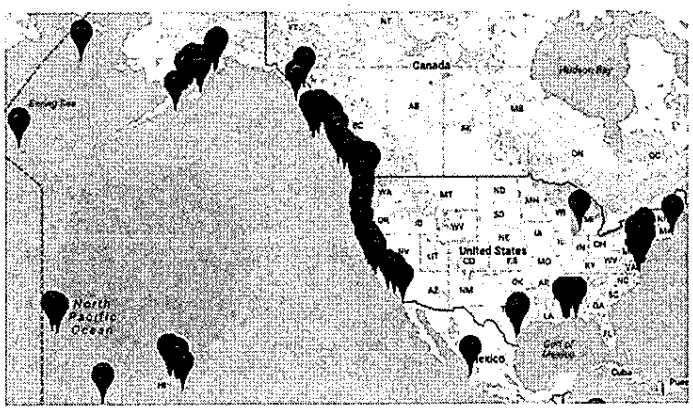
MDMAP Stats

- Shoreline Sites: 320
- Surveys Uploaded: 5,792
- Database account holders: 345



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Database

- mdmap.orr.noaa.gov
- "Verified" data is available to users
- Custom Item feature for locally relevant items

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MDMAP "Get Started Toolbox"

- Tutorial Series
- Protocol Documents and Field Datasheets
- Protocol Quiz
- Database User Guide
- Data Analysis Templates
- Searchable Photo Gallery
- FAQs

Shoreline Monitoring FAQs

Have a question about the MDMAP? Visit our Frequently Asked Questions page.

https://marinedebris.noaa.gov/research/monitoring-toolbox

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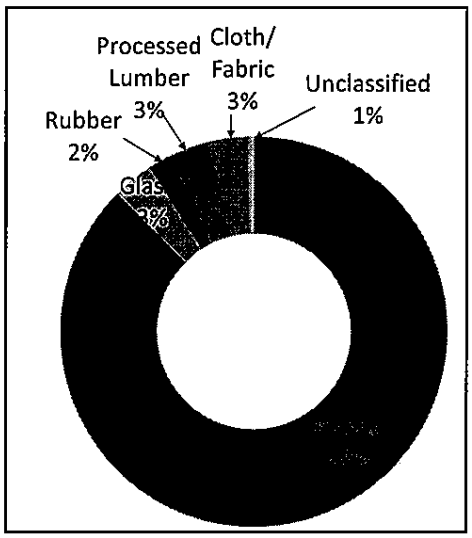
Results

- U.S. Pacific States
- 91 sites; 1476 surveys
- Mar 2012 – Feb 2016
- 211,709 items recorded



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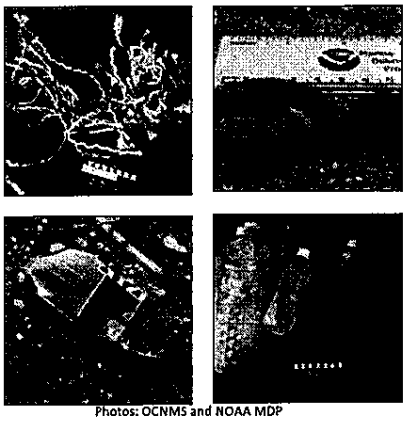
Results

- 42% of items were plastic fragments

•Plastic rope & net, bottle/container caps, food wrappers, & plastic beverage bottles are top 10 "Identifiable Items" across all states.



Photos: OCNMS and NOAA MDP

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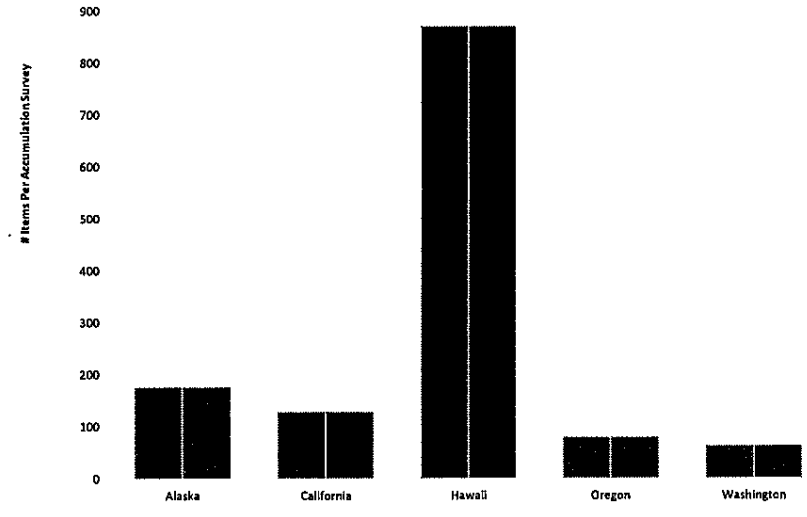
Results



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Results

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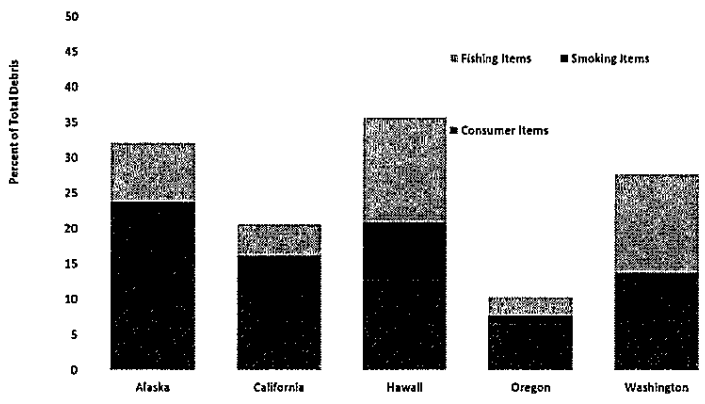
Results



* Does not include cigarette butts < 2.5 cm

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MDMAP Successes

- High level of interest & engagement
- Rewarding citizen science experience
- Qualified and committed partners
- Requests for data access

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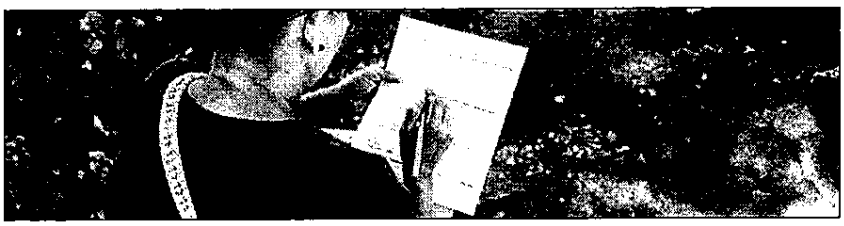
MDMAP Next Steps

- Improvements to MDMAP Toolbox and Database
- Promote & expand the program
- Partnering with Ocean Conservancy on analysis of drivers and trends



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Questions?

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EPA's Trash Free Waters Program

A strategic approach to prevent and reduce marine litter



Capacity Building for Marine Debris Prevention and Management in the APEC Region
June 12 – 17, 2017
Yeosu, Republic of Korea
Andrew Horan, *U.S. Environmental Protection Agency*

Why is marine litter a problem? Why EPA?

- Approximately 80% of marine litter comes from land-based sources. Trash, especially plastics, follows the waterways to the marine environment.
- Poor and inadequate solid waste management is the main generator of litter and debris to our oceans.
- Plastic is estimated to make up 60-80% of marine litter, there fore Sustainable Materials Management (SMM) must be more of the focus
- Plastic litter is a vector for transferring PBTs from the water to the food web, elevating the risk to animals in the marine food web and ultimately to humans.

EPA Trash Free Waters

A holistic, strategic national approach

A land-based trash prevention and reduction focus

Preventing trash from entering our waterways is essential to ensuring healthy water, healthy habitats, and healthy communities.

Former EPA Administrator Gina McCarthy

Trash Free Waters Goal Statement:

Significantly reduce the amount of trash entering U.S. water bodies and the ocean through actions taken by government (at all levels), the business community, and individual citizens, approaching zero loadings of trash entering aquatic ecosystems within 10 years (by 2023).

EPA Trash Free Waters Program: Four Focus Areas

(1) **Research**

- Assess ecological and human health effects from plastics (macro and micro) in the marine food chain.
- Convene Pellston-like workshop to prioritize research
- Webinars to help standardize methodologies

(2) **International**

- Support U.S. delegations at international marine trash conferences.
- Engage in multi-national & bilateral initiatives (e.g., Caribbean and S.America TFW pilots).

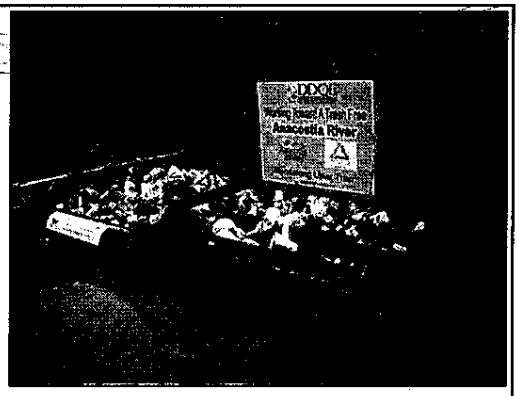
Our Ocean II Conference, Chile 2015

Trash Free Waters Program: Four Focus Areas, continued

(3) Regional Strategies

Build State and Municipal Trash Prevention Programs

- EPA is a catalyst and facilitator for strategic planning.
- Create tools & resources to support state/local programs (e.g., Great Practices, Gulf Atlas, The Flow, website).



Anacostia River Trash Trap Device

Pacific Northwest
New program under development

California/Pacific
Research
Education
State/city regulatory standards

NY/NJ: Grant funding to support municipal projects re: bottles, bags, butts

Mid-Atlantic: 'Great Practices' resource.

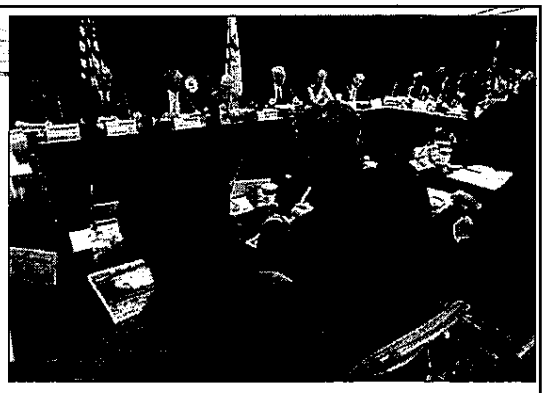
Puerto Rico: Bag ban and practical litter prevention pilots; citizen science project.

Gulf of Mexico: Innovative partnership projects in states, watersheds, and a major port.

Trash Free Waters Program: Four Focus Areas, continued

(4) Public/Private Partnerships

Collaboration to Address Key Leverage Points for Source Reduction



Trash Free Waters Executive Dialogue with EPA Administrator McCarthy, Sept. 2015

- Support external "grand technology challenges" to "solve" the marine plastics problem.
- Expand the WRAP plastic film recycling program into a public/private partnership.
- Connect willing corporate sponsors with urban watershed projects for litter prevention.
- Support development of new fiber filtration technologies by white goods manufacturers.
- Design the next generation anti-litter campaign with cause marketing elements tied to brand loyalty and social influence on behaviors – Sports partnerships and University competition.

Trash Free Waters International

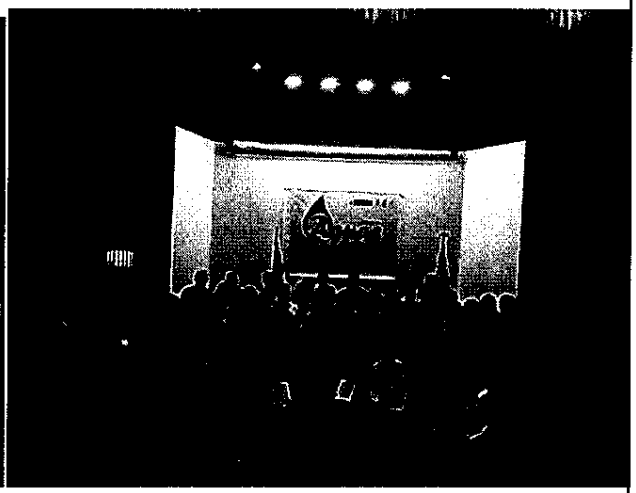
- **Partnership between US EPA, Peace Corps and UN Environment launched at Our Ocean Conference in 2015**
- **Launch and implementation of TFW in Jamaica, Panama and Peru – 2016-2017**
- **Trash Free Waters Toolkit and How-To Guide coming 2017**

Waters off of Kingston, Jamaica – June 2016

Trash Free Waters International - Peru

- Bilateral, multi-stakeholder engagement with the U.S. Government and the Government of Peru
  - United States agencies: U.S. Embassy Peru, USEPA, USAID
  - Peruvian agencies: Ministry of Environment, GORE Ica (Regional Environment), City of Chincha, Ciudad Saludable
- High level roundtable with former USEPA Administrator McCarthy and Peruvian Minister of Environment Galarza
- Trash Free Waters stakeholder workshop involving 70 participants from a variety of local, regional, and national agencies across all sectors
- Discussed plans and potential projects spanning 5 focus areas: Infrastructure, Technology, Policy and Governance, Coordination and Collaboration, and Awareness Raising and Education

Trash Free Waters International - Peru

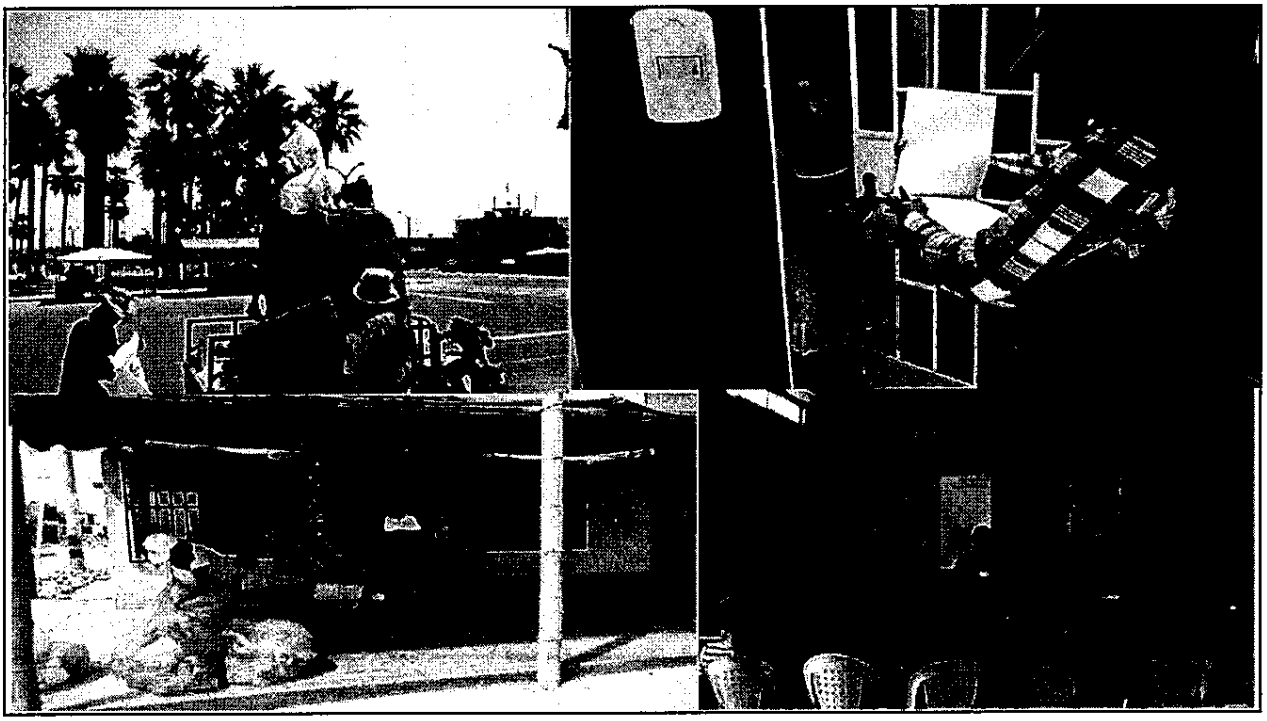


Trash Free Waters International - Peru

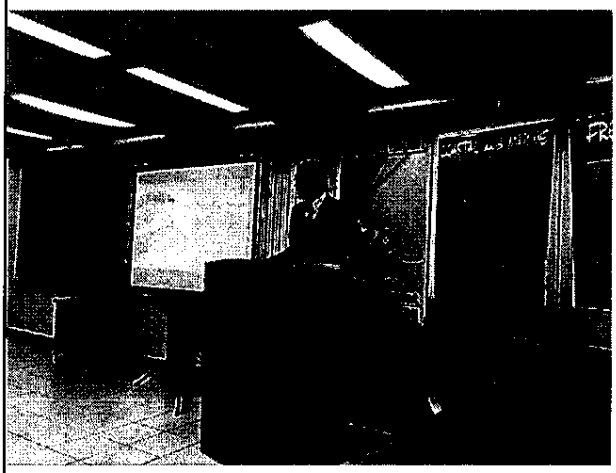
Peruvian stakeholders in breakout groups during Trash Free Waters workshop, Fall 2016

Trash Free Waters International - Peru

EPA staff work with Peruvian stakeholders on finding solutions to their marine litter problem



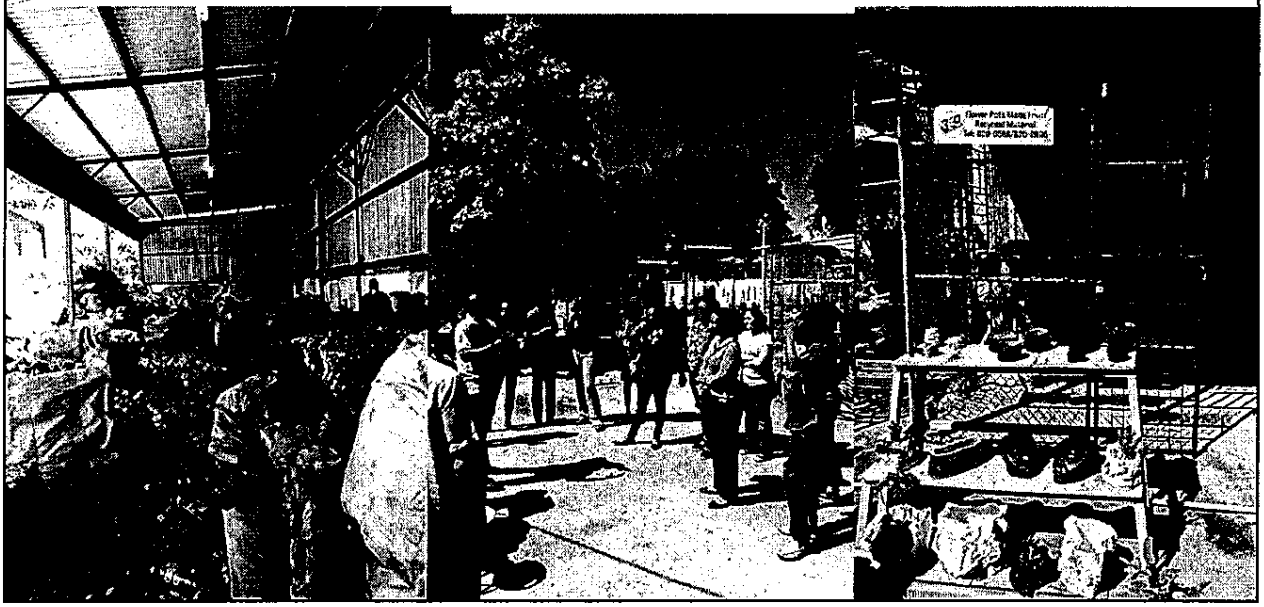
Trash Free Waters International - Jamaica



Ministry of Jobs and Economic Growth Chief Technical Director, Lt Col. Oral Khan opening the workshop

Jamaican Environmental Youth participant summarizing small group input

Trash Free Waters International - Jamaica



Trash Free Waters International – Other Engagements

- Land-Based Sources Protocol to the Cartagena Convention – U.S. National Technical Focal Point
- G7/G20 Engagements
- APEC VWG on Marine Debris
- Global Partnership on Marine Litter
- Arctic Council
- London Convention/London Protocol on Ocean Dumping
- MARPOL Annex V - Garbage
- Bilateral engagements

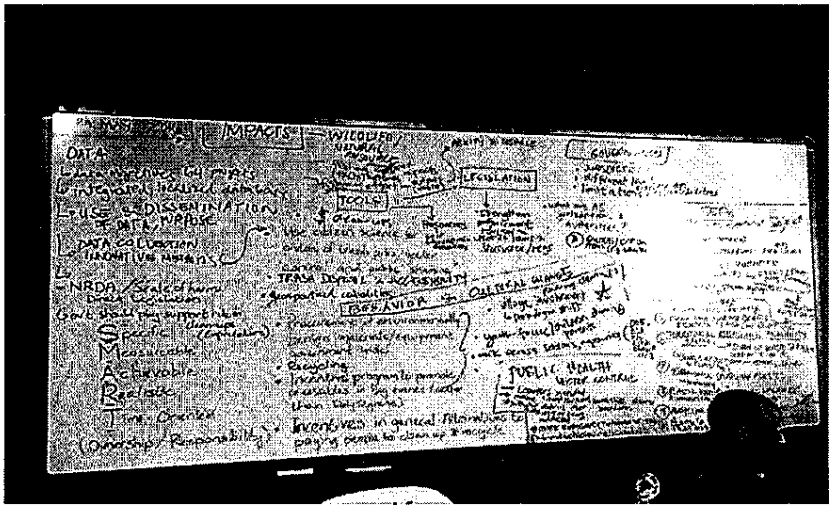
Trash Free Waters Stakeholder Dialogues:

A snapshot of American Samoa, Puerto Rico, Gulf Coast

Trash Free Waters American Samoa

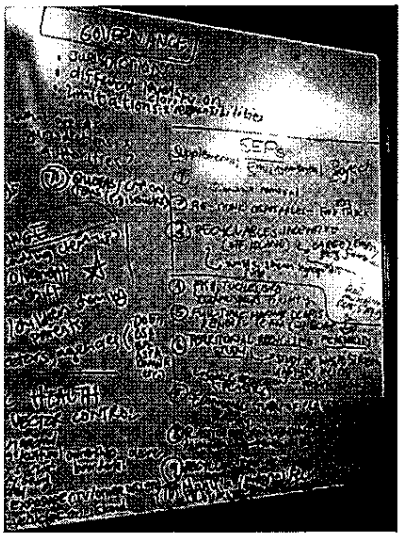
- 2016 Marine Debris Action Plan workshop convened by American Samoa EPA and USEPA Region 9
- Provided background of known impacts of marine litter, share knowledge of existing initiatives, and discuss opportunities to develop action items
- Identified six priority projects:
  - Moving waste and recyclables off island
  - Education and Outreach
  - Generating village-based Materials Recovery Facility (MRF)
  - Legislation on Styrofoam ban
  - Removal of grounded longliner vessel
  - Establishing dedicated clean-up team in Pago Pago harbor

Trash Free Waters American Samoa



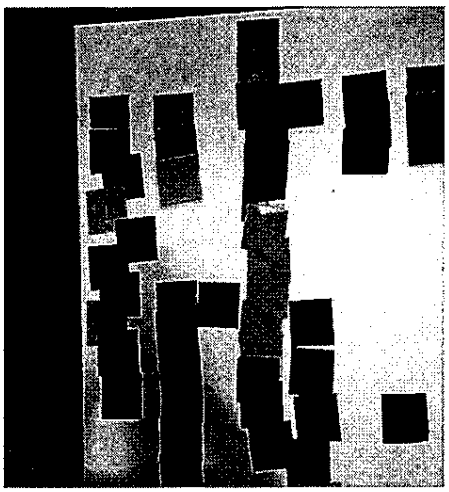
Summary of challenges and opportunities identified by participants

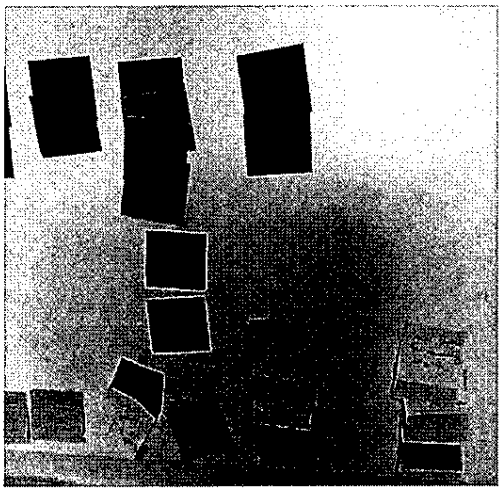
Trash Free Waters American Samoa



Marine Debris projects proposed by participants

Trash Free Waters American Samoa





Tally of project proposal votes

Trash Free Waters Puerto Rico

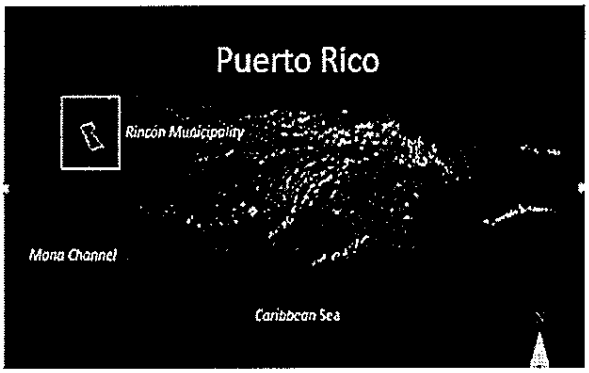
- Series of stakeholder dialogues held in Puerto Rico in 2015
- Focused primarily on plastics and the following five materials referred to as "PB5": plastic Bags, micro-beads/micro-plastics, single-use plastic beverage bottles, food service boxes, cigarette butts
- Identified 6 proposed projects based on stakeholder collaboration:
  - Database/Information Resource Pertaining to Island-wide Marine Litter Prevention and Reduction Efforts
  - Cigarette Butt Data Gathering and Messaging for Diversion
  - Alternatives to Single-use Plastic Bags at Stores
  - Anti-litter Messaging and Disposal Options at Food Truck Restaurants Within a Watershed
  - Stormwater Management to Prevent Trash from Entering Receiving Waters
  - Alternatives to Single-use Plastic Bottles and Styrofoam Cups at Government Agencies and Sponsored Events

Trash Free Waters Puerto Rico: Stormwater Pilot

Trash Free Waters Puerto Rico: Stormwater Pilot

- In partnership with San Juan Municipality's Planning and Environmental Compliance Office and the University of Puerto Rico, workers installed eight metallic grates in storm water sewers that drain into Condado Lagoon
- Group performed weekly characterization of waste for data
- Conducted survey and "face-to-face" interviews" for public perception of proper disposal of solid waste
- Results:
  - Over 3 first 3 months, almost 400 lbs of waste was collected
  - 62% of waste collected was plastics
  - Survey showed that 60% of public does not fully understand recycling and reuse of materials
  - Publication of citizen guide for Condado Lagoon on preserving water quality

Trash Free Waters Puerto Rico: Rincon Plastic Bag Reduction



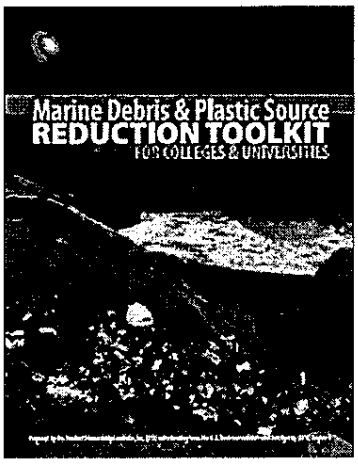
Trash Free Waters Puerto Rico: Rincon Plastic Bag Reduction

- Municipal-wide effort to reduce plastic bag use and occurrence in the environment
- Municipal law passed on bag fee at local stores at $0.15/bag
- Reduced plastic bags found in the environment by 60% over a 6 month period
- After success from Rincon, transferred to San Juan the capitol where the government then issues Bill 247 in 2015 that bans single-use plastic bags island-wide

Trash Free Waters Southwestern Swing: Texas, Louisiana, Mississippi

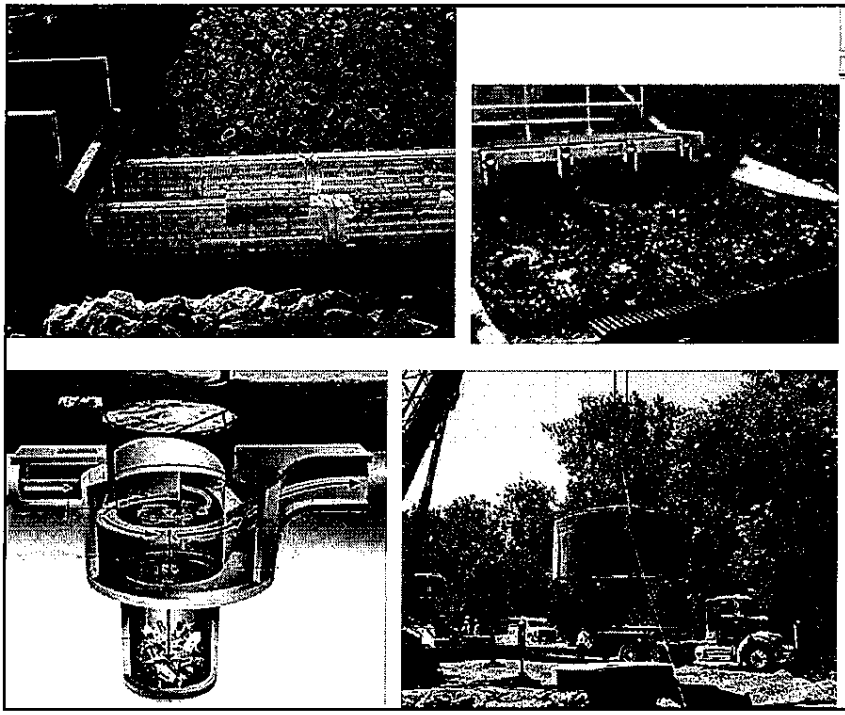
- Trash Free Waters in 3 Phases: Reconnaissance, Regional Strategizing, Implementation
- 11 cities, 13 stakeholder meetings, 230 people
- Main waste streams of concern: Single-use food items, plastic bags, tires, straws, construction packaging
- Tires identified as big problem due to previous efforts at bank stabilization and illegal dumping
- Re-aligning initiatives to be preventative, not reactionary
- Trash "hot spots": Convenience stores, grocery stores, parking lots, bridges/overpasses, roadsides
- Barriers: Bottle bill legislation prevention, intense rain and flooding events, regional culture of littering, some areas with little or no collection, no trash monitoring

Trash Free Waters Projects



Trash Free Waters Projects

- San Francisco Bay Area Trash Capture Demonstration Project
  - Part of San Francisco Estuary Partnership
    - EPA funding: $735K Match Funding: $4.26 million
  - Installed 4,000 small to medium trash capture devices in more than 60 Bay Area jurisdictions
  - Installed 42 large trash devices
  - Created a password protected online tool to assist municipalities in tracking maintenance of the trash capture devices

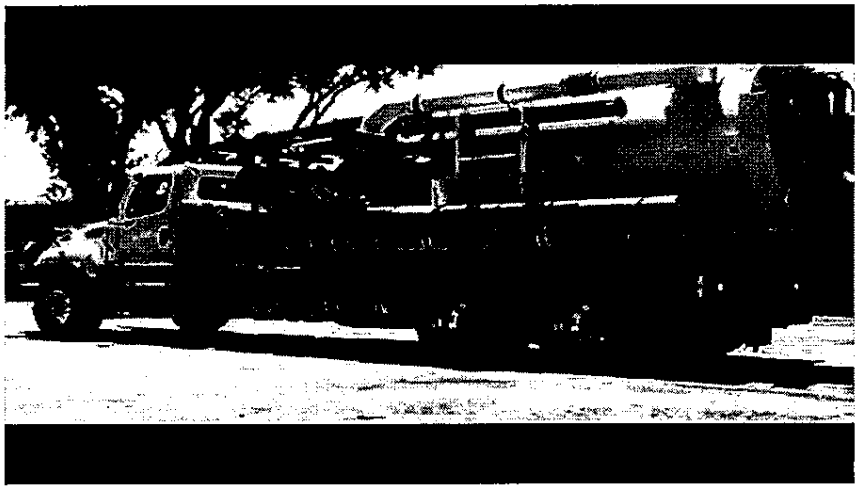


Clockwise from top-left: A gross solids removal device, Large trash nets collecting trash and vegetation after a storm, installation of a hydrodynamic separator in San Jose, California, a diagram of a hydrodynamic separator.

Trash Free Waters Projects

- Hayward Youth-Based Trash Capture, Reduction, and Watershed Education Project
  - San Francisco Bay Water Quality Improvement Fund
    - EPA funding: $800K Match Funding: $800K City of Hayward
  - Install 3 large capture devices
  - Treat over 1,000 acres of high trash generating area
  - Prevent over 20,000 gallons of trash from entering San Francisco Bay per year
  - Trash reduction curriculum to be taught in all schools in Hayward

City of Hayward Video – Saving the Bay: The Trash Capture Device Under Your Feet

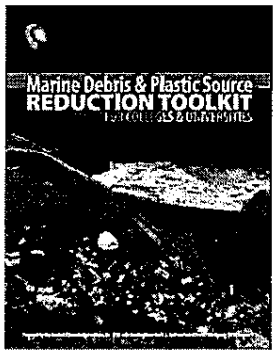


Trash Free Waters in New Jersey and New York

- New York State Pollution Discharge Permit
  - Goal: Establish the loading rate of trash, debris, floatables and settleables in the receiving waters
- New York City is developing a floatable and settleable trash and debris management program
- NYC will implement an education media campaign to further educate public on trash and debris control issues.
- EPA awarded 365K from Region 2's Aquatic Trash Prevention Grant Program to help New York and New Jersey meet these goals

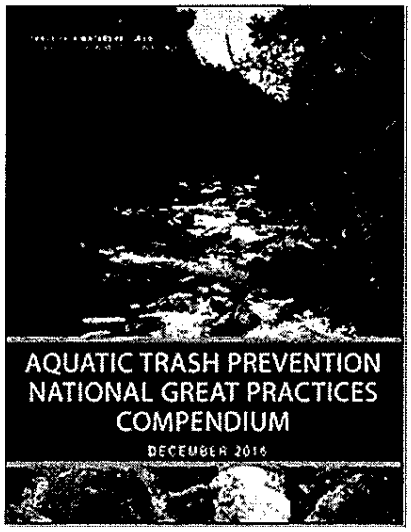
Reducing Plastics on College Campuses

- The Product Stewardship Institute (PSI), in partner with EPA, designed a project to promote plastic source reduction on California college campuses
- Implemented strategies to reduce the use of disposable plastics in food service settings, replacing plastics with durable, reusable products
- Development of Marine Debris and Plastic Source Reduction Toolkit for Colleges and Universities:
  - Identifies four steps in reducing packaging on campus
  - Helps determine campus's plastic footprint
  - Guidelines for source reduction planning



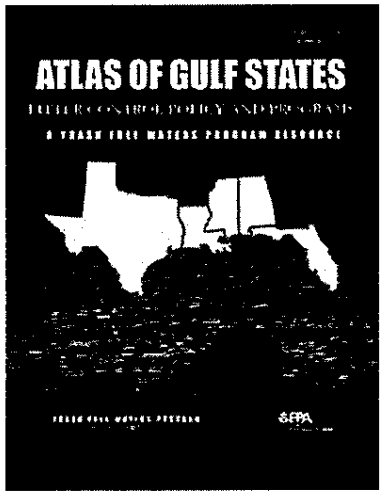
Compendium of Great Practices for Mid-Atlantic

- The National Great Practice Compendium highlights outstanding activities, technologies, and programs that prevent trash from entering the aquatic environment and/or that reduce the overall volume of trash that is generated



Atlas of Gulf States Litter Control Policy and Programs

- The Gulf Atlas is a compendium of state and local policies and programs that reduce and prevent marine litter, as well as the related enforcement mechanisms that support them.
- Developed in response to strong stakeholder request for information on programs that are addressing this issue.



Research

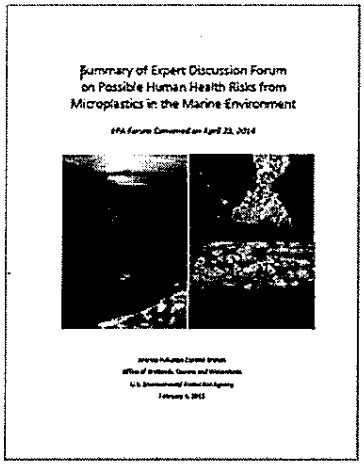
- Citizen Science: Microplastics Sampling Protocol
  - Partnership between EPA and 5Gyres
  - Sampling trawl and beach/shoreline training
  - Using Protocol developed by 5Gyres
  - Effort to harmonize monitoring and analysis methodologies for microplastics

Puerto Rico Microplastics Sampling Protocol

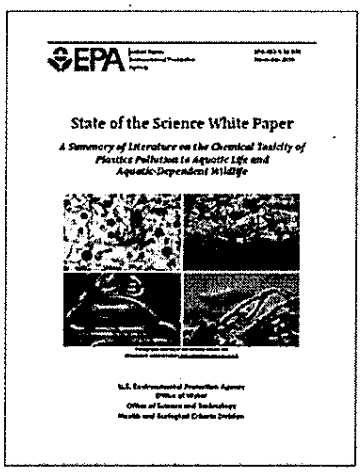
Puerto Rico Microplastics Sampling Protocol

Puerto Rico Microplastics Sampling Protocol

EPA Published Reports



Summary of Expert Discussion Forum on Possible Human Health Risks from Microplastics in the Marine Environment



State of the Science White Paper: A Summary of the Effects of Plastics Poullation on Aquatic Life and Aquatic-Dependent Wildlife

Summary of Expert Discussion Forum (2014)

- Key Takeaways:
  - Purpose of forum is to discuss available data and studies on human health risks from microplastics in the marine environment
  - Discussion focused on lack of an established, uniform method for measuring and reporting microplastics
  - Large background noise with chemical pollutants in marine life difficult to address
  - Contribution of PBT's form plastic and non-plastic sources to aquatic life not well understood, needs further research

State of the Science White Paper (2016)

- Key Takeaways:
  - Literature summary on chemical toxicity of plastics pollution to aquatic life
  - Several groups of aquatic life can accumulate chemicals with plastic ingestion.
  - Bioaccumulation modeling shows that this effect of exposure to body burdens and effects of chemical pollutants may be relatively small compared with other exposure pathways, such as direct chemical exposure via water, sediment, or ingestion of contaminated prey.
  - Further research is needed in:
    - Understanding the fate of chemicals both sorbed to and in plastics under different environme

State of the Science White Paper (2016)

- Further research is needed in:
  - Understanding the fate of chemicals both sorbed to and in plastics under different environmental conditions
  - Relative role plastics play in chemical contaminant transfer to the tissues of organisms compared to other exposure pathways
  - Understanding the relative impacts of physical and chemical effects of ingested plastic particles
  - Nanoplastics potential to permeate membranes and how they may increase toxicological risk to organisms

Microplastics Occurrence in Great Lakes Fish

- EPA is working with Great Lakes National Program Office to assess occurrence of microplastics in stomachs of Great Lakes sport fish.
- A Human Health Fish Fillet Tissue Study was conducted in 2015 as part of EPA's National Coastal Condition Assessment. These fish will be repurposed for microplastics study
- Analysis will determine the amount of plastics in fish stomachs down to very small particle sizes. Results will improve understanding of microplastics distribution in the Great Lakes and their occurrence in fish
- Links: http://www.lakescientist.com/microplastics-pollution-great-lakes-ecosystem-summary-presentations-iaglr-2014/; http://www.gesamp.org/work-programme/workgroups/working-group-40/wg-40-brochure

EPA Trash Free Waters HQ Program Contacts: Questions/Comments? Thank you!

Office of International and Tribal Affairs

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- Andrew Horan – 202-564-5383
  horan.andrew@epa.gov

Office of Water

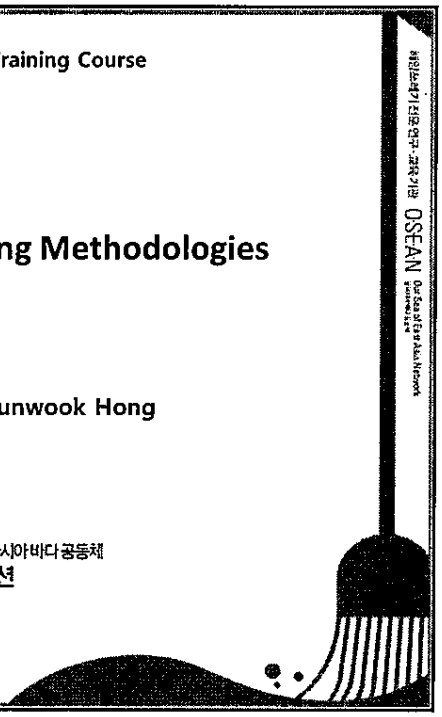
- Bob Benson – 202-566-2954
  benson.robert@epa.gov

Marine Debris Prevention and Management Training Course
in the APEC Region. 2017. 6. Yeosu, Korea.

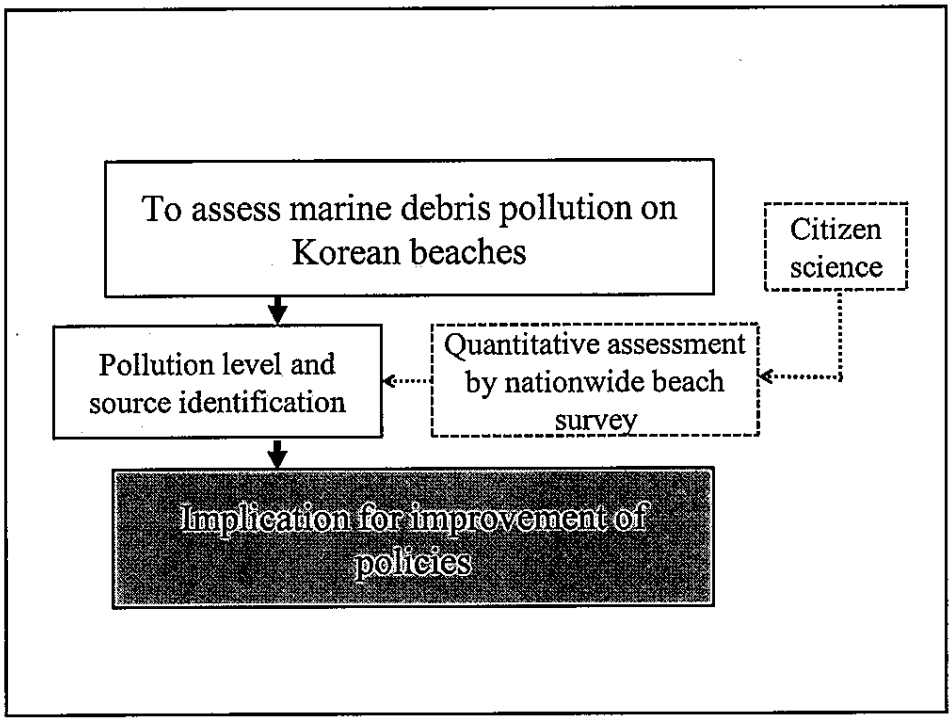
Marine Debris Monitoring Methodologies

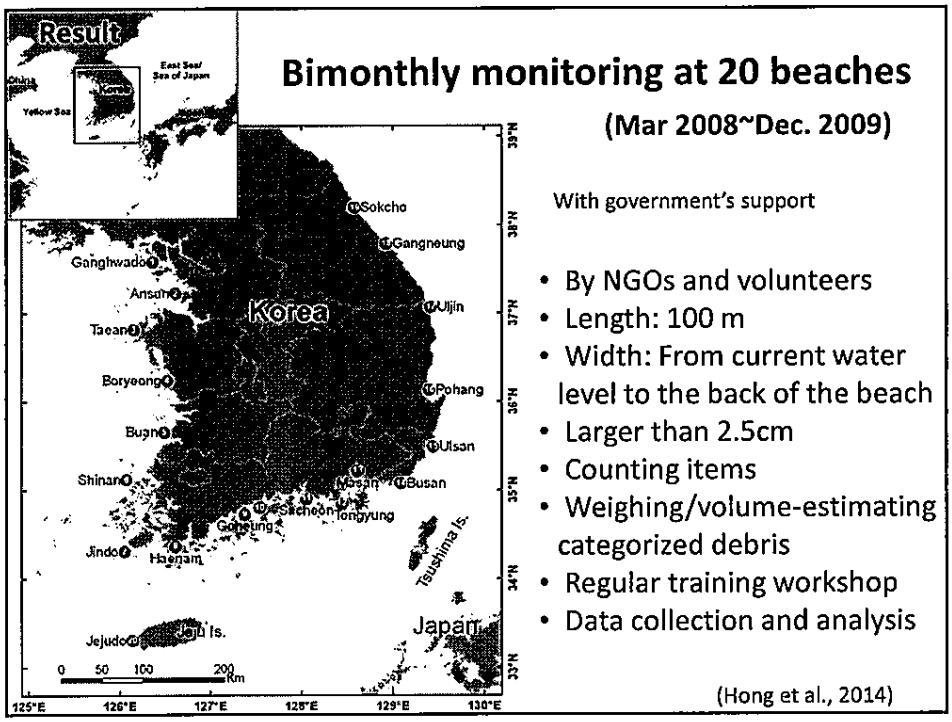
Jongmyoung Lee, Sunwook Hong

O·S·E·A·N 동아시아바다공동체 오션
Our Sea of East Asia Network



- Korea National Marine Debris Monitoring Program
- Beach Debris Rapid Assessment
- International Coastal Cleanup


To assess marine debris pollution on Korean beaches
Citizen science
Pollution level and source identification
Quantitative assessment by nationwide beach survey
Implication for improvement of policies


Result
Bimonthly monitoring at 20 beaches
(Mar 2008~Dec. 2009)
With government's support
• By NGOs and volunteers
• Length: 100 m
• Width: From current water level to the back of the beach
• Larger than 2.5cm
• Counting items
• Weighing/volume-estimating categorized debris
• Regular training workshop
• Data collection and analysis
(Hong et al., 2014)
Korea
Japan
Sokcho
Gangneung
Uljin
Pohang
Ulsan
Busan
Jeju Is.
Tsushima Is.
125°E
126°E
127°E
128°E
129°E
130°E

Result

Average quantity

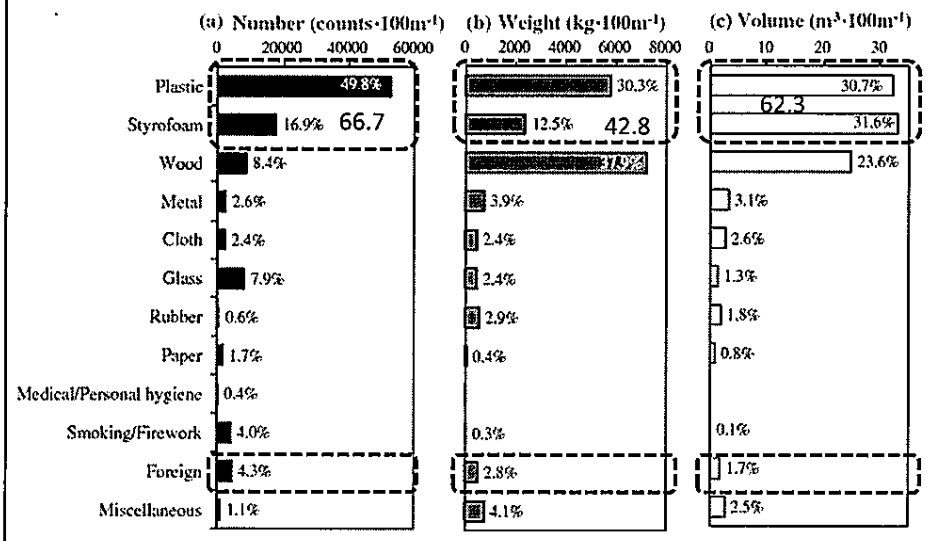
Unit/100m/2month

Site No.	Coast	Land use type	Number (counts)		Weight (kg)		Volume (m^3)	
			Av	SE	Av.	SE	Av.	SE
1	West	Rural	700.2	146.1	58.8	13.3	0.42	0.13
2		Rural	337.4	48.9	17.9	4.2	0.09	0.02
3		Tourist	307.9	68.5	58.5	27.3	0.27	0.11
4		Island	269.5	35.9	71.3	15.3	0.40	0.08
5		Tourist	443.1	94.4	180.5	60.2	1.30	0.31
6		Island	198.1	36.6	71.0	17.0	0.47	0.09
7		Island	345.1	59.0	345.8	71.0	0.64	0.11
8	South	Rural	150.0	19.4	44.1	9.3	0.33	0.11
9		Rural	557.9	83.7	159.5	30.6	0.61	0.14
10		Rural	607.8	111.9	176.4	29.9	1.18	0.21
11		Island	579.5	153.3	82.7	13.2	0.43	0.10
12		Urban	832.1	99.7	56.6	7.7	0.40	0.06
13		Urban	1206.8	136.7	76.1	14.9	0.46	0.09
14		Urban	299.7	55.3	18.3	5.3	0.10	0.02
15	East	Urban	248.3	36.8	24.5	7.2	0.17	0.05
16		Tourist	625.9	67.6	50.6	8.6	0.31	0.06
17		Tourist	198.3	48.5	19.9	6.1	0.08	0.02
18		Tourist	294.3	37.6	32.0	6.7	0.24	0.05
19		Urban	682.3	84.7	69.0	23.1	0.29	0.03
~~20~~	~~South~~	~~Island~~	~~733.8~~	~~182.0~~	~~115.6~~	~~35.4~~	~~1.34~~	~~0.44~~
Av			**480.9**	19.4	**86.5**	4.5	**0.48**	0.03

(Hong et al., 2014)

Result

Composition

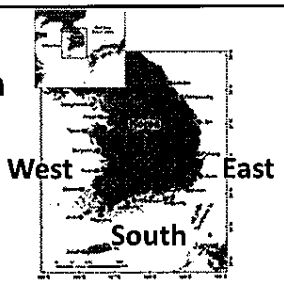


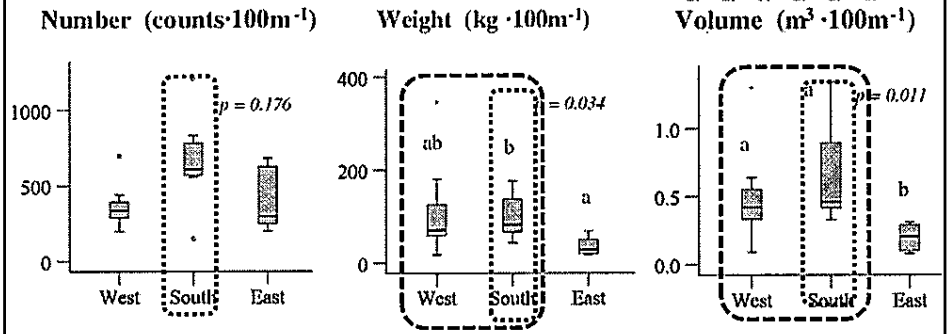
(Hong et al., 2014)

Result

Spatial distribution

Comparisions among three coasts

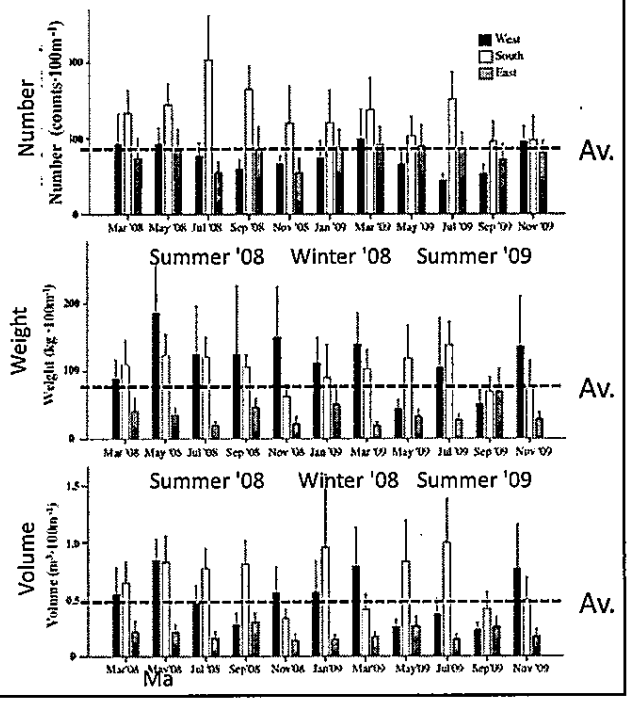




(Hong et al., 2014)

Result

Seasonal variation among coasts



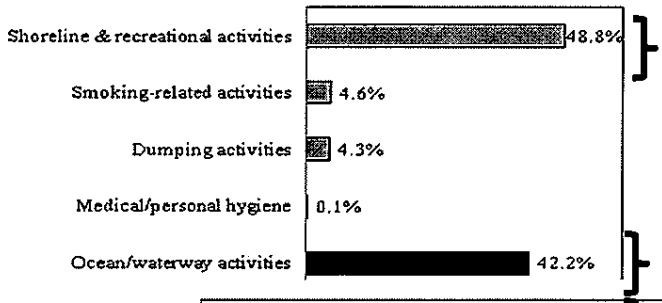
(Hong et al., 2014)

Result

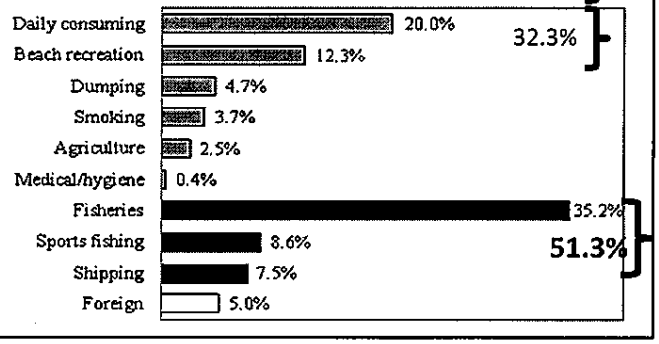
Source identification

(Hong et al., 2014)

ICC method



Scoring method
(Whiting, 1998)

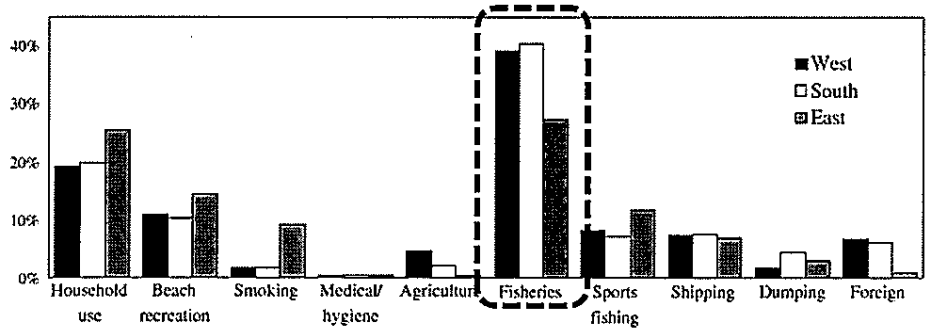


Land-based
Sea-based
Foreign

Result

Sources in W-S-E coasts

Capture fisheries + aquaculture



(Hong et al., 2014)

Result

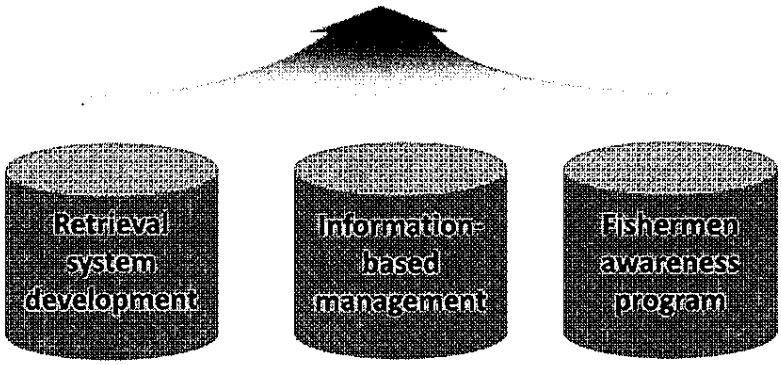
Top 10 items in number

(Hong et al., 2014)

Rank		Items	Count	%
1	Aquaculture + capture fisheries	Styrofoam buoys	13,588	12.8
2		Fishing ropes	8,703	8.2
3		Beverage bottles (glass)	7,326	6.9
4		Plastic bags	6,974	6.6
5		Plastic food wrappers	6,819	6.4
6		Plastic caps, lids	5,176	4.9
7		Beverage bottles (plastic)	5,065	4.8
8		Plastic strapping bands	4,737	4.5
9		Miscellaneous plastic items	4,223	4.0
10		Timber (for ships, aquaculture facilities)	3,676	3.5
Subtotal			66,287	62.7
Total			105,797	100.0

Developing Integrated Management System for EPS Buoys (2016~)

Prevent EPS buoy debris, protecting marine ecosystem



Governmental project

KMI/OSEAN

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Background

- Most of beach debris monitoring or surveys examine materials, types, counts/weights, and sources at limited number of sites. However, it requires a lot of cost, time, and human resources (UNEP/IOC, 2009).
- What if we want
  - to cover wide area
  - with limited human resources
  - in a short period of time?

INTRODUCTION

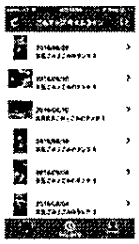
Previous studies

Cases	Classification	Status	Score (index)	References
USA	Optimal Sub optimal, Marginal Poor	<10 pieces 10-50 pieces 51-100 pieces >100 pieces	20-16 15-11 10-6 5-0	Moore et al. (2005)
Brazil	Absent Trace Unacceptable Objectionable	0 items/m >0-4 items/m >4-10 items/m >10items/m	A B C D	Araujo and Costa (2006)
Israele	Very clean Clean Moderate Dirty Extremely dirty	0-0.1 parts/m^2 0.1-0.25 parts/m^2 0.25-0.5 parts/m^2 0.5-1 parts/m^2	0-2 2-5 5-10 10-20 20+	Alkalay et al. (2007)

INTRODUCTION

Previous cases of mobile app

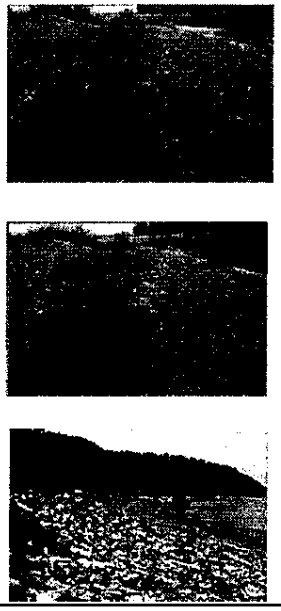
Area	Title	Since	Main body	References
USA	Marine Debris Tracker	2011	University of Georgia, NOAA	Jambeck and Johnson (2015)
Japan	Gomi-map	2014	MLIT	gomi-map.org
Asia	Global alert	2016	Ocean Recovery Alliance (NGO)	Woodring (2016)
World	Clean Swell	2016	Ocean Conservancy	Ocean Conservancy (2016)

INTRODUCTION

Best practice in Japan: Litter Pollution Index

Level	Description	Example	Volume (ℓ/100 ㎡)
⋮			
1	Few litter	2 Mineral water bottles	5
⋮			
4	Many litter	16 Mineral water bottles	40
⋮			
8	Wholly covered by litter	3 refrigeraters	640



(JEAN & MLIT, 2007)

GOALS

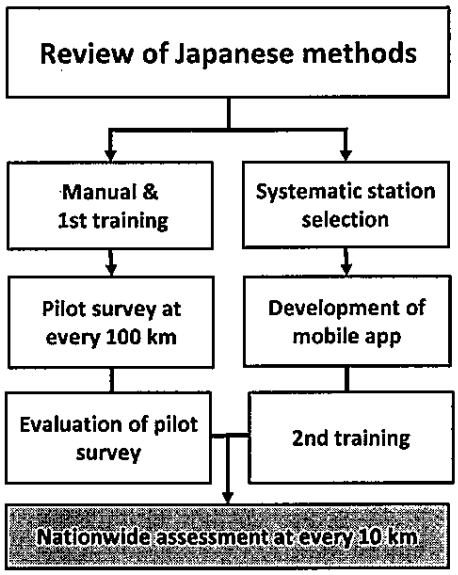
- Rapid assessment of anthropogenic debris by visual scoring and understanding its distribution along the coastal line of Korea
- Contribution to cost-efficient cleanup and hot spot management of marine debris in Korean coast

OBJECTIVES

- Development of tools for promoting citizen's active participation in anthropogenic debris pollution assessment
- Pilot survey at every 100 km and main survey at every 10 km
- Development of system for assessment at all times

www.osean.net

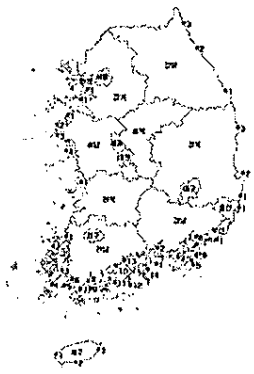
METHODS



Survey area

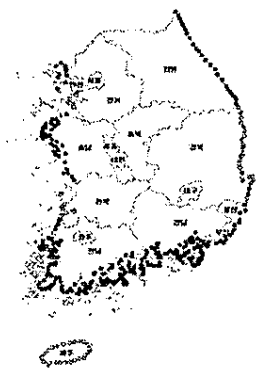
◆ Only for unconstructed coasts in main land

Pilot Survey



◆ 40 stations (100m length) at every 100 km

Main Survey



◆ 382 stations (100m length) at every 100 km

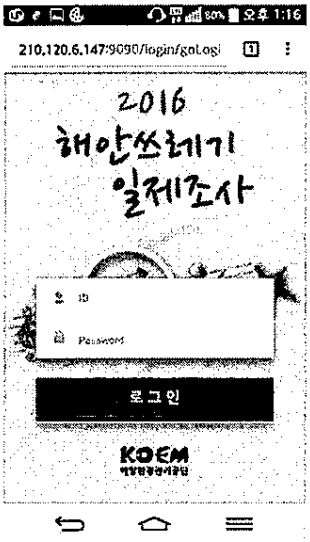
Data Sheet

Location	**Serial number** **GPS** **Location Name**					
Address	Province, City, Street, etc					
Date & time						
Level of Pollution (p. 3)	100 m beach				Beach width	
					m	
Major type of debris (%)	Fishing gear	Consumers waste	Dumping	Foreign debris	Others	
Source (%)	Aquaculture	Residents	Stream input	Other		
Inland (%)	Aquaculture	Agriculture	Beach	Village	Commercial area	Industrial area
Reporter's information						

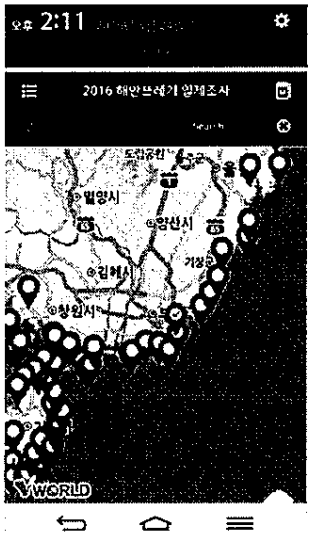
Reference quantity of pollution level

Level	Description	Debris conversion	Reference quantity (ℓ/100m²)
0	Trash is unseen.	<1	<2.5
1	Trash is nearly unseen.	2ℓ-plastic bottle, 2	5
2	Trash is visible.	2ℓ-plastic bottle, 4	10
3	Trash is visible here and there.	2ℓ-plastic bottle, 8	20
4	There is lots of trash.	2ℓ-plastic bottle, 16	40
5	There is pretty lots of trash.	2ℓ-plastic bottle, 32	80
6	There is so much trash.	Drum, 1	160
7	Trash covers most of beach.	Drum, 2	320
8	Trash completely covers.	Refrigerater, 3	640
9	Trash is accumulated in 30cm-depth.	Refrigerater, 6	1,280

Mobile app for the survey



Main screen

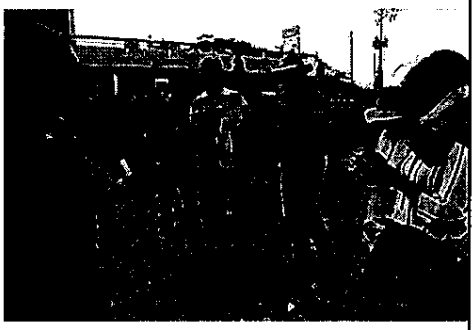


Location of stations

Training workshops

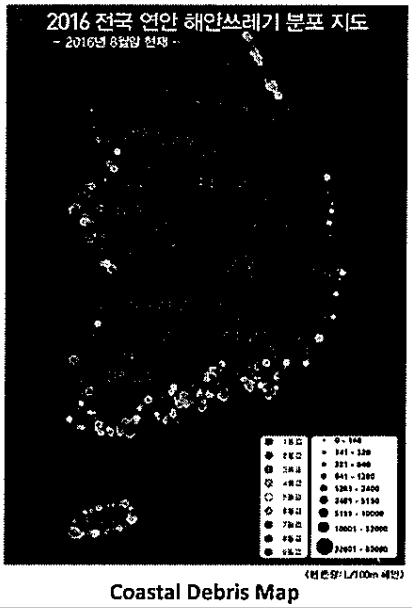
- Background and purposes of the survey
- Using the mobile application
- Field training

1st WS(16. 4.15)

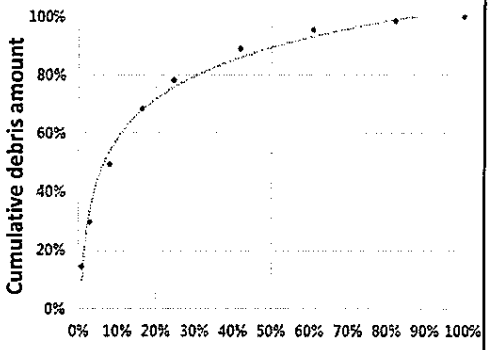


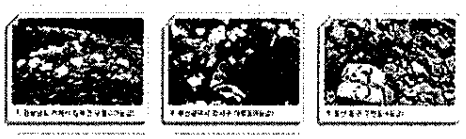
2nd WS(16. 8.19)

Spatial distribution and hot spots



Coastal Debris Map





Hot spots

Sources and impacts

◆ **Coastal Litter Index (CLI)**

$$CLI = [\alpha_1 \cdot S] + [\alpha_2 \cdot T] + [\alpha_3 \cdot U]$$

Where,

S: standing stock

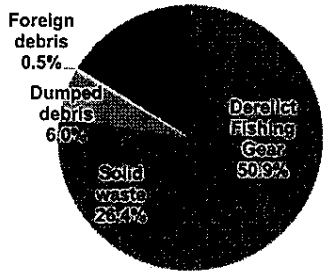
T: type of debris

U: land use

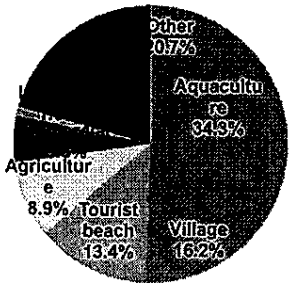
α_1: weight for S

α_2: weight for T

α_3: weight for U



Dominant debris type



Land use

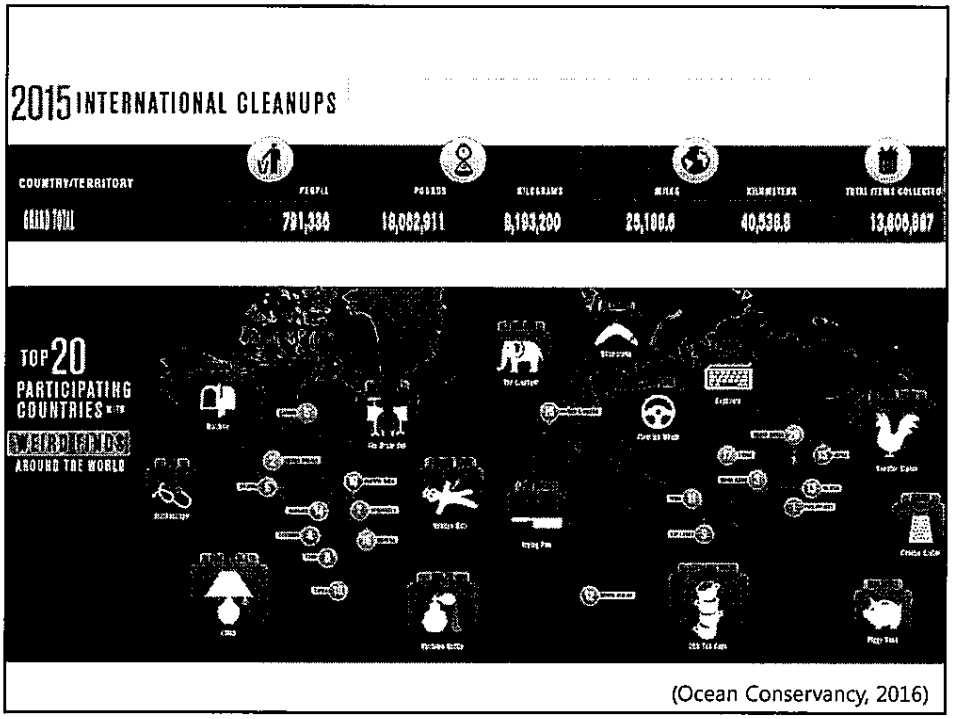
DISCUSSION

- **Rapid** assessment: 30 surveyors, 382 stations over 400 km of coastal line, 8 days, less than 30 minutes per station
- Debris accumulated in hotspot areas: **60% of debris in 10 % of beach length**
- Rapid response to the assessment result would contribute to **efficient management.**
- **Mobile app** is very useful tool to record the results in field and to gather each result. However, internet connection in remote areas can be a barrier to assess using the app.
- Assessment on pollution level can be **dependent on surveyors.**
- **Visible debris** can be better detected (e.g., white styrofoam buoys).

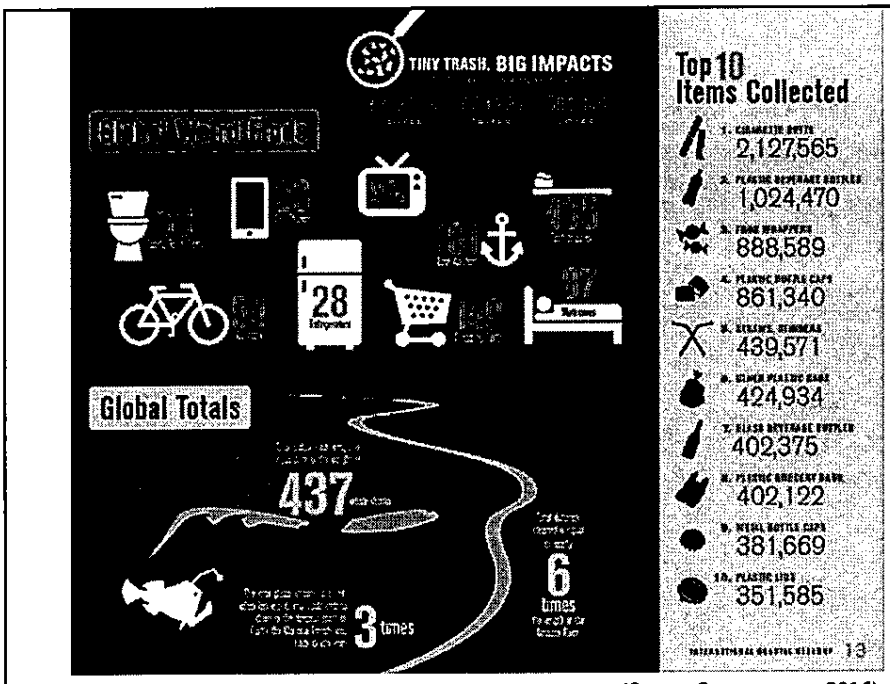
International Coastal Cleanup

World's largest volunteer action for oceans, celebrating every third Saturday of September every year.

Cleanup and recording the debris, to raise awareness on and prevent marine debris problems.



(Ocean Conservancy, 2016)



(Ocean Conservancy, 2016)

Debris classification

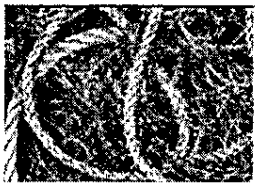
MOST LIKELY TO FIND ITEMS:	TOTAL #		TOTAL #
Cigarette Butts:	=	Beverage Bottles (Plastic):	=
Food Wrappers (candy, chips, etc.):	=	Beverage Bottles (Glass):	=
Take Out/Away Containers (Plastic):	=	Beverage Cans:	=
Take Out/Away Containers (Foam):	=	Grocery Bags (Plastic):	=
Bottle Caps (Plastic)	=	Other Plastic Bags:	=
Bottle Caps (Metal)	=	Paper Bags:	=
Lids (Plastic) :	=	Cups & Plates (Paper):	=
Straws/Stirrers:	=	Cups & Plates (Plastic):	=
Forks, Knives, Spoons:	=	Cups & Plates (Foam):	=

Most Likely to Find. These are trash items that appeared on the Cleanup's 25-year cumulative top ten list, which highlighted the most abundant items of trash collected during the Cleanup since 1986. They include cigarette butts, food wrappers butts, bottle caps/lids, straws/stirrers, among others.

Debris classification

FISHING GEAR:	TOTAL #	PACKAGING MATERIALS:	TOTAL #
Fishing Buoys, Pots & Traps:	=	6-Pack Holders	=
Fishing Net & Pieces:	=	Other Plastic/Foam Packaging:	=
Fishing Line (1 yard/meter = 1 piece):	=	Other Plastic Bottles (oil, bleach, etc.):	=
Rope (1 yard/meter = 1 piece):	=	Strapping Bands:	=

Fishing gear. Debris from recreational fishing and boating, municipal and commercial fishing, cargo, military and cruise ships, and offshore industries, like oil drilling. They include buoys, pots & traps, fishing net, rope, and fishing line

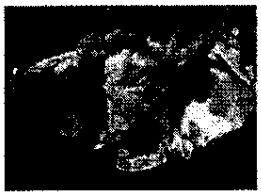


Packaging Materials. Debris items from producers and consumers of goods which include 6- pack holders, other plastic/foam packaging, other plastic bottles, etc.

Debris classification

PERSONAL HYGIENE:	TOTAL #
Condoms:	=
Diapers:	=
Syringes:	=
Tampons/Tampon Applicators:	=

Personal Hygiene. Materials discarded into the sewer systems, toilets, waterways or open areas. This category includes disposable diapers, condoms, sanitary napkins and syringes.



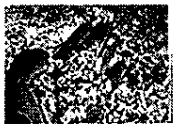
OTHER TRASH:	TOTAL #
Appliances (refrigerators, washers, etc):	=
Balloons:	=
Cigar Tips:	=
Cigarette Lighters:	=
Construction Materials:	=
Fireworks:	=
Tires:	=

Other debris. They include items that are prevalent but in moderate quantities, such as, appliances, balloons, cigar tips, cigarette lighters, construction materials, fireworks and tires

Debris classification

TINY TRASH LESS THAN 2.5CM:	TOTAL #
Foam Pieces	=
Glass Pieces	=
Plastic Pieces	=

Tiny Trash. These are called macro debris which is 2.5 cm in diameter and include Foam Pieces, Glass Pieces and Plastic Pieces.



DEAD/INJURED ANIMAL	STATUS	ENTANGLED	TYPE OF ENTANGLEMENT ITEM
	Dead or Injured	Yes or No	

ITEMS OF LOCAL CONCERN:		
1.	2.	3.

Item of Local Concern. Debris that can be found in a particular area which warrant some attention

Tips on Data Collection

- Review Data Card before starting!
- Collect data as a team (4-5 individuals/team), one person will record information on the Data Card, while others to collect and bag the trash
- Find a shady area to sort out and record the trash collected
- Apply what you have learned on proper estimations
- Use numbers not words, like several or many during tallying. Be accurate as possible. The more accurate your information, the better we can work to reduce and eliminate debris pollution
- NOTE: BE SURE TO FILL-IN ALL NECESSARY INFORMATION!

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Sunwook Hong (Ph.D)
oceanook@gmail.com

Thank you for listening!

www.osean.net

[illegible] project of Korea-Sri Lanka

KMI 한국해양수산개발원 KOREA MARITIME INSTITUTE MATEC Ocean Research Institute, Inc.

Table of Contents

1. Background

Plastic waste inputs from land into the ocean

Jenna R. Jambeck,[1]* Roland Geyer,[2] Chris Wilcox,[3] Theodore R. Siegler,[4] Miriam Perryman,[3] Anthony Andrady,[5] Ramani Narayan,[6] Kara Lavender Law[7]

Rank	Country	Econ. classif.	Coastal pop. [millions]	Waste gen. rate [kg/ppd]	% plastic waste	% mismanaged waste	Mismanaged plastic waste [MMT/year]	% of total mismanaged plastic waste	Plastic marine debris [MMT/year]
1	China	UMI	262.9	1.10	11	76	8.82	27.7	1.32–3.53
2	Indonesia	LMI	187.2	0.52	11	83	3.22	10.1	0.48–1.29
3	Philippines	LMI	83.4	0.6	15	83	1.88	5.9	0.28–0.75
4	Vietnam	LMI	55.9	0.79	13	88	1.83	5.8	0.28–0.73
5	Sri Lanka	LMI	14.6	5.1	7	84	1.59	5.0	0.24–0.64
6	Thailand	UMI	26.0	1.2	12	75	1.03	3.2	0.15–0.41
7	Egypt	LMI	21.8	1.37	13	69	0.97	3.0	0.15–0.39

Annually 1.59million tons of plastic waste enter the ocean from Sri Lanka (5th rank in the world)

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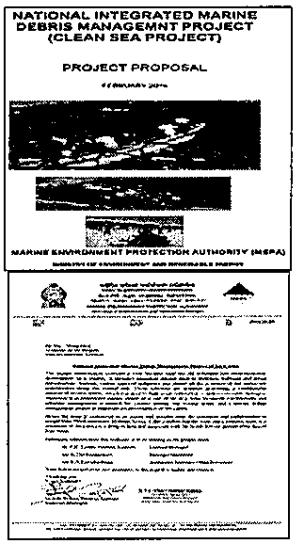
▷ Draft National Plan was established in 2014

- Difficulties in implementing due to financial problem
- Needs more scientific research on the marine debris problem


NATIONAL INTEGRATED MARINE DEBRIS MANAGEMNT PROJECT (CLEAN SEA PROJECT)

PROJECT PROPOSAL

MARINE ENVIRONMENT PROTECTION AUTHORITY (MEPA)

▷ Request from Sri Lanka to Korea

- for cooperation to solve the marine debris problem
- for mutual benefit and development

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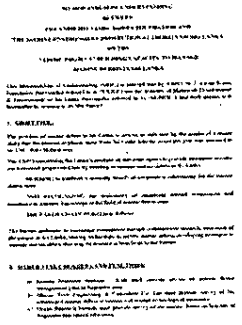
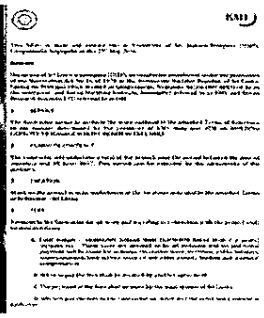
2. Project Summary

- Project Title : Building capacity to manage Marine Debris in Sri Lanka
- Period : 2015. 7. 1 ~ 2017. 10. 31
- Financial Supporting Organization : The EXPO 2012 Yeosu Korea Foundation
- Project Partners
  - Korea : KOREA MARITIME INSTITUTE, Marine Tech Engineering & Consultant Co. Ltd, Ocean Research Institute, Ltd.
  - Sri Lanka : Marine Environmental Protection Agency, Univ. Sri jayawardenapura



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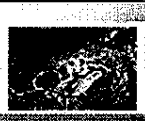
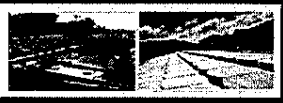
2012여수세계박람회재단
EXPO 2012 Yeosu Korea Foundation

2-1. Main Objectives and Activities

CAPACITY BUILDING TO MANAGE MARINE DEBRIS

1. Research	• To survey marine debris at Negombo Fish Harbour • To survey marine debris at Negombo Beach • To survey marine debris on coral reefs
2. Policy	• To assess current management • **To establish management strategy in Negombo** • To provide tools to make strategy of management
3. Education	• To build capacity through co-work • To educate fishers in Negombo • To educate government officials
4. Facilities	• To educate how to operate survey equipment(submerged) • **To provide beach debris survey tools** • **To educate how to operate survey equipment (corals)**






2- 2. Target Region

- Negombo

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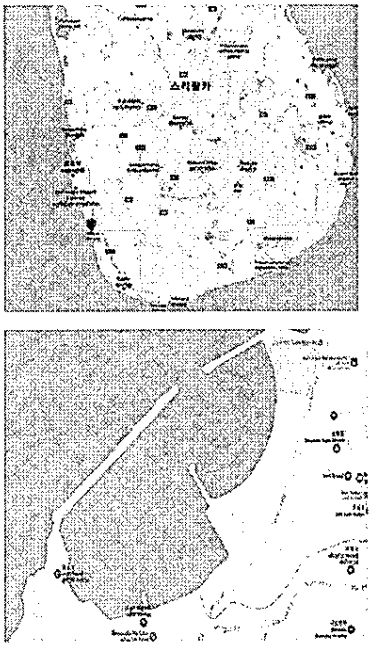
2- 2. Target Region

- Beruwalla



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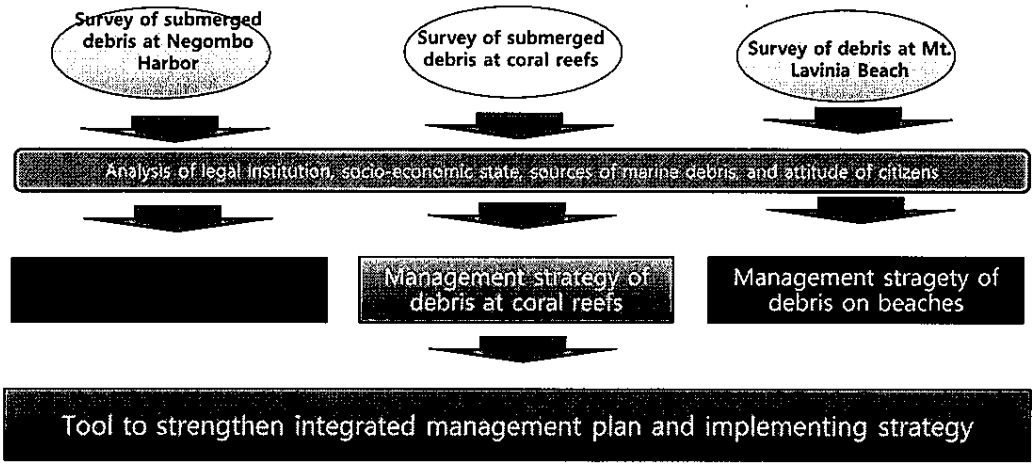
2- 3. Research Process



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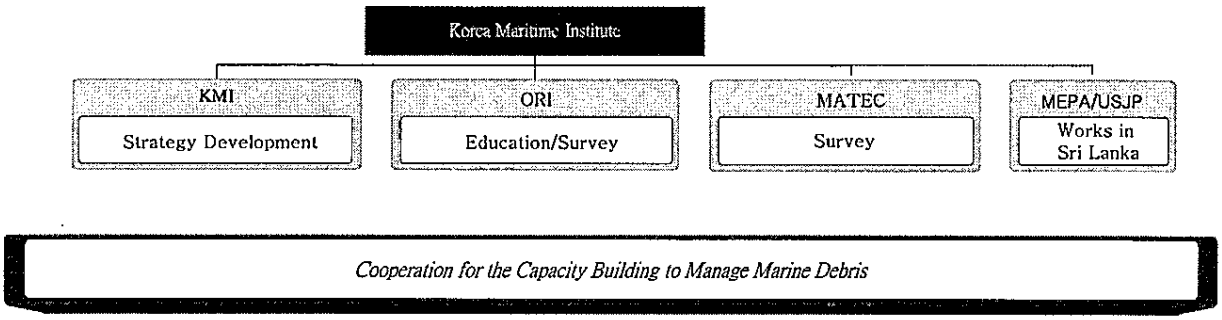
2-4. Project Organization



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2- 5. Project Organization

Main roles of MEPA/USJP

Areas	Main roles
Basic Information	• Current situation of Negombo Harbor/Coral reefs • Current legal institution (fishery, environment, etc.) • Current management of marine debris
Co-research	• Marine debris Survey at Negombo and Beruwalla Fish Harbor • Marine debris Survey at Negombo Beach (Bi-monthly) and Nation wide • Marine debris Survey at coral reefs and Sunken ship(Negombo and Beruwalla) • Development of management strategy
Supporting field visits	• Meeting with stakeholders • Rent-cars and survey ships • Questionnair of citizens/fishermen • Organizing workshops

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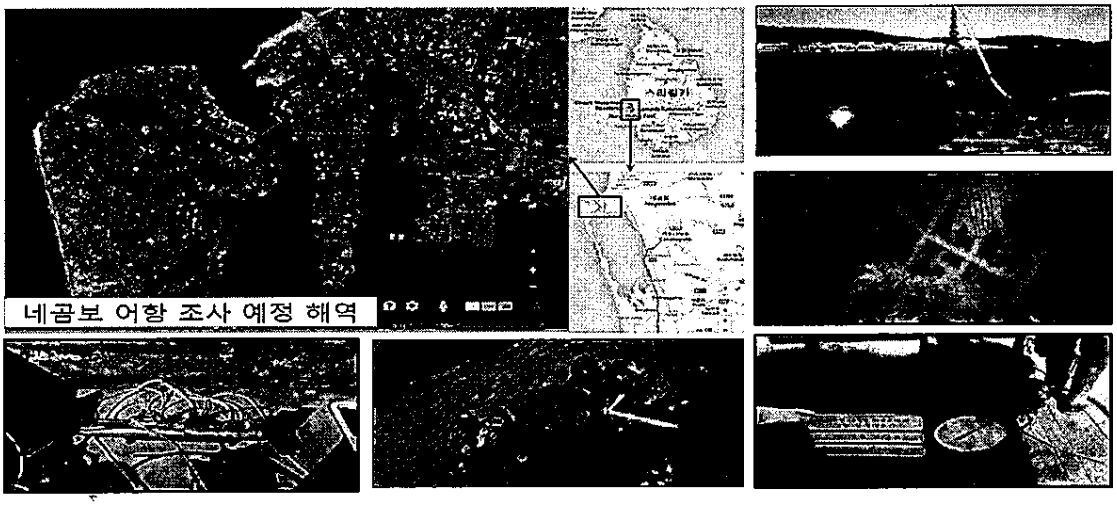
3-1. Project Result of fishery harbor

Negombo

Survey of seabed debris (side scan sonar, Scuba, Lifting gear)



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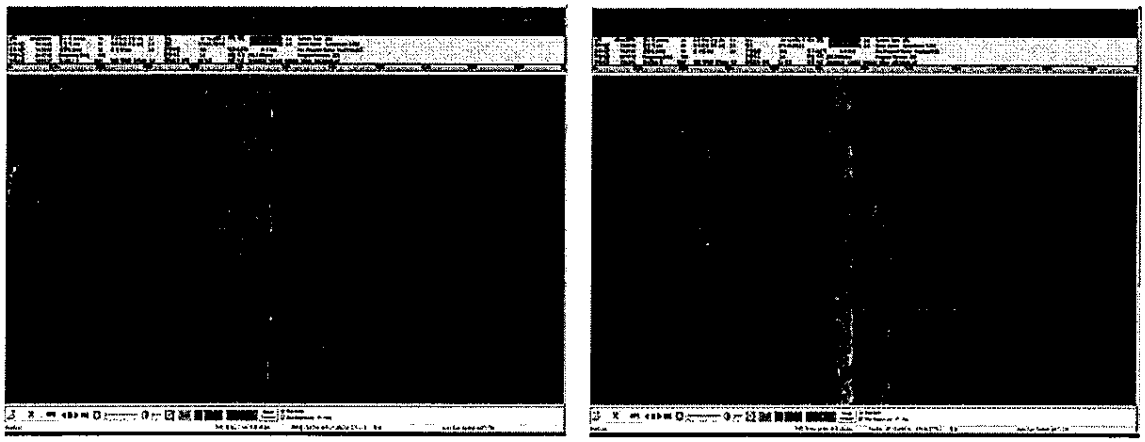
Survey of seabed debris in Negombo fishery harbor(side scan sonar, Starfish 450F)



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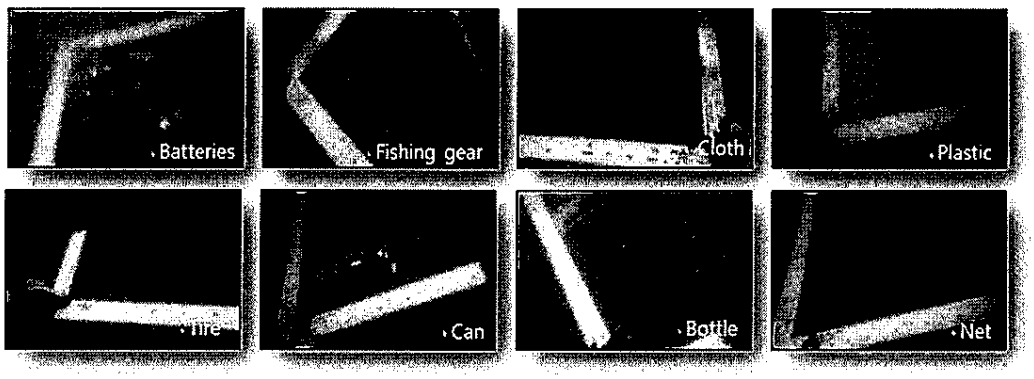
Survey of seabed debris in Negombo fishery harbor(side scan sonar, Starfish 450F)



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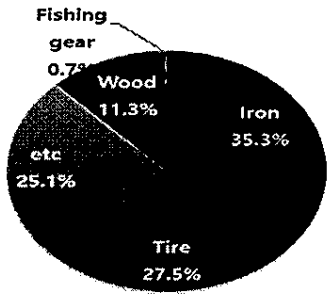
Marine Debris in Negombo Fishery Harbor(SSS survey + diving survey)

Location	Total Area (ha)	Survey Area(m^2)	Surveyed Debris(kg)	Marine Debris Per Unit Area (kg/ha)	Total Marine Debris(ton)	Remarks
Port Area	10.0	100,000	7,083	708	7	SSS Survey(2016)
	2.4	508	1,090	85,554	30	Diving Survey(2017)
Total					37	

Type	Weight(kg)	%
Iron	2,336.58	35.3%
Tire	1,820.12	27.5%
etc	1,663.54	25.1%
Wood	746.97	11.3%
Fishing gear	48.35	0.7%
Vinyl	5.40	0.1%
Choth	4.95	0.1%
Plastic	1.26	0.0%
Rope	0.24	0.0%
Total	6,627.42	100



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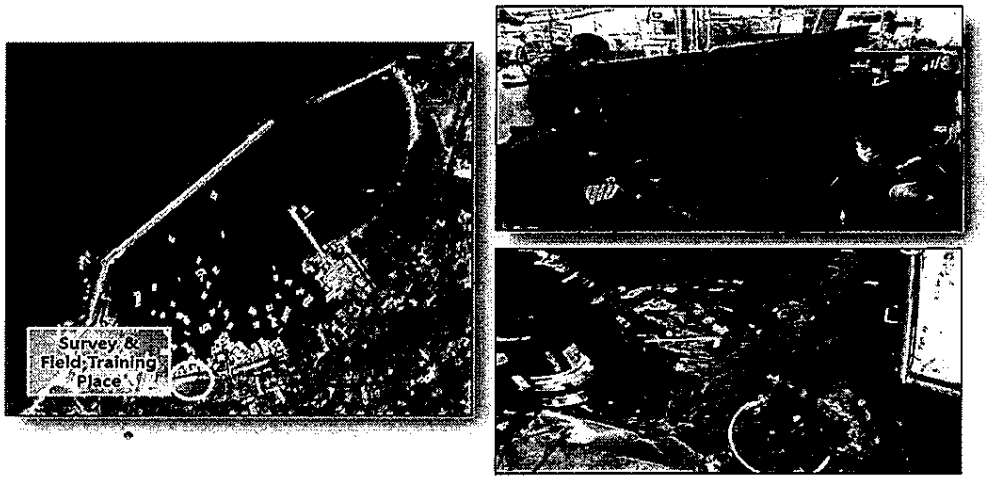
Beruwalla

Survey of seabed debris (Scuba)



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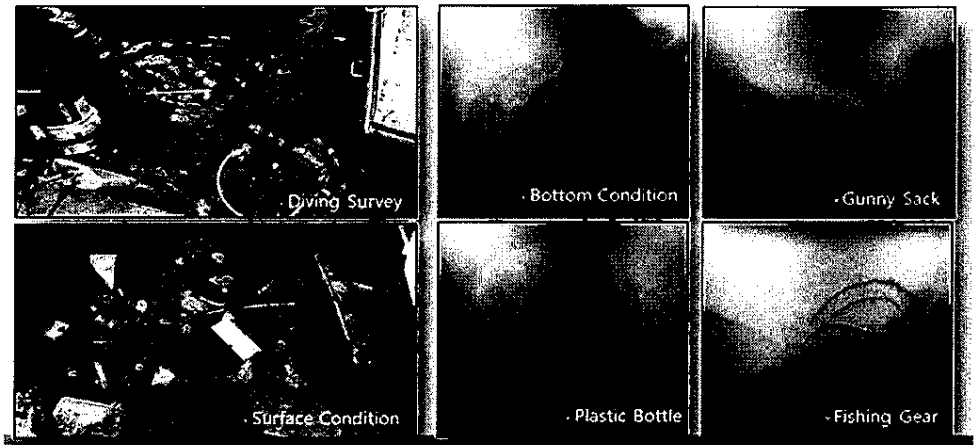
Diving Survey Results



- Impossible to survey because of poor visibility and low water depth

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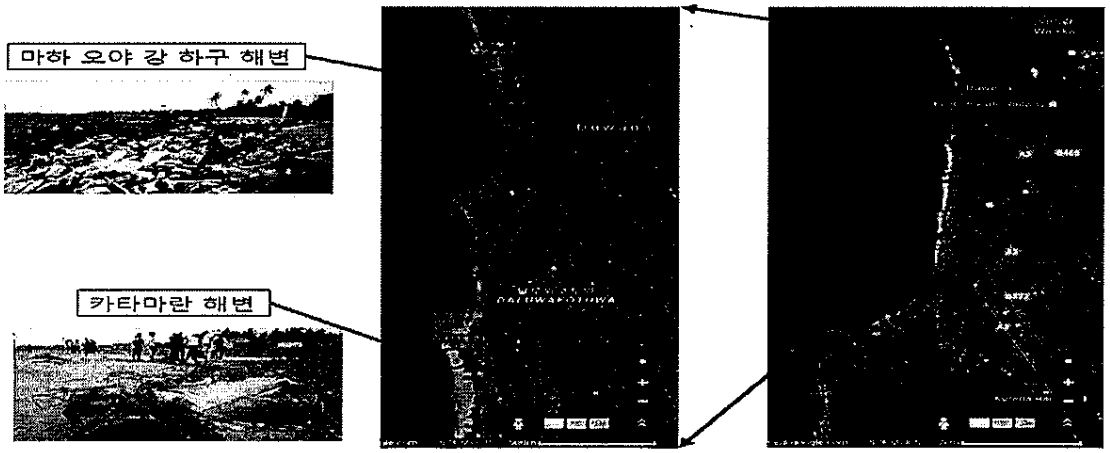
3-2. Project Result of Beach debris

Negombo

Survey of beach debris Bi-monthly)



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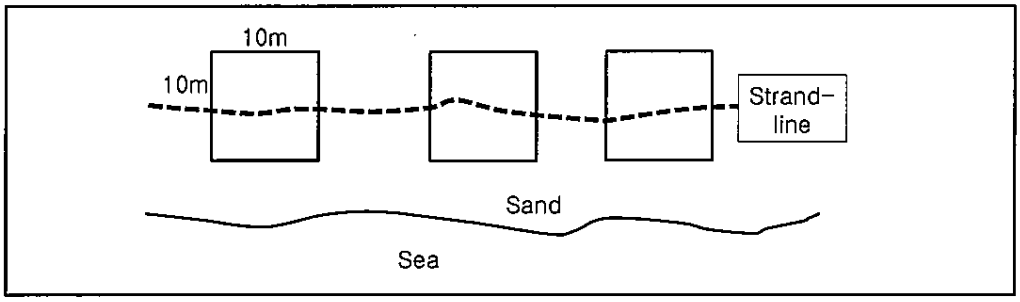
Survey Methods



- Marine debris (bigger than 25mm) in three quadrats (10*10m) are collected and surveyed
- They are classified with the category of usage and materials

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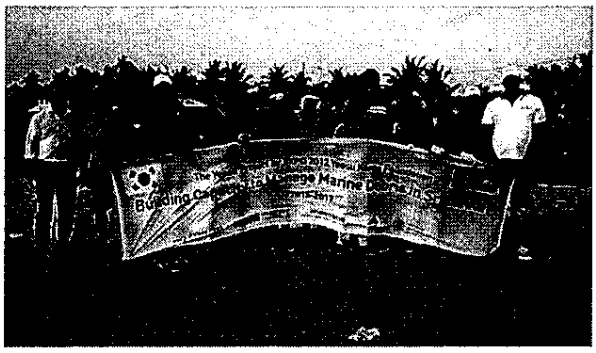
Survey of beach debris at Negombo



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Results (Two beaches in Negombo)

Used in	Number	Weight(g)	Number Ratio	Weight Ratio
Sri Lanka	2,081	34,558	99%	98%
Foreign countries	28	881	1%	2%
Total	2,109	35,439	100%	100%

Material type	Number	Weight(g)	Number Ratio	Weight Ratio
Plastics	2,023	27,928	96%	79%
Metals	42	685	2%	2%
Glass & Ceramics	40	6,281	2%	18%
Woods	2	270	0%	1%
Papers	1	10	0%	0%
Other materials	1	265	0%	1%
Total	2,109	35,439	100%	100%

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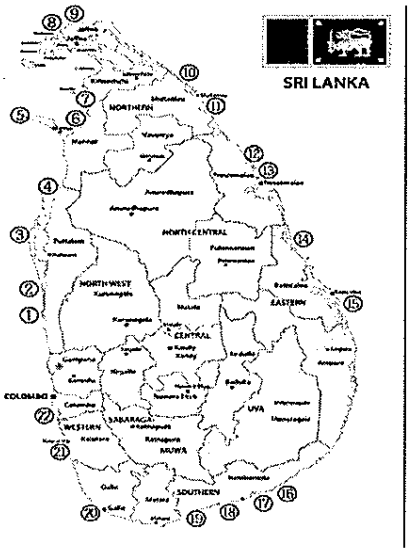
National Wide

Survey of Beach debris (December, 2016)



Province	Beach	Macro(>25mm) (per30m²)		Small(5-25mm) (per0.75m²)	
		Number	Weight(g)	Number	Weight(g)
North West	1-Deduru Oya	1257	42725	45	3.03
	2-Udappu	218	5155	9	1.34
	3-Kudawa	32	1380	10	1.23
	4-Wilpattu	266	1405	62	1.19
Northern	5-Urumale	99	8695	11	1.60
	6-Iluppaikkadavai	46	185	11	0.11
	7-Mulankavil	102	4305	7	0.45
	8-Casuarina	127	570	44	5.53
	9-Sri Sangamitta	75	779	35	14.33
	10-Mullaitivu	143	1382	379	20.09
	11-Alampil	573	8005	345	25.78
Eastern	12-Pankulam Aru	1937	12107	314	36.54
	13-Back Bay	6967	216240	365	33.05
	14-Sallitivu Island	179	1765	165	13.52
	15-Thalankudah	650	5431	200	27.28
Southern	16-Kirinda	120	1610	58	18.32
	17-Bundala	60	365	36	8.11
	18-Hambantota	748	2530	21	0.53
	19-Kudawella	11652	5695250	93	1.95
	20-Galle	280	17527	36	2.71
Western	21-Kalutara	874	32092	167	26.19
	22-Modara	821	47570	186	63.24
	Average	1238	277594	118	13.91

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National Wide

Survey of Beach debris (December, 2016)

Back Bay of Trincomalee

Kudawella in Southern Province

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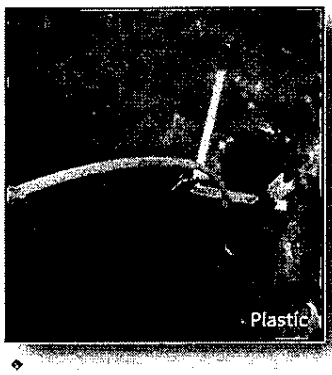
3-3. Project Result of Coral reefs and Sunken ship

Coral reefs

- Joint survey and field training
- Activate buddy diving system according to diving ability of surveyor



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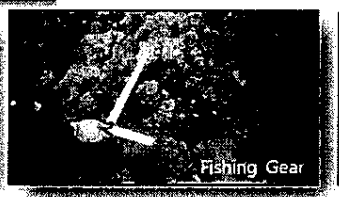
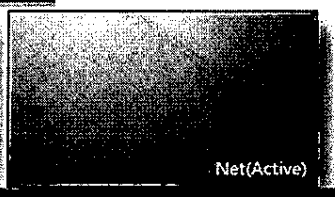
Coral Reef Survey near Negombo



Coral Reef Survey near Beruwalla



- There is a small quantity of marine debris because of collecting by divers

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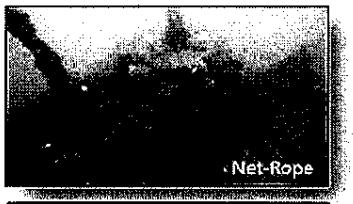
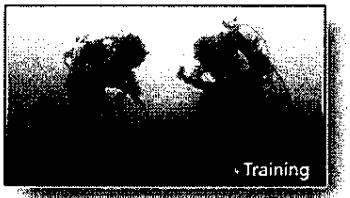
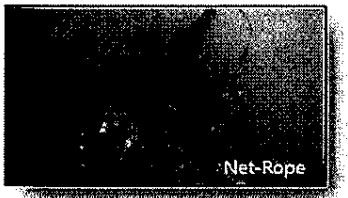
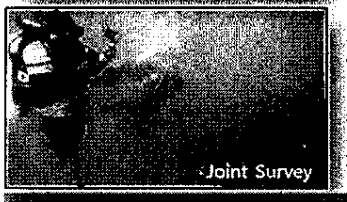
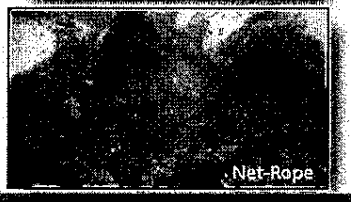
Sunken ship











- **Surveyed 74.7kg of net-ropes**
  (Ship wreck : 30m long x 6m wide x 2m high, 250 tons cargo ship)

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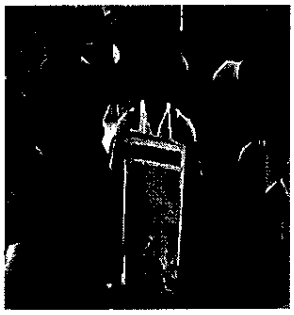
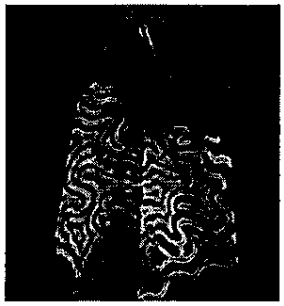
3- 4. Project Result of Education

Elementary Students

- Purpose : Understanding impacts of marine debris
- Time : 2017. 2
- Method : Marine Litter Activity Book(Material), Sri lanka leading, Korea supporting

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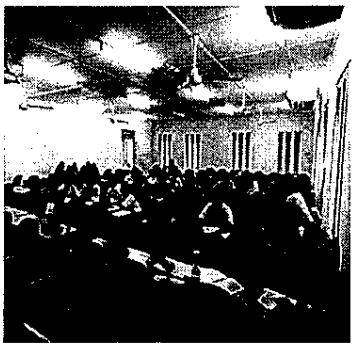
Fisherman and Univ. students

- Purpose : Sharing Problems and Discussing Solution on Marine debris of Sri lanka
- Time : 2017. 2
- Method : Seminar(Presentation and Discussion)





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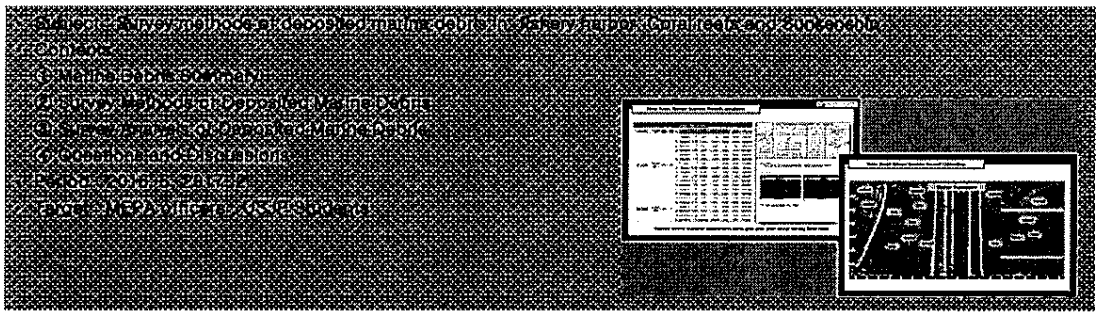
Public Officers



3- 5. Project Result of Planning

Strategy and Action Plan

Intensive Management of Marine Debris Sources	• Rigid enforcement of regulations on dumping waste at the beach, seashore, fishery harbor • Marine debris collecting box on beaches • Construction & Installation of Marine waste repository • Minimizing the inflow of the floating debris from Hamilton canal and rivers
Building of Marine Debris Collection Systems	• Cleaning the beach • Collecting Marine Debris in Fishery Harbor • Residential coastal clean-up • Collecting Waste Mangrove Forest Area • Collecting Marine Debris Coral Reef Area • Operation of Ships for Fishery Harbor Management
Building on Marine debris Disposal and Recycling	• Styrofoam compressor • Eco-friendly Utilization of Fishery By-products • Waste Treatment Facility(Incineration and Landfill facilities • Disposal of abandoned ships
Customized Education and Research	• Public awareness programs • Education of the fishermen • Research and Development

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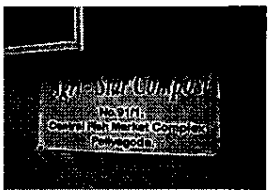
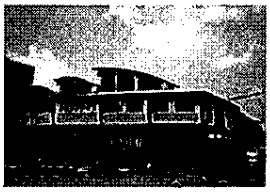
3- 5. Project Result of Planning

Utilization of fishery by-products








3- 6. Video

Survey of Negombo and Beruwalla(Fisher harbor, Coral reef, Market etc.)

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Thank you
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Asia-Pacific
Economic Cooperation

APEC Capacity Building for Marine Debris Prevention and Management in the APEC Region

Research of Microplastics in Chinese Marine Environment

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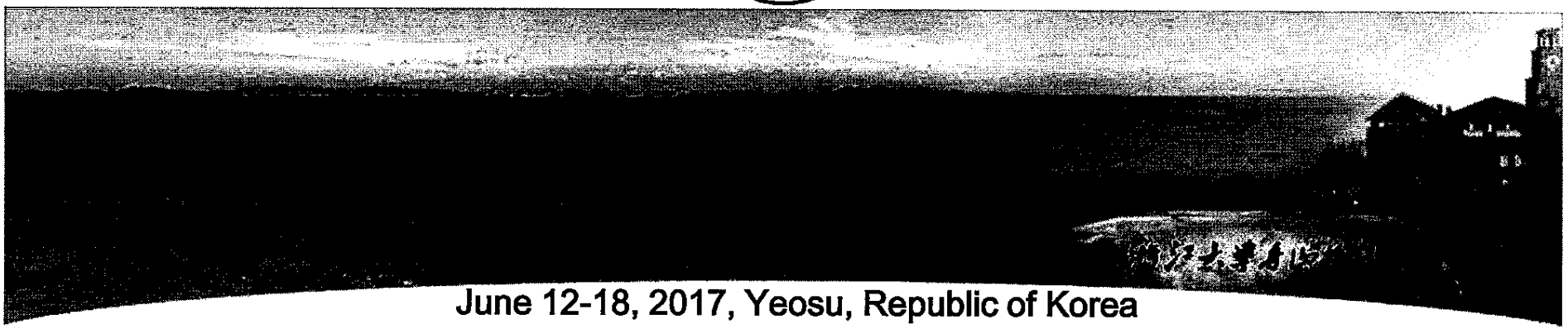

June 12-18, 2017, Yeosu, Republic of Korea

Global plastics waste

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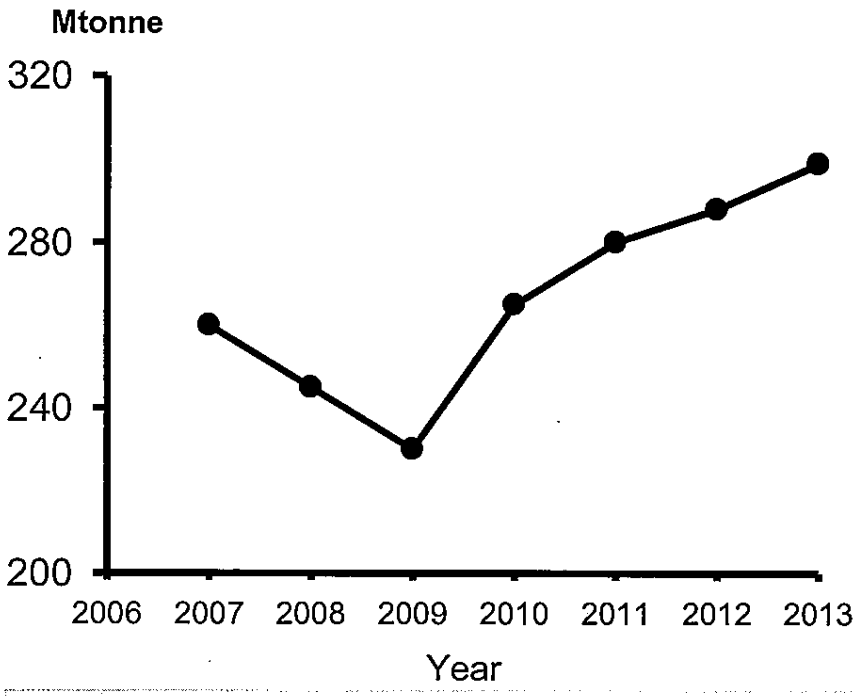
7	Egypt	LMI	21.8	1.37	13	69	0.97	3.0	0.15–0.39
8	Malaysia	UMI	22.9	1.52	13	57	0.94	2.9	0.14–0.37
9	Nigeria	LMI	27.5	0.79	13	83	0.85	2.7	0.13–0.34
10	Bangladesh	LI	70.9	0.43	8	89	0.79	2.5	0.12–0.31
11	South Africa	UMI	12.9	2.0	12	56	0.63	2.0	0.09–0.25
12	India	LMI	187.5	0.34	3	87	0.60	1.9	0.09–0.24
13	Algeria	UMI	16.6	1.2	12	60	0.52	1.6	0.08–0.21
14	Turkey	UMI	34.0	1.77	12	18	0.49	1.5	0.07–0.19
15	Pakistan	LMI	14.6	0.79	13	88	0.48	1.5	0.07–0.19
16	Brazil	UMI	74.7	1.03	16	11	0.47	1.5	0.07–0.19
17	Burma	LI	19.0	0.44	17	89	0.46	1.4	0.07–0.18
18*	Morocco	LMI	17.3	1.46	5	68	0.31	1.0	0.05–0.12
19	North Korea	LI	17.3	0.6	9	90	0.30	1.0	0.05–0.12
20	United States	HIC	112.9	2.58	13	2	0.28	0.9	0.04–0.11

*If considered collectively, coastal European Union countries (23 total) would rank eighteenth on the list

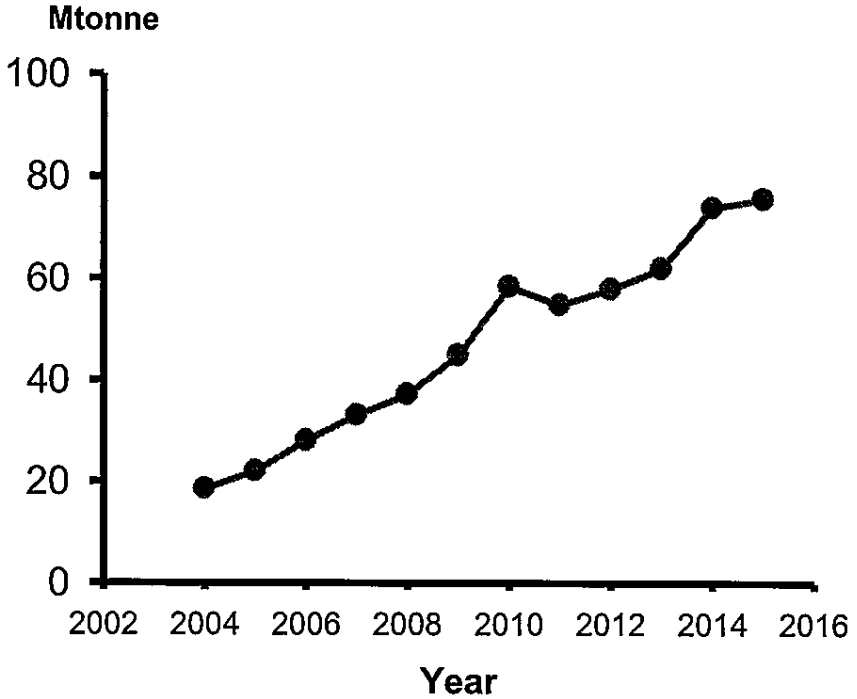
Jambeck, 2015

Global Plastic Production



- Production of plastics has greatly increased the last 60 years; from 5 mt in the 50's to 280 mt today (about 4% increase per year).

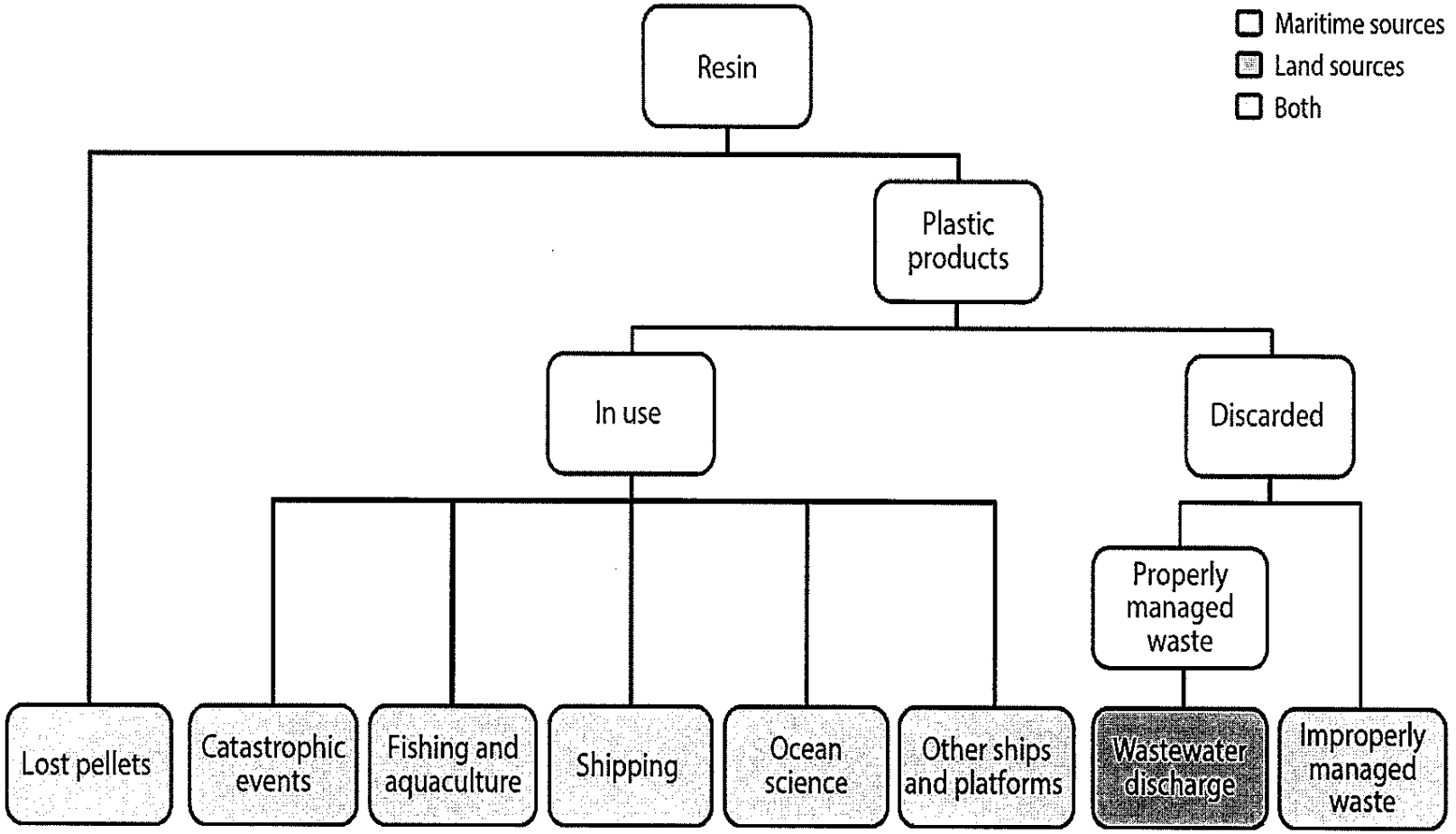
Chinese Plastic Production



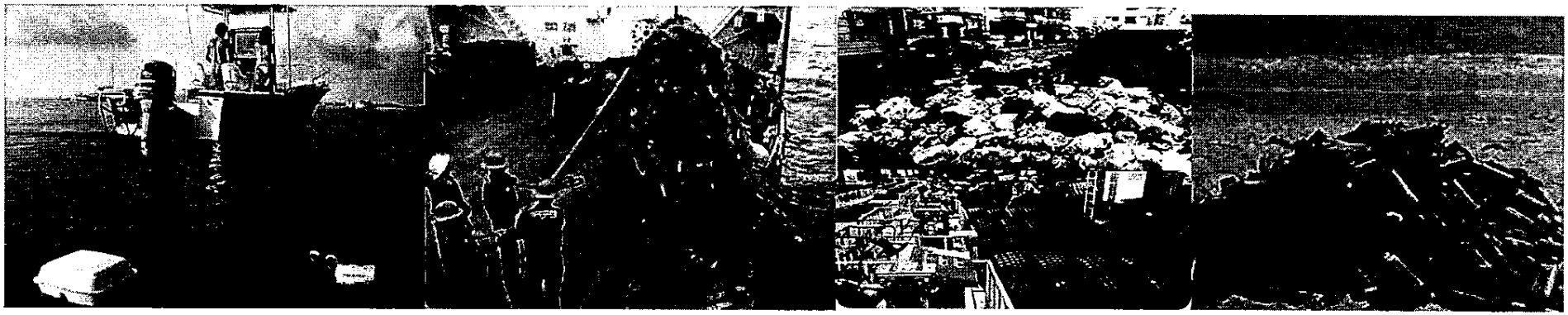
- Production of plastics has significantly increased by 3.9% from 2012 to 2013. There are over 24.8% of plastics produced in China.

Data source: Progress in global plastics industry, 2009-2013

Jambeck, 2015


Maritime sources
Land sources
Both
Resin
Plastic products
In use
Discarded
Properly managed waste
Lost pellets
Catastrophic events
Fishing and aquaculture
Shipping
Ocean science
Other ships and platforms
Wastewater discharge
Improperly managed waste

Law, 2017

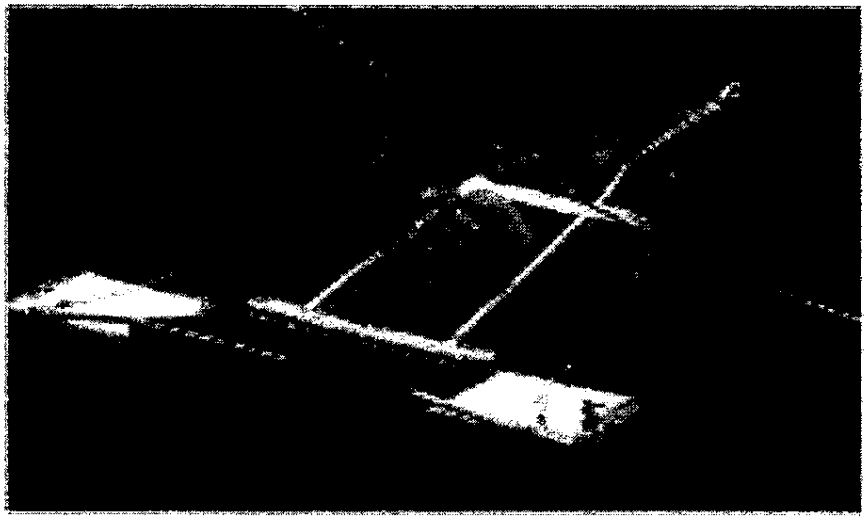


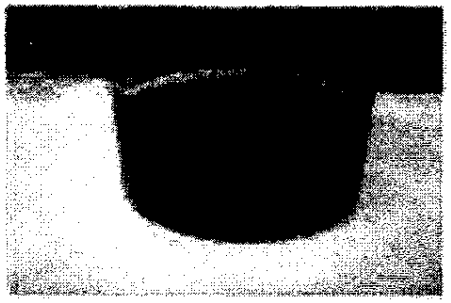
Microplastic: Diameter smaller than 5 mm

Thompson *et al*, 2004

Microplastics can be found everywhere

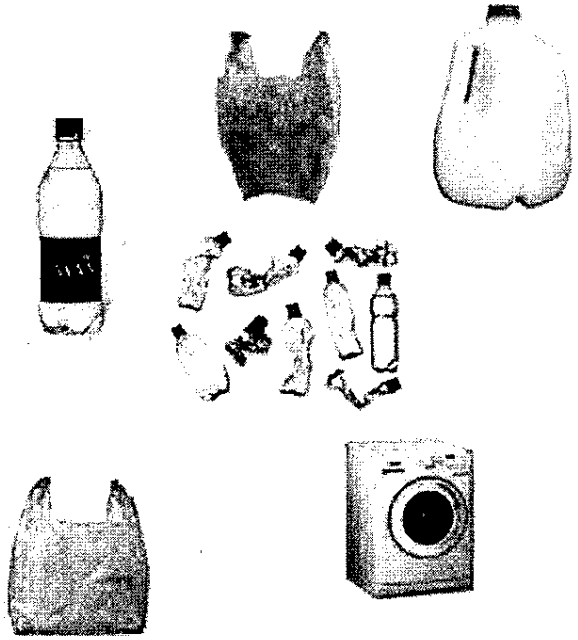
2mm , 500µm , 450µm , 333 µm , 300 µm , 250µm , 200µm , 150 µm , 112µm , 90 µm , 80 µm , 55 µm , 50 µm , 30 µm , 10 µm



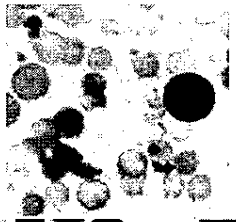


Type of Sampler	Lower Size limit(µm)	Water Sampled	Reference
Mazur	330	Samples surface water with flow meter	NOAA
Regular Plankton or neuston net (Continuous plankton recorder)	330	Sample surface water at 10m depth	U. Plymouth (UK)
Algalita Manta trawl	333	Sample Surface water, Approx. 500-3000m² per trawl	Algalita (USA), Cefas (UK)
Bongo Plankton Net	333	Samples mid-depth water column sample	Lattin et al. [129]
Epibenthic Sled	333	Sample water column near sea bottom	Lattin et al. [129]

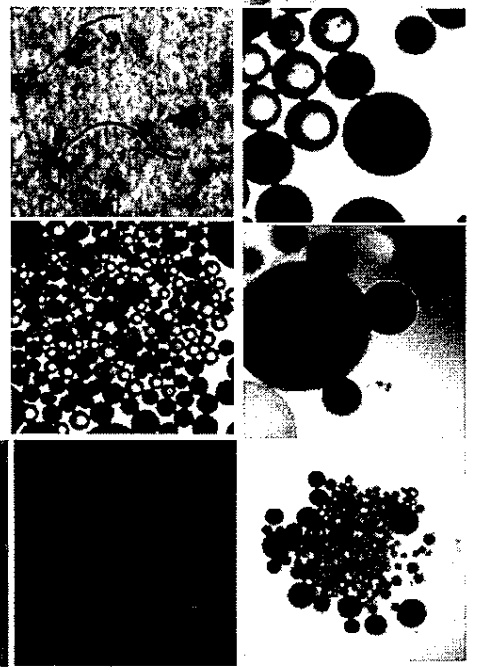
Source: Adapted from (Leslie et al. [39]).



Primary microplastics are produced either for direct use, such as for exfoliants, cosmetics, industrial abrasives or for indirect use as precursors (nurdles or virgin resin pellets) for the production of multiple plastic consumer products.



Microplastics?



Secondary microplastics formed in the environment as a consequence of the breakdown of larger plastic material, especially marine litter, into smaller and smaller fragments (so called "secondary microplastics"). The breakdown is caused by a combination of mechanical forces (e.g. waves) and photochemical processes triggered by sunlight (especially UVB)

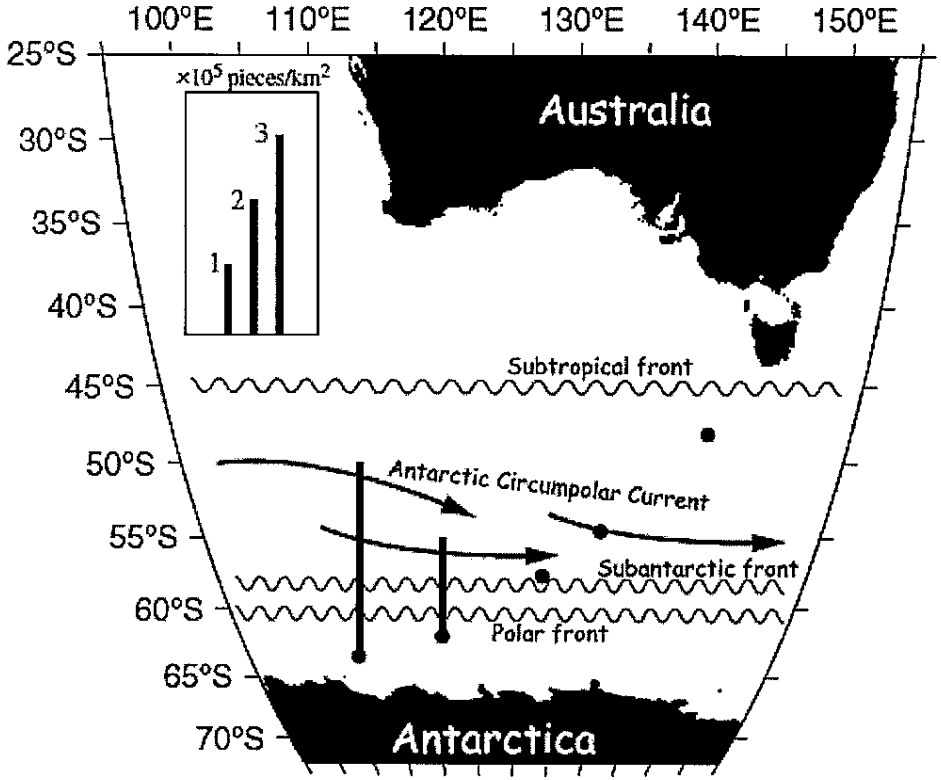
Microplastics in seawater

Net mesh	Microplastics / m^3	Location	Ref
280 µm	0.04 - 0.05	shipping routes UK, 10 m depth	Thompson et al. 2004
80 µm	150-2400	Swedish coast, sea surface	Norén 2008
0.5-2 mm	102,000	Swedish harbour near PE plant, sea surface	Norén 2008
10-500 µm	200-1000	Skaggerak, Norwegian S coast, sea surface	Norén & Naustoll 2011
333 µm	0.2-1.6	Doggerbank, sea surface	Leslie, 2012

In China: 4137.3±2461.5 microplastics/m^3 near Yangzi Estuary and 0.167±0.138 microplastics/m^3 near the coastline

Continent	Area	Quantity or concentration	Microplastics (type or form)	References
America	Western North Atlantic	3500 particles/km^2	Pellets 2.5-5 mm	Carpenter and Smith (1972)
	North Pacific Ocean	0.004-0.19 particles/m^3	Fragment predominant	Doyle et al. (2011)
	Atlantic	<0.1 particles/m^3	Fragment predominant	
	South Pacific SG	26,898 pieces/km^2	Fragment predominant	Eriksen et al. (2013)
	North Pacific SG	32.76 particles/m^3	Fragment predominant	Goldstein et al. (2012)
	Equatorial Atlantic Ocean	0.01 particles/m^3	Fragment predominant	Ivar do Sul et al. (2013)
	Southern Californian	3.92 items/m^3	Fragment predominant	Lattin et al. (2004)
	North Atlantic Ocean	1534 pieces/km^2	PE+PP 99%	Law et al. (2010)
	Caribbean Sea	1414 pieces/km^2	PE+PP 99%	
	North Pacific Gyre	2.23 particles/m^3	PP monofilament	Moore et al. (2001)
	North Pacific Central Gyre	334,271 fragments/km^2	predominant	
	Southern California	7.25 particles/m^3	Fragment 58.5%	Moore et al. (2002)
	North Pacific offshore	0.43-2.23 particles/m^3	Fragment 92.7-100%	Moore et al. (2005)
	North Pacific, inshore	5-7.25 particles/m^3	Fragment predominant	
	Pacific Ocean	370,000 particles/km^2		Shaw and Day (1994)
	NE Pacific Ocean	8 to 9200 particles/m^3	Fragment 92.6%	Desforges et al. (2014)
	Northeast Pacific Ocean	0.021-0.448 particles/m^2	Fibers 75%	Goldstein et al. (2013)
Asia	Western Pacific Ocean	87,000 pieces/km^2	Fragment 56%	Yamashita & Tanimura ,2007
	China	0.167 particles/m^3	Fibers, granules	Zhao et al. (2014)
Australia	Australia	4256-8966 pieces/km^2	PE+PP 98.5%	Reisser et al. (2013)
Europe	North Sea	50-100 fibers/l	Fibers predominant	Buchanan (1971)
	Mediterranean Sea	0.116 particles/m^2	Filaments, PS	Collignon et al. (2012)
	Italian coast	0.62 particles/m^3	Plastic fragment	Fossi et al. (2012)
	Plymouth, UK	<0.04 pieces/m^3	Plastic fibers	Thompson et al. (2004)
	French-Belgian-Dutch	0.1-0.7 particles/l L	DPE, HDPE and PS	Van Cauwenberghe et al. 2015
	Mediterranean-Corsica	6.2 particles/100 m^2	predominant	Collignon et al. (2014)
	Northeast Atlantic Ocean	2.46 particles/m^3	Filaments, PS	Lusher et al. (2014)
	Mediterranean Sea	243,853 items/km^2	Plastic fibers > 80.3%	Cozar et al. (2015)
	Western Mediterranean	0.15 items/m^3	Fragment 87.7%	Lucia et al. (2014)
			Foam, filament, pellet	

Personal communication with Dr. Juying Wang



Total particle counts at two stations near Antarctica were estimated to be in the order of 100,000 pieces km^{-2}.

Sta.	Date	Particle count (pieces)	Seawater volume (m^3)	Concentration (pieces m^{-3})
1	Jan 30, 2016	20	202	9.9×10^{-2}
2	Jan 31, 2016	18	392	4.6×10^{-2}
3	Feb 1, 2016	2	566	3.5×10^{-3}
4	Feb. 2, 2016	2	502	4.0×10^{-3}
5	Feb. 4, 2016	2	417	4.8×10^{-3}
Average				3.1×10^{-2}

Isobe, A., et al, 2016

polyester (15%),

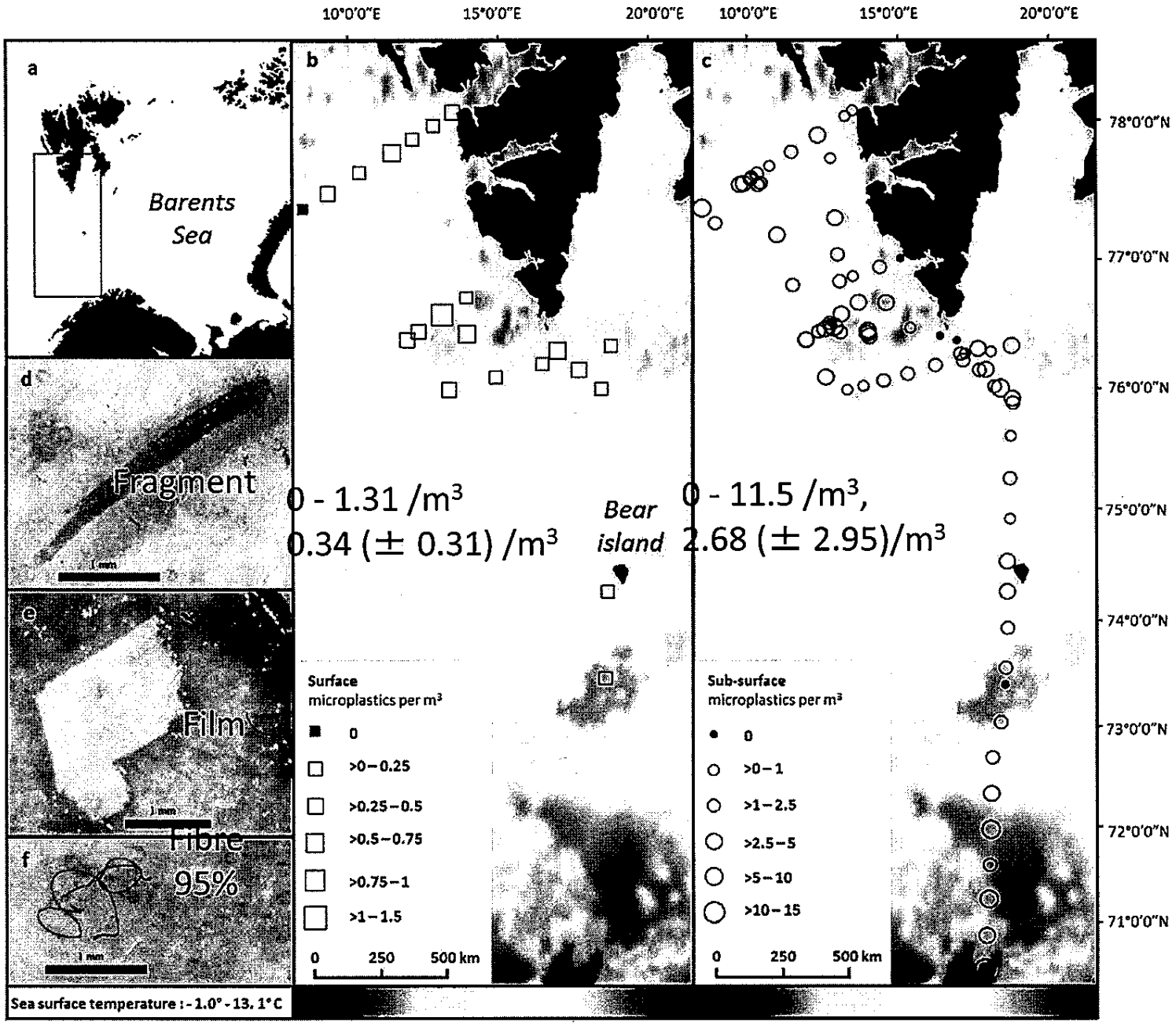
polyamide (15%),

polyethylene (5%),

acrylic (10%),

polyvinyl chloride (5%),

cellulose (30%)



• Phytoplankton

Location	Types of items and contamination pattern	Mesh size	Main focus	Reference
North Atlantic	-	335µm	Plastic concentrations depend on wind speed.	Kukulka et al., 2012
SPSG	~26,898 fragments km^{-2}	333µm	Higher amounts associated with weaker winds.	Eriksen et al., 2013
North Sea	64 pellets L^{-1}; 88 fibres L^{-1}	40µm	Microplastics associated with industries (paper facility plants). Fragments were absent.	Dubaish and Liebezeit, 2013
Equatorial Atlantic	~1 fragment m^{-3}	300 µm	Microplastics, as well as larvae, were retained around an Archipelago. Autochthonous sources of fragments were suggested.	Ivar do Sul et al., 2013

• Sediment

Location	Methodology	Contamination pattern	Main focus	Reference
Lagoon of Venice	box-corer, 1-5cm deep	672 - 2175 fragments kg^{-1} sediment	Plastic fragments (PE and PP, 30-500µm) accumulated at low hydrodynamic sites.	Vianello et al., 2013
Chile	50X50 cm, 2cm deep	~27 fragments m^{-2}	Volunteer survey. 90% of samples (N=39) contaminated by plastic fragments (1-4.75mm).	Hidalgo-Ruz and Thiel, 2013

• Other organisms

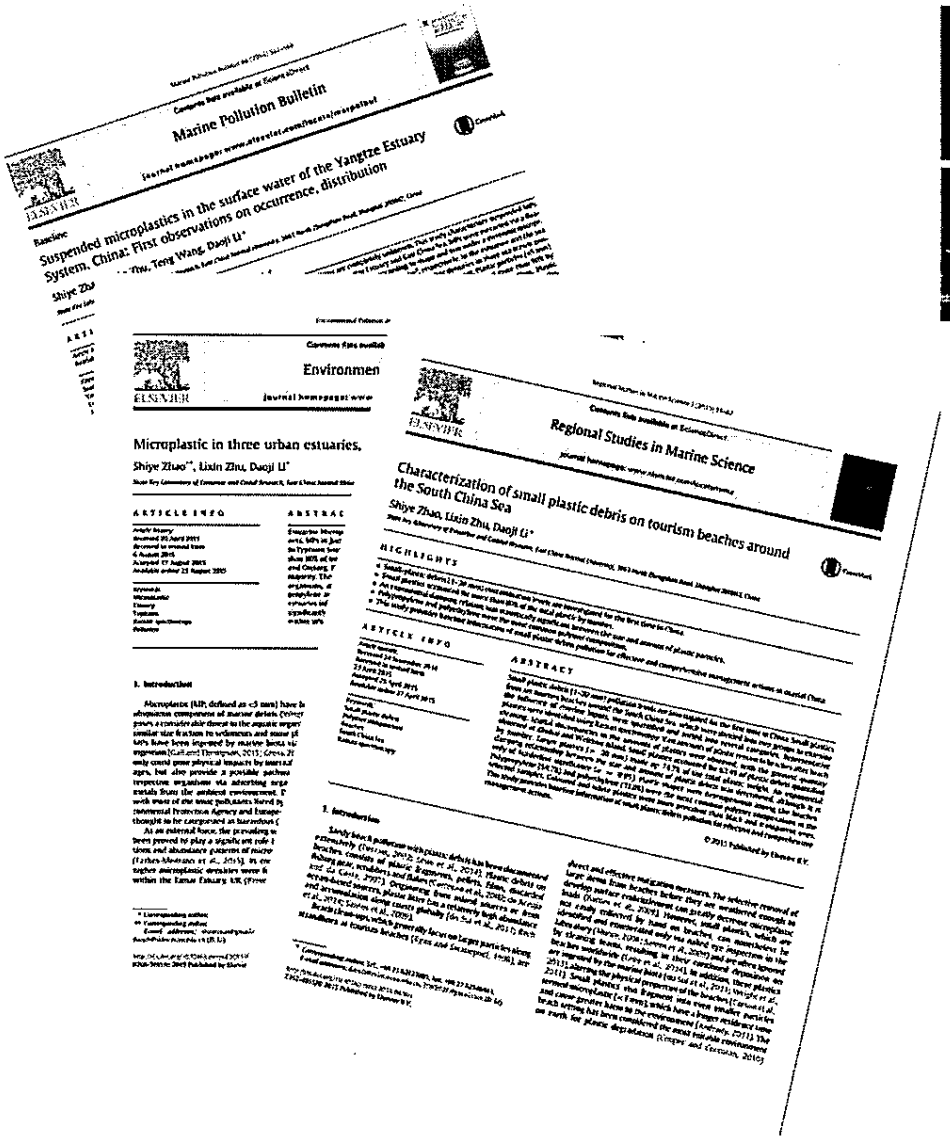
Biota	Main focus	Reference
Fish		
Gerreidae	~13% ingested blue nylon fragments (1-5mm) probably during feeding.	Ramos et al., 2012
Stellifer brasiliensis, *Stellifer stellifer*	~8% ingested blue nylon fragments; highest number was in adults during the late rainy season in the middle estuary.	Dantas et al., 2012
Myctophidae	~40% (mostly *M. lychnobium* and *C. andreae*) ingested plastics. No relation with the fish size.	van Noord, 2013

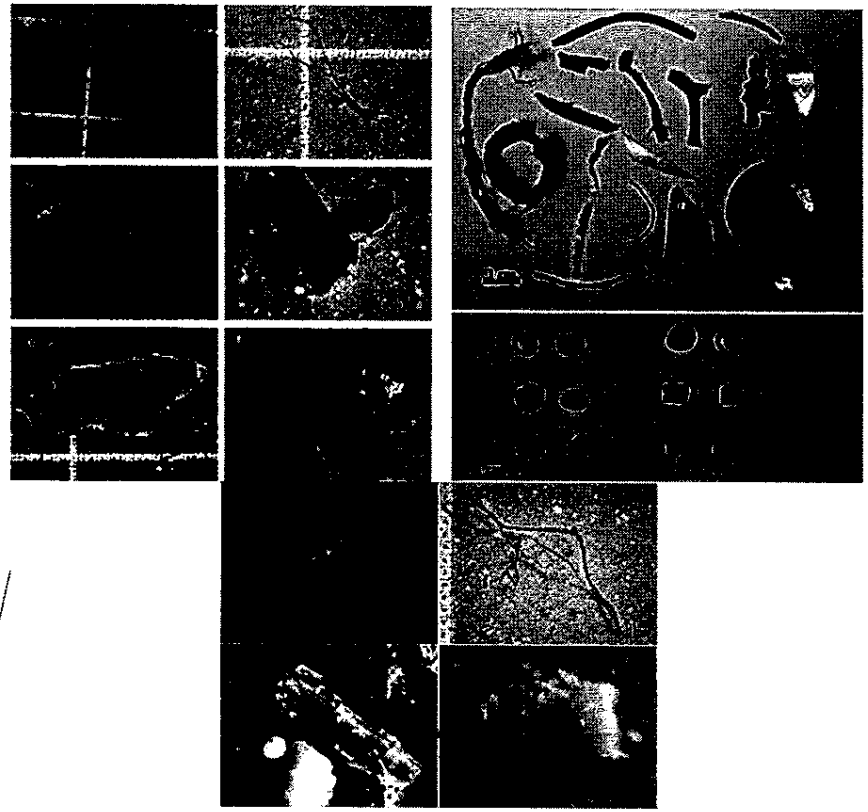
Ivar do Sul et al., 2014

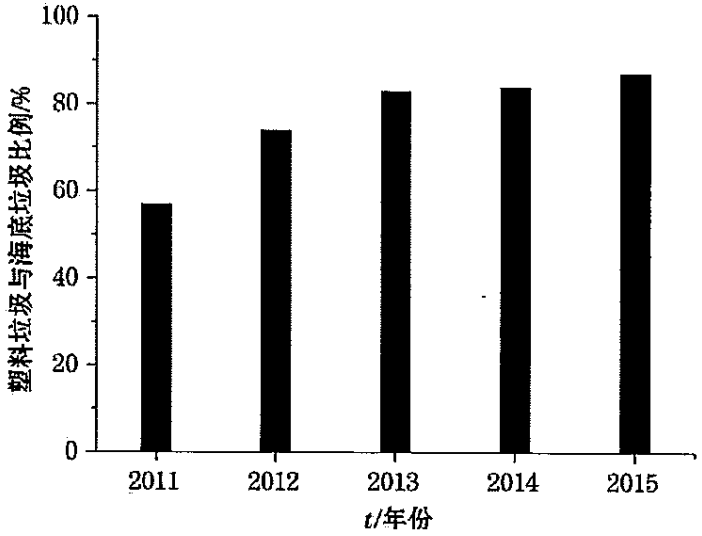
Table 3
Type of organisms, species, type or form and quantity of MPs found in biota with references of the corresponding studies.

Organisms	Species	Microplastics type or form	Quantity	References
Zooplankton	*Neocalanus cristatus*	Fibers (50%)	0.026 particles/individual	Desforges et al. (2015)
	Euphausia pacifia	Fibers (68%)	0.058 particles/individual	
Polychaete	*Clymenella torquata*	Fibers	2–8/gram (equal in sediment)	Mathalon and Hill (2014)
	Alitta virens	Fibers	2–8/gram (equal in sediment)	
Bivalvia	*Mytilus eduis*	Fibers	106–178/mussel	Mathalon and Hill (2014)
			0.36 ± 0.07 particles/g	Van Cauwenberghe and Janssen (2014)
			0.2 ± 0.3 particles/g	Van Cauwenberghe et al. (2015)
		Fibers	0.26–0.51/gram	De Witte et al. (2014)
	Mytilus galloprovincialis	Fibers		
	Crassostrea gigas		0.47 ± 0.16 particles/g	Van Cauwenberghe and Janssen (2014)
Crustacean	*Nephrops norvegicus*	Filaments	83% had MPs in stomach	Murray and Cowie (2011)
	Crangon crangon	Synthetic fibers	0.68 ± 0.55 MP/g	Devriese et al. (2015)
Thaliacea	*Thetys vagina*	Fragment, PP/monofilament		Moore et al. (2001)
Fish	*Astronesthes indopacifica*	Fragments	MPs predominant	Boerger et al. (2010)
	Cololabis saira			
	Hygophum reinhardtii			
	Lowelna interrupta			
	Myctophum aurolanternatum			
	Symbolophorus californiensis			
	Merlangius merlangus	Polyamide (35.6%), polyester (5.1%), PS (0.9%), LDPE (0.3%)	32% fish had MPs	Lusher et al. (2013)
	Micromesistius poutassou		51.9% fish had MPs	
	Trachurus trachurus		28.6% fish had MPs	
	Trisopterus minutus		40% fish had MPs	
	Zeus faber		47.6% fish had MPs	
	Aspitrigla cuculus		51.5% fish had MPs	
	Callionymus lyra		38% fish had MPs	
	Cepola macrophthalma		32.3% fish had MPs	
	Buglossidium luteum		26% fish had MPs	
	Microchirus variegates		23.5% fish had MPs	
Seabird	*Puffinus tenuirostris*	Fragments	Observation	Tanaka et al. (2013)
	Fulmarus glacialis	Fragments	Observation	Bond et al. (2014)
	Puffinus gravis		Observation	
	Puffinus griseus		Observation	
	Calonectris diomedea	Fragments	Observations	Codina-García et al. (2013)
	Puffinus mauretanicus			
	Puffinus yelkouan			
	Morus bassanus			
	Ichthyaetus audouinii			
	Ichthyaetus melanocephalus			
	Larus michahellis			
	Rissa tridactyla			
	Catharacta skua			
Mammalia	*Phoca vitulina*		11.2% seal had MPs in stomach	Bravo Rebolledo et al. (2013)
			1% seal had MPs in intestine	
	Megaptera novaeangliae	PE (56.3%)	16 MPs in gastrointestinal	Besselinga et al. (2015)

Microplastics in China







Zhao SY., Zhu LX., and Li DJ., 2015

Location	n/m^2	n/m^3	Particle abundance	Reference
Arctic waters	0.028	0.34	0–1.31/m^3	Lusher et al., 2015
Bering Sea	.	0.004–0.19	.	Doyle et al., 2011
North Pacific subtropical gyre	.	0.116	.	Goldstein et al., 2012
North Pacific subtropical gyre		0.02–0.45	.	Goldstein et al., 2013
N. Atlantic (accumulation area)		1.70		Reisser et al., 2015
South Californian current system	.	0.011–0.033	0.00–3.14/m^3	Gilfillan et al., 2009
South Pacific	0.027	.	0–0.40/m^2	Eriksen et al., 2013
North Atlantic	.	0.01–0.04	.	Thompson et al., 2004
North Atlantic subtropical gyre	0.0015	.	0–0.2/m^2	Law et al., 2010
South Atlantic	.	0.03	.	Ivar do Sul et al., 2014
Equatorial Atlantic	.	0.01	.	Ivar do Sul et al., 2013
Southern Ocean		0.0035-0.099		Isobe, A., et al., 2016
Portuguese coast	.	0.02–0.036	.	Frias et al., 2014
Mediterranean	0.12	.	0–0.89/m^2	Collignon et al., 2012
Mediterranean	0.25	.	.	Cózar et al., 2015
Mediterranean	.	0.15	0.01–0.35/m^3	de Lucia. et al., 2014
East Asian seas		3.70		Isobe et al., 2015
Seto Inland Sea		0.39		Isobe et al., 2014
Yangtze Estuary		**4137.3 ± 2461.5***		**Zhao et al., 2014**
East Sea of China		**0.167 ± 0.138**		
Jiaojiang Estuaries, China		**955.6 ± 848.7**		**Zhao et al., 2015**
Oujiang Estuaries,		**680.0 ± 284.6**		
Minjiang Estuaries,		**1245.8 ± 531.5**		

BEACH

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Baseline

Occurrence of microplastics in the coastal marine environment: First observation on sediment of China

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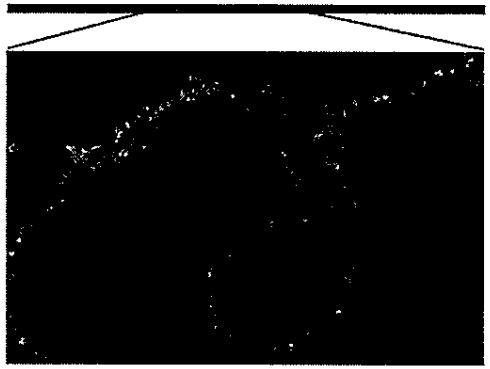


Fig. 1. Location of sampling sites.

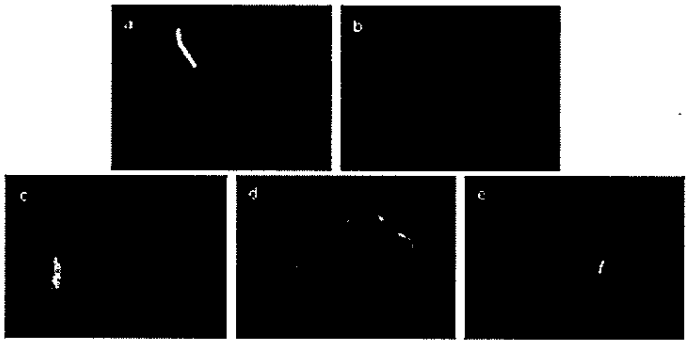


Fig. 5. Images of microplastics by an upright fluorescence microscope from Shapawan (a), Haikou (b), Wanning (c), Sanya (d), and Beihai (e).

Table 2
Incidence of microplastics in sediments of China (number of items per 50 g dry sediment).

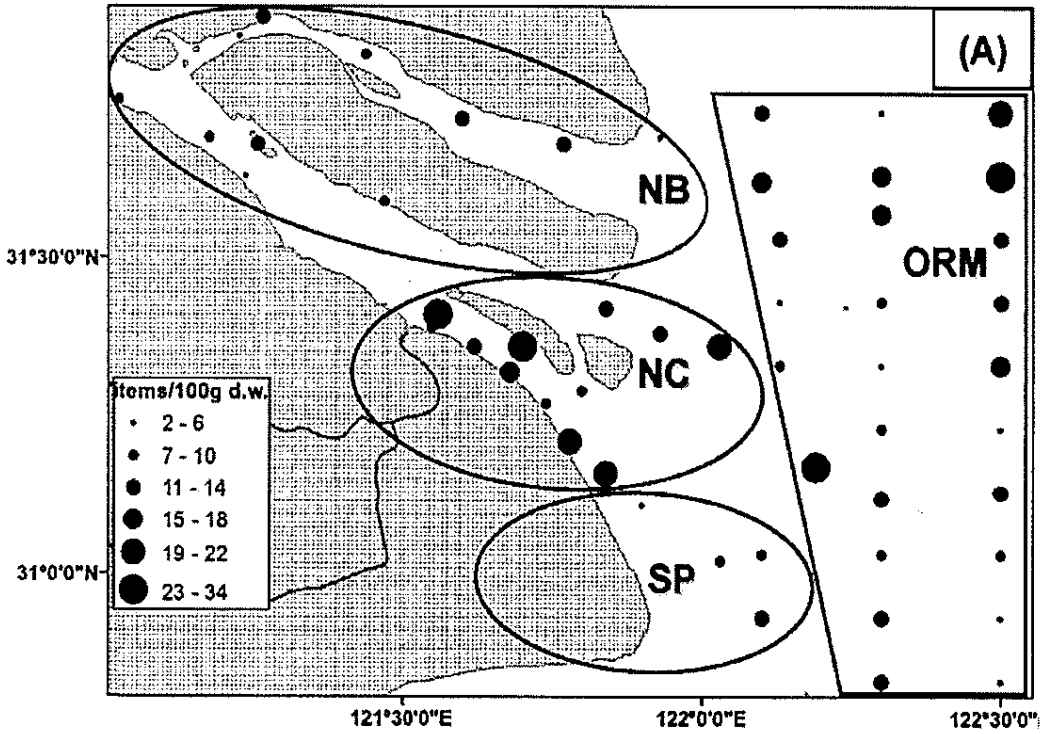
Sites	Place	No.	Long class	Middle class	Short class	Total
S1	Shapawan	1	45	80	150	275
		2	44	60	112	216
		3	49	58	154	261
		Average	46	66	138.7	250.7
S2	Haikou	1	26	82	153	261
		2	83	212	295	590
		3	61	107	171	339
		Average	56.7	133.7	206.3	396.7
S3	Wanning	1	77	85	148	310
		2	118	134	137	389
		3	165	222	221	608
		Average	120	147	168.7	435.7
S4	Sanya	1	164	175	185	524
		2	39	62	119	220
		3	61	76	150	287
		Average	88	104.3	151.3	343.6
S5	Beihai	1	99	101	138	338
		2	66	56	117	239
		3	93	94	148	335
		Average	86	83.7	134.3	304

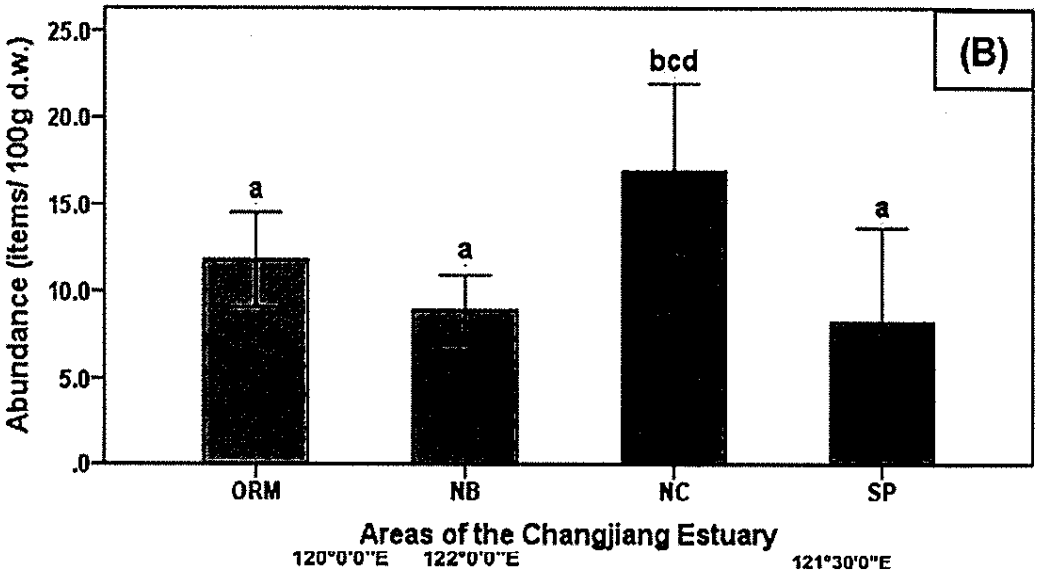
Table 3
The abundance of microplastics (items/kg sediment) has been summarized from five reports. Values are reported to the nearest integer.

Location	Maximum observed concentration	References
Wanning, China	8714	–
Kachelotplate, German	621.00	Liebezeit and Dubaish (2012)
Venice, Italy	2175	Vianello et al. (2013)
Nieuwpoort, Belgium	391	Claessens et al. (2011)
Beach, UK	86	Thompson et al. (2004)
Kallang River, Singapore	10.7	Ng and Obbard (2006)
Sentosa Island, Singapore	0	Ng and Obbard (2006)

Qiu et al., 2015

Area	Density		MP (type or form)	References
SCS, Zhuhai	347.0±205.9 n/m²	24.8±21.4 g/m²	Granule65%,Pellet18%,	Zhao et al., 2015
Qinzhou	14.0±5.2	1.9±1.2	Granule35%,film35%	
Weizhou	178.0±137.1	7.6±7.5	Fiber89%	
Beihai	30.0±10.1	0.3±0.2	Granule57%,film40%	
HongKong	3.0±2.0	2.7±3.3	Fiber33%film33%granule33%	
Macau	13.0±17.1	4.82±6.9	Granule64%,film21%	
SCS, Hong Kong	5595 n/m²		Fragments 5%;Pellets 3%	Fok et al., 2015
SCS, Shapawan	5014 n/kg dw			Qiu et al, 2015
Haikou	7934			
Wanning	**8714**			
Beihai	6872			
Sanya	6080			
Bohai Sea, Bijianshan	102.9 ± 39.9 n/kg		PEVA, LDPE, PS	Yu et al., 2016
Xingcheng	163.3 ± 37.7			
Dongdaihe	117.5 ± 23.4			
Kachelotplate,German	**62100** n/kg dw			Liebezeit & Dubaish, 2012
Coastal beach, Germany	2.3 n/kg			Dekiff et al., 2014
River shore, Germany	4000 n/kg			Kein et al., 2015
Coastal beach, Slovenia	177.8 n/kg			Laglbauer et al., 2014
Venice Lagoon, Italy	672-2175n/kg dw			Vianello et al. 2013
Nieuwpoort, Belgium	391 (52.8-213.4) n/kg dw			Claessens et al.,2011
Beach, UK	86 n/kg dw			Thompson et al.,2004
Kallang River,Singapore	10.7 n/kg dw			Ng and Obbard, 2006
Sentosa Island,Singapore	0 n/kg dw			Ng and Obbard, 2006





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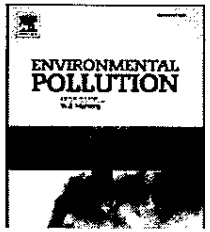
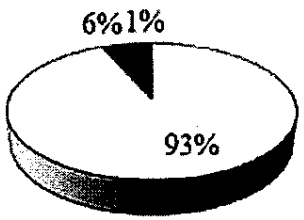
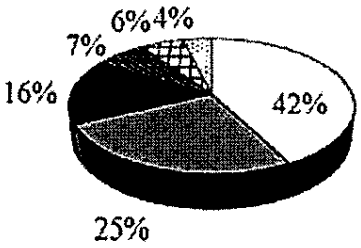




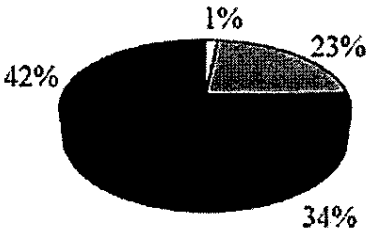
(A) shape

- fibre
- fragment
- pellet



(B) color

- transparent
- blue
- black
- yellow
- red
- white



(C) size

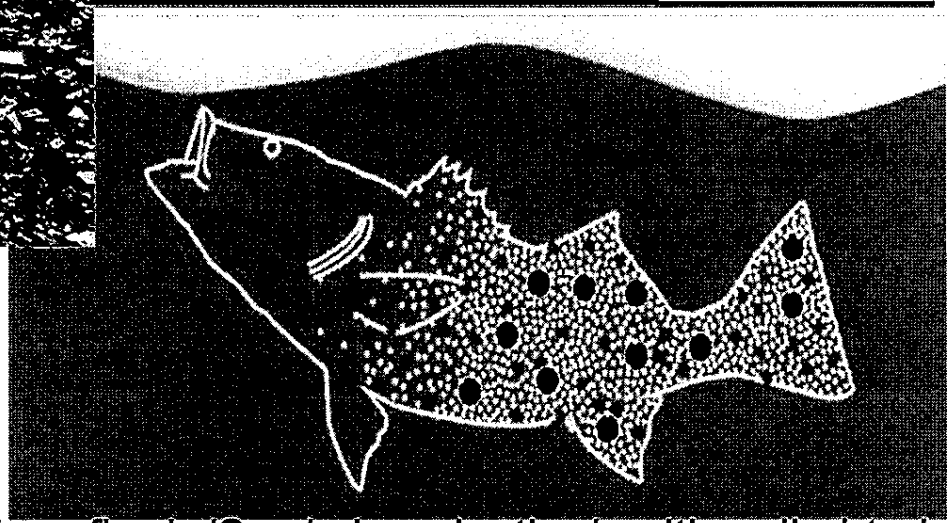
- SMP,0-100μm
- SMP,100-500μm
- SMP,500-1000μm
- LMP,1000-5000μm

Serious damages caused by microplastics

UNEP Year Book 2014 emerging issues update

Plastic Debris in the Ocean

UNEP United Nations Environment Programme



http://stjohns.ifas.ufl.edu/Sea/microplastics/multimedia.html

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ecology & evolution

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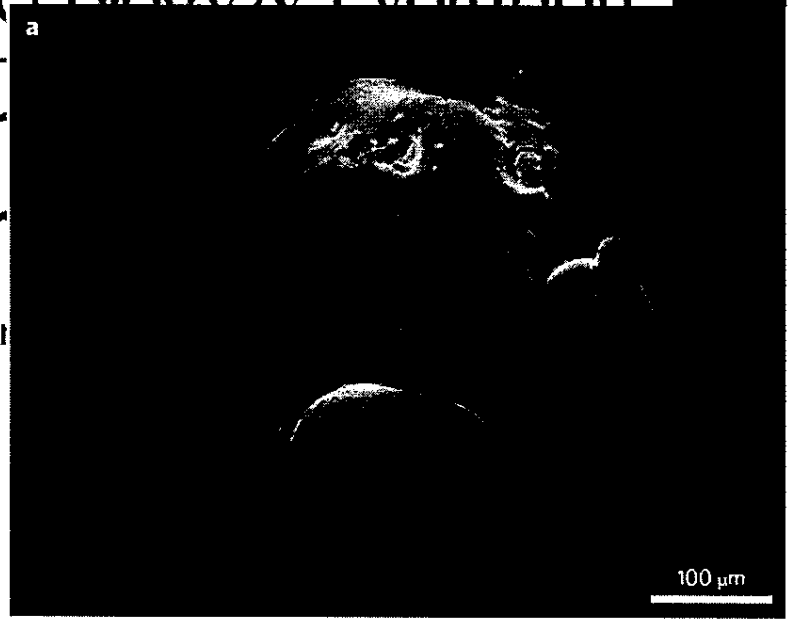
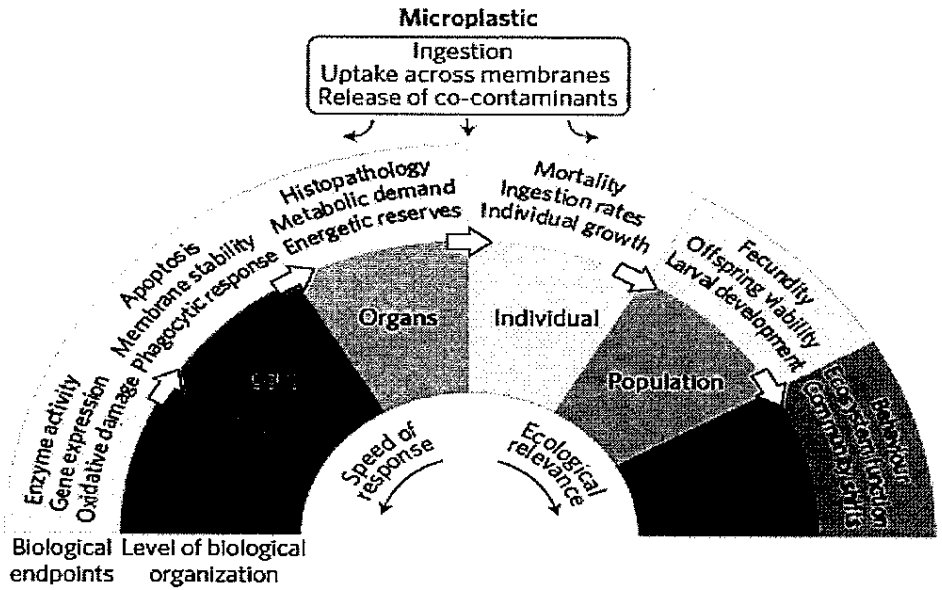
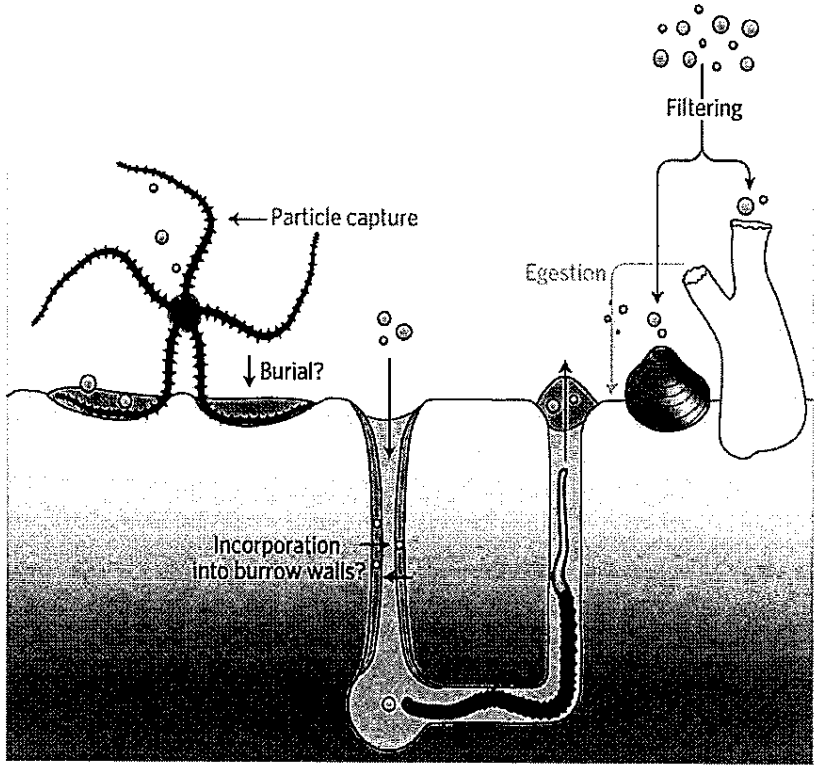
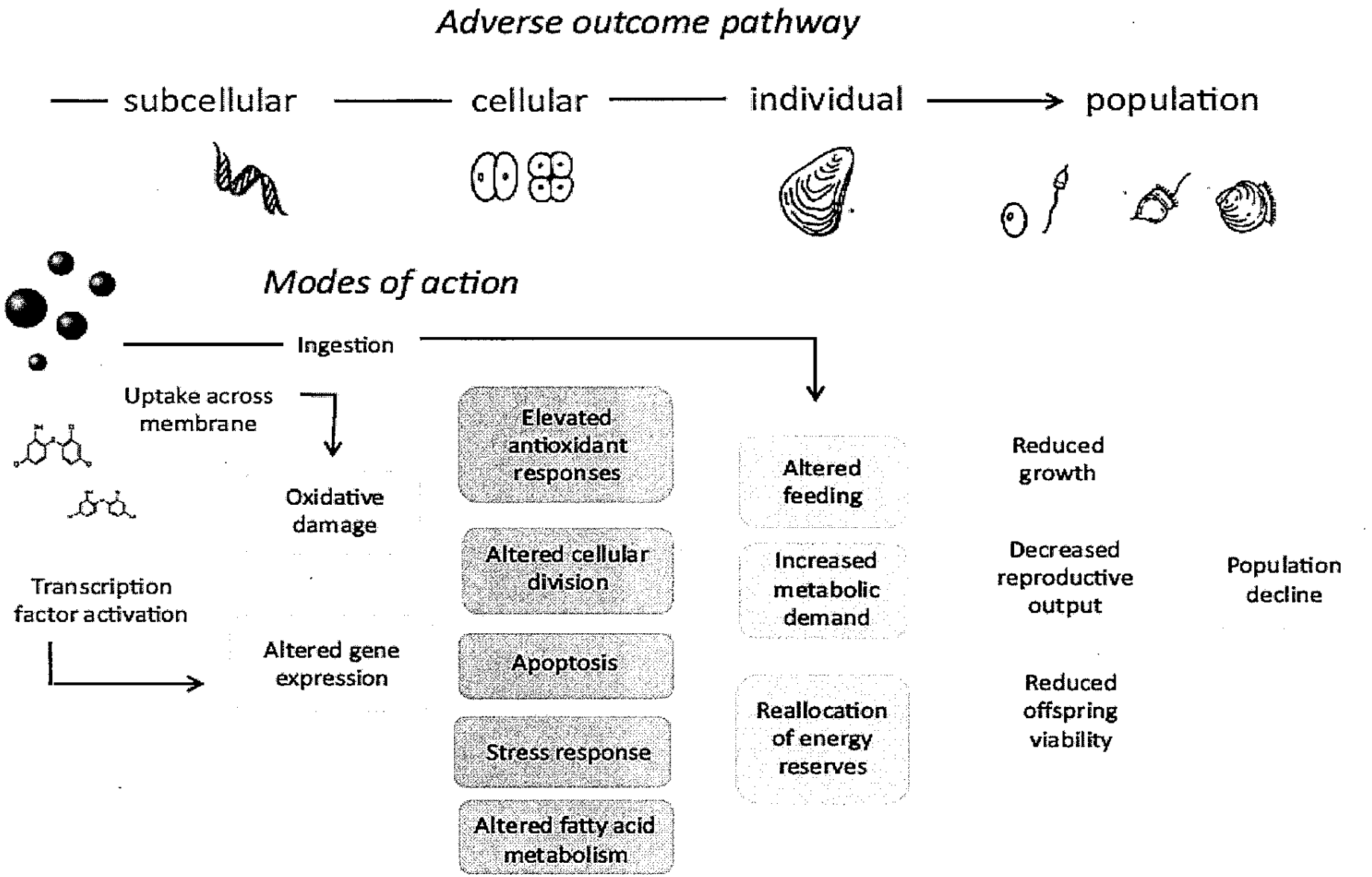


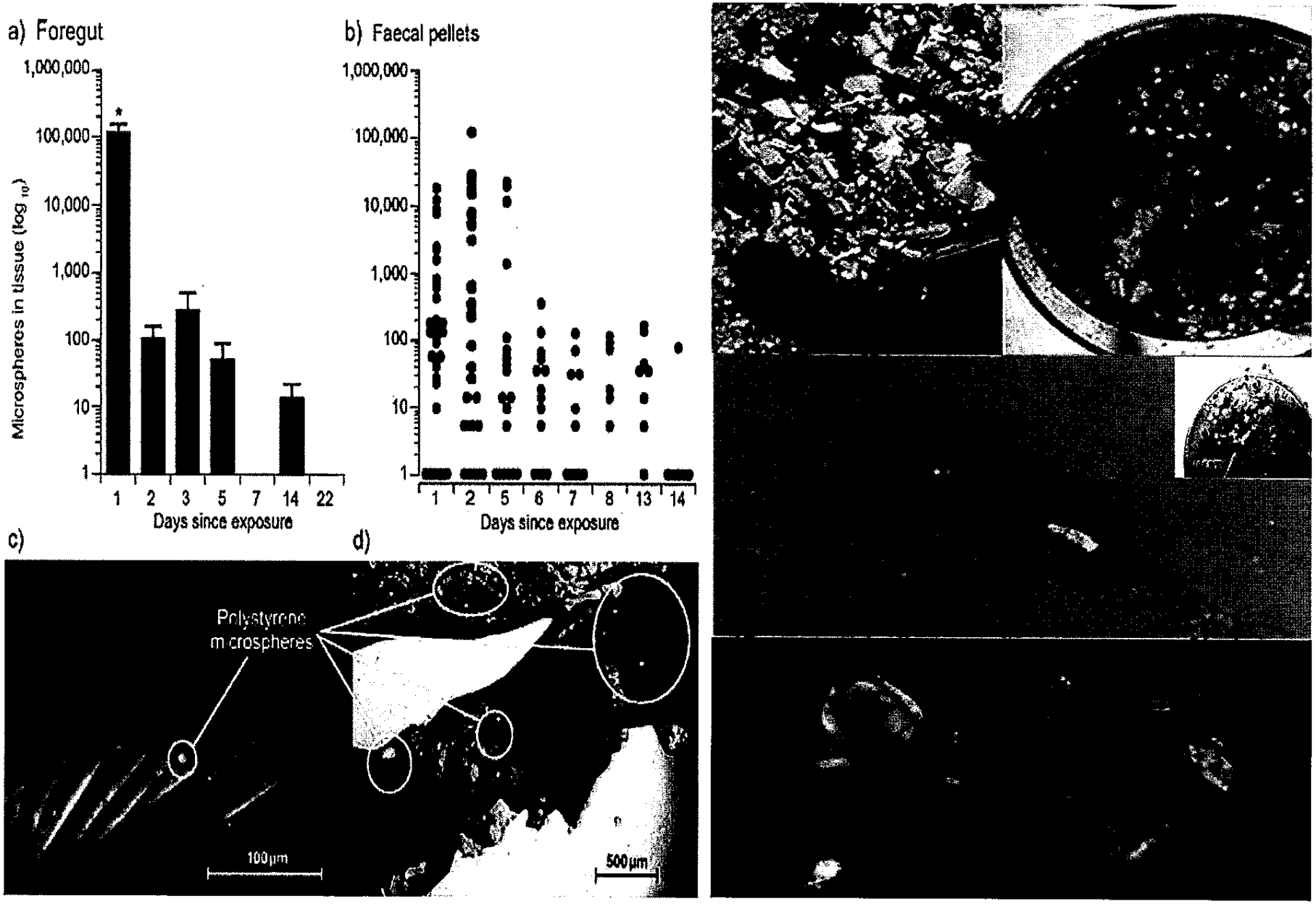




Impacts induced by microplastics



Smaller in size, easier to ingest



ENVIRONMENTAL Science & Technology

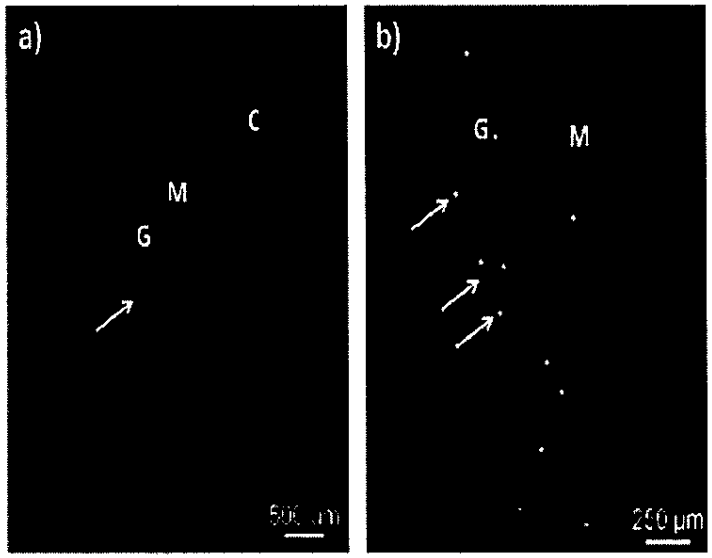
Article

pubs.acs.org/est

Fate of Microplastics in the Marine Isopod *Idotea emarginata*

Julia Hämer,[†,‡] Lars Gutow,[†] Angela Köhler,[†] and Reinhard Saborowski*[,†]

[†]Helmholtz Centre for Polar and Marine Research, Alfred Wegener Institute, Am Handelshafen 12, 27570 Bremerhaven, Germany
[‡]Department of Ecology, Evolution and Biodiversity, Ruhr University Bochum, 44780 Bochum, Germany



SCIENTIFIC REPORTS

OPEN

SUBJECT AREAS:
ECOPHYSIOLOGY
ECOLOGY
CONSERVATION
ENVIRONMENTAL CHEMISTRY

Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress

Chelsea M. Rochman[1], Eunha Hoh[2], Tomofumi Kurobe[1] & Swee J. Teh[1]

Current Biology

Cell Press

Volume 23, Issue 23, 2 December 2013, Pages R1031–R1033

Correspondence

Microplastic ingestion decreases energy reserves in marine worms

Stephanie L. Wright[1], Darren Rowe[1], R

Current Biology

Cell Press

Volume 23, Issue 23, 2 December 2013, Pages 2388–2392

Report

Microplastic Moves Pollutants and Additives to Worms, Reducing Functions Linked to Health and Biodiversity

Mark Anthony Browne[1,2], Stewart J. Niven[1,3,4], Tamara S. Galloway[5], Steve J. Rowland[4], Richard C. Thompson[1]

Environmental Pollution 207 (2015) 190–195

Contents lists available at ScienceDirect

Environmental Pollution

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

Microplastics in commercial bivalves from China

Jiana Li [a], Dongqi Yang [a], Lan Li [b], Khalida Jabeen [a], Huahong Shi [a, *]

[a] State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai 200062, China
[b] Research Center for Analysis and Measurement, Donghua University, Shanghai 201620, China

Environmental Pollution 214 (2016) 177–184

Contents lists available at ScienceDirect

Environmental Pollution

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

Microplastics in mussels along the coastal waters of China☆

Jiana Li [a], Xiaoyun Qu [a], Lei Su [a], Weiwei Zhang [b], Dongqi Yang [a], Prabhu Kolandhasamy [a], Daoji Li [a], Huahong Shi [a, *]

[a] State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai 200062, China
[b] Division of Marine Chemistry, National Marine Environmental Monitoring Center, Dalian 116023, China

Science of the Total Environment 550 (2016) 1110–1115

Contents lists available at ScienceDirect

Science of the Total Environment

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

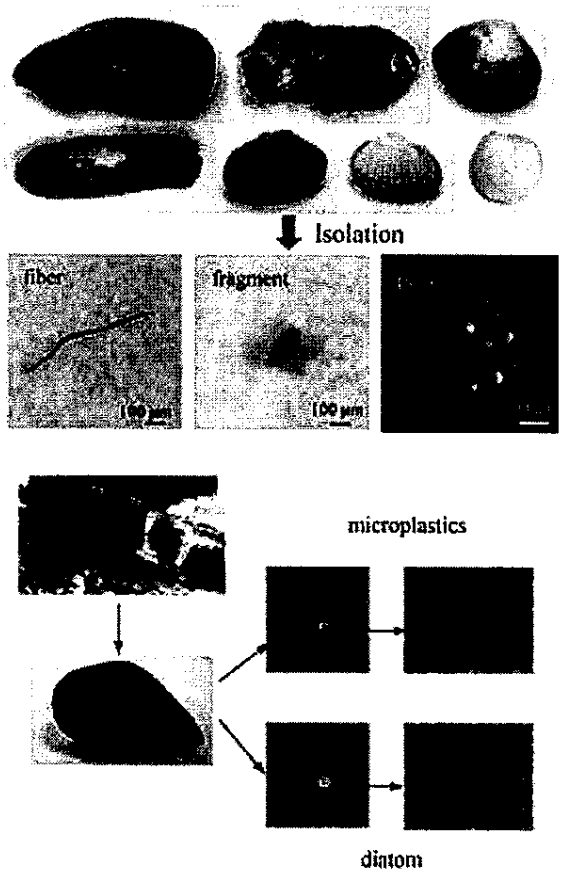
Short Communication

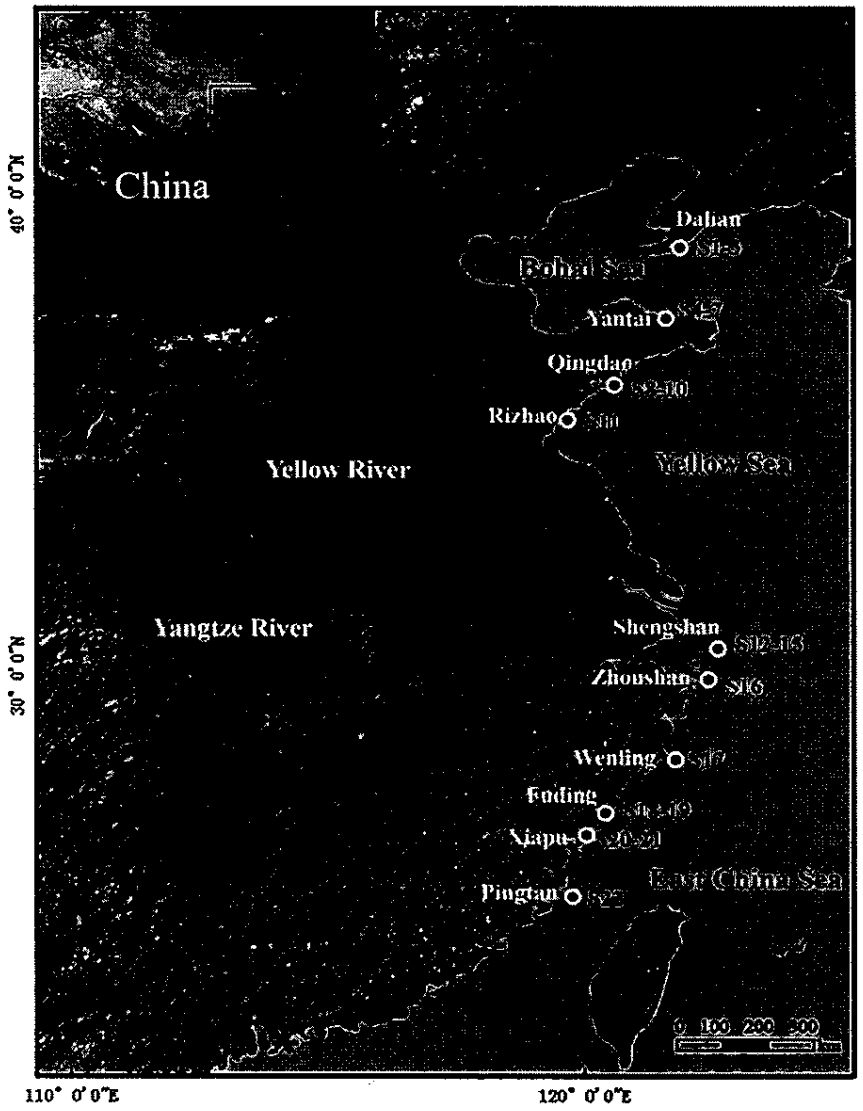
Microscopic anthropogenic litter in terrestrial birds from Shanghai, China: Not only plastics but also natural fibers

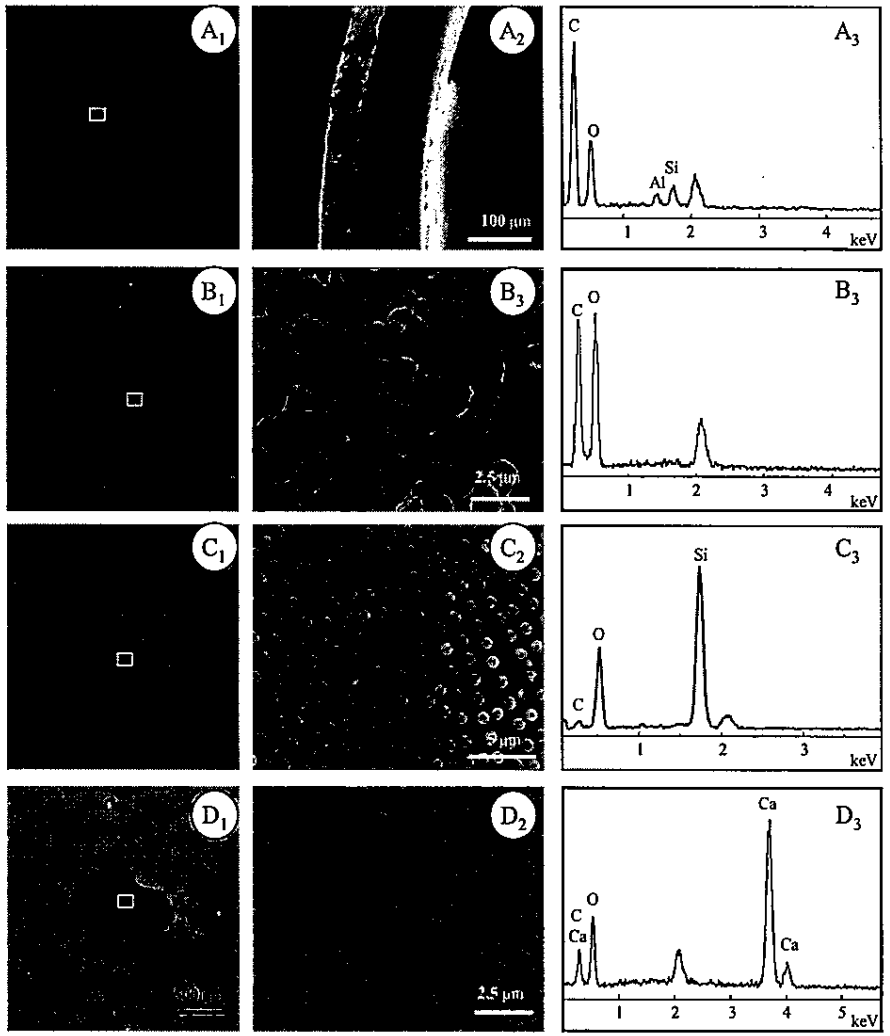
Shiye Zhao, Lixin Zhu, Daoji Li *

State Key Laboratory of Estuarine and Coastal Research, East China Normal University, 3663 North Zhongshan Road, Shanghai 200062, China

Biological tissue







Li et al., *Environ. Pollut.* (accepted)

Type of organisms, species, type or form and quantity of MPs found in biota with references of the corresponding studies.

Organisms	Species	Microplastics type or form	Quantity	References
Zooplankton	*Neocalanus cristatus*	Fibers (50%)	0.026 particles/individual	Desforges et al. (2015)
	Euphausia pacifia	Fibers (68%)	0.058 particles/individual	
Polychaete	*Clymenella torquata*	Fibers	2-8/gram (equal in sediment)	Mathalon and Hill (2014)
	Alitta virens	Fibers	2-8/gram (equal in sediment)	
Bivalvia	*Mytilus eduis*	Fibers	106-178/mussel	Mathalon and Hill (2014)
			0.36 ± 0.07 particles/g	Van Cauwenberghe and Janssen (2014)
			0.2 ± 0.3 particles/g	Van Cauwenberghe et al. (2015)
		Fibers	0.26–0.51/gram	De Witte et al. (2014)
	Mytilus galloprovincialis	Fibers		
	Crassostrea gigas		0.47 ± 0.16 particles/g	Van Cauwenberghe and Janssen (2014)
Crustacean	*Nephrops norvegicus*	Filaments	83% had MPs in stomach	Murray and Cowie (2011)
	Crangon crangon	Synthetic fibers	0.68 ± 0.55 MP/g	Devriese et al. (2015)
Thaliacea	*Thetys vagina*	Fragment, PP/monofilament		Moore et al. (2001)
Fish	*Astronesthes indopacifica*	Fragments	MPs predominant	Boerger et al. (2010)
	Cololabis saira			
	Hygophum reinhardtii			
	Loweina interrupta			
	Myctophum aurolanternaaum			
	Symbolophorus californiensis			
	Merlangius merlangus	Polyamide (35.6%), polyester (5.1%), PS (0.9%), LDPE (0.3%)	32% fish had MPs	Lusher et al. (2013)
	Micromesistius poutassou		51.9% fish had MPs	
	Trachurus trachurus		28.6% fish had MPs	
	Trisopterus minutus		40% fish had MPs	
	Zeus faber		47.6% fish had MPs	
	Aspitrigla cuculus		51.5% fish had MPs	
	Callionymus lyra		38% fish had MPs	
	Cepola macrophthalma		32.3% fish had MPs	
	Buglossisium luteum		26% fish had MPs	
	Microchirus variegates		23.5% fish had MPs	
Seabird	*Puffinus tenuirostris*	Fragments	Observation	Tanaka et al. (2013)
	Fulmarus glacialis	Fragments	Observation	Bond et al. (2014)
	Puffinus gravis		Observation	
	Puffinus griseus		Observation	
	Calonectris diomedea	Fragments	Observations	Codina-García et al. (2013)
	Puffinus mauretanicus			
	Puffinus yelkouan			
	Morus bassanus			
	Ichthyaetus audouinii			
	Ichthyaetus melanocephalus			
	Larus michahellis			
	Rissa tridactyla			
	Catharacta skua			
Mammalia	*Phoca vitulina*		11.2% seal had MPs in stomach	Bravo Rebolledo et al. (2013)
			1% seal had MPs in intestine	
	Megaptera novaeangliae	PE (56.3%)	16 MPs in gastrointestinal	Besselinga et al. (2015)

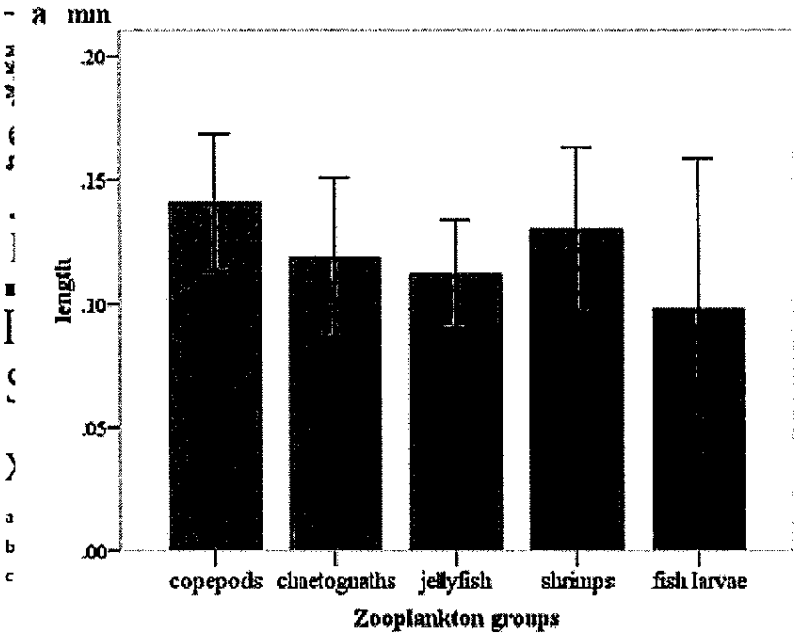
Mytilus edulis
0.9-4.6 /g
1.5-7.6 /individual
Commercial Bivalves
2.1-10.5 /g (ww)
4.3-57.2/individual

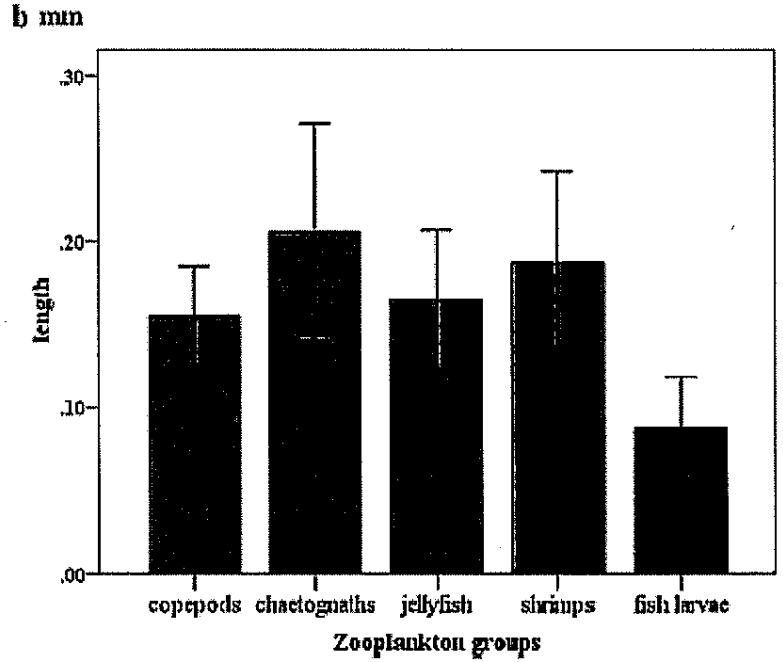
22.8 (± 33.4) /bird
Zhao et al., 2016

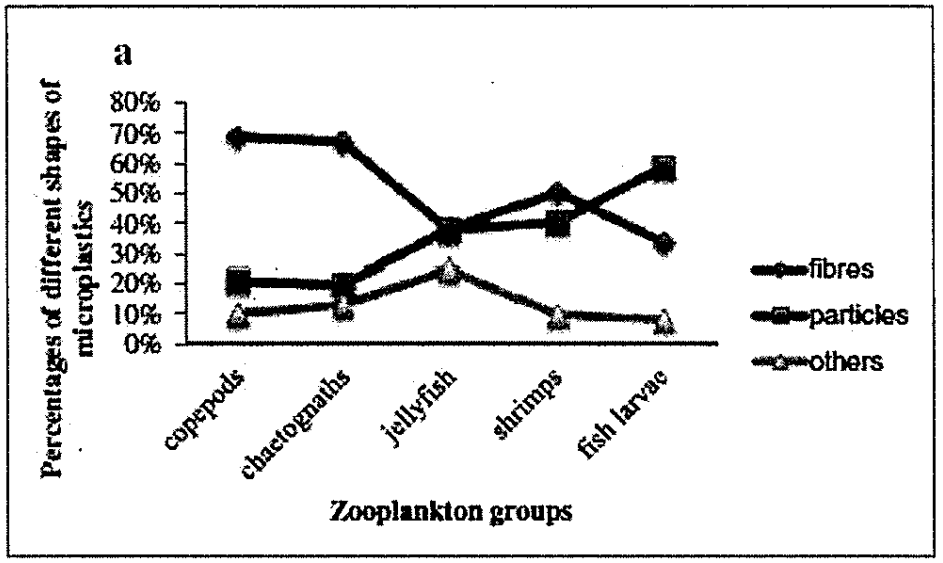
s available at ScienceDirect

Pollution Bulletin

MARINE POLLUTION BULLETIN







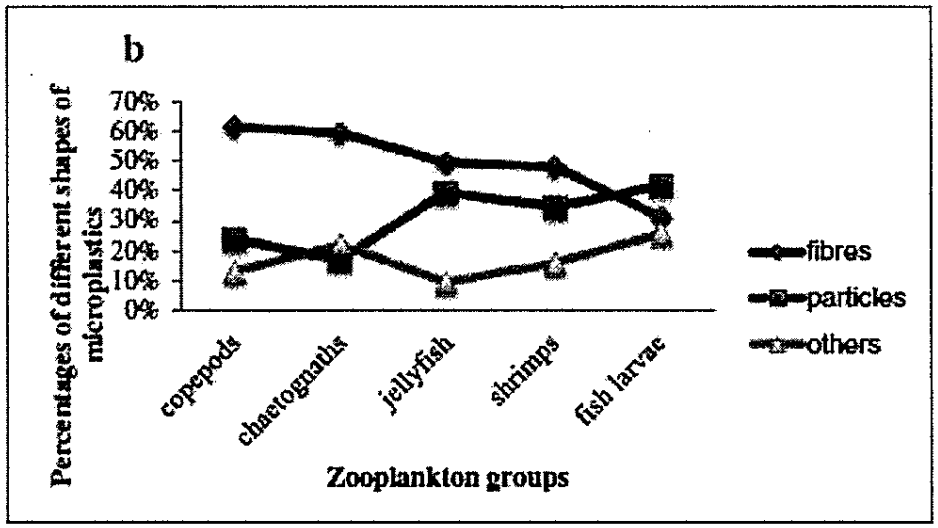
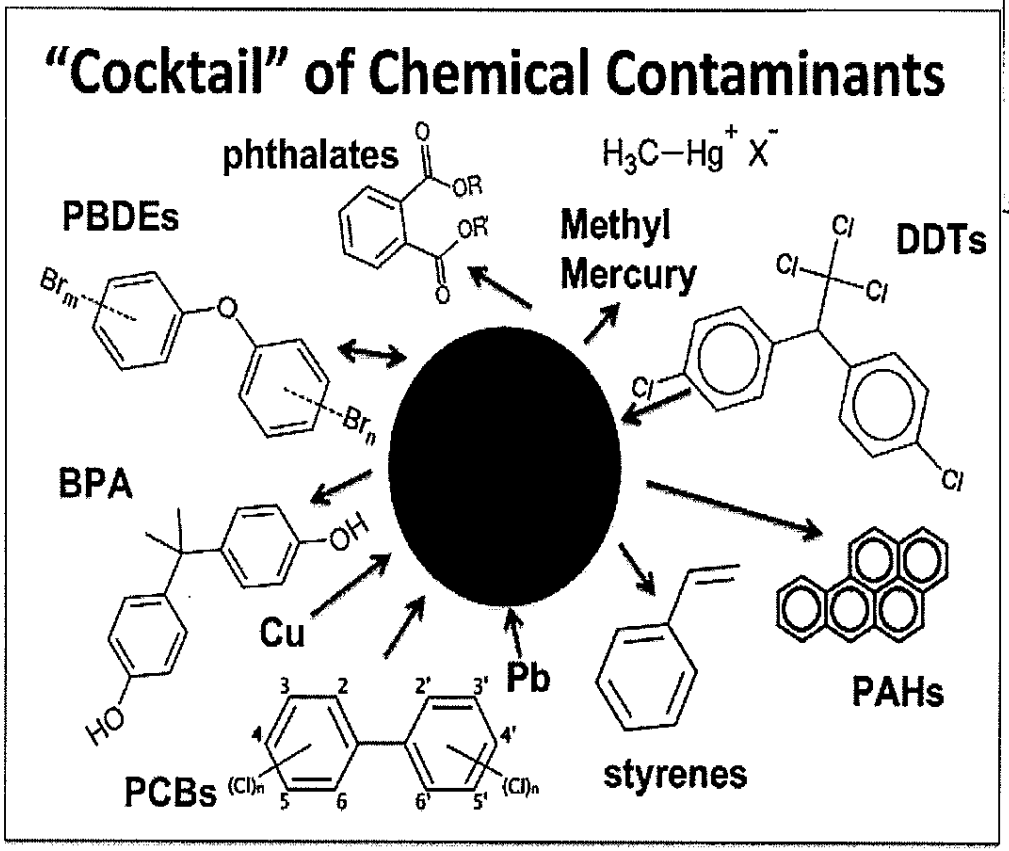


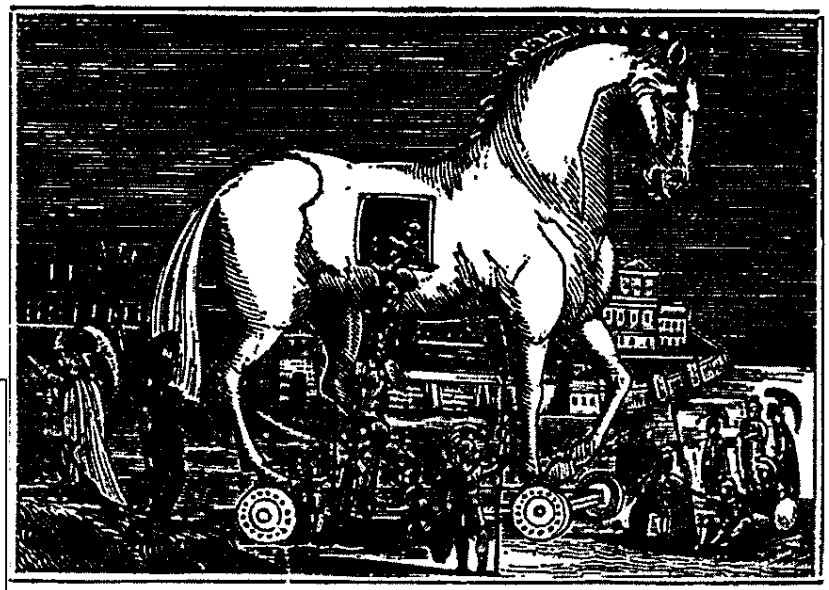
Fig. 1. Sampling stations in the northern part of the South China Sea.

Interaction with other contaminations

- PAHs
- PCBs
- Flame Retardant
- Heavy metals

.....





Environmental Pollution 219 (2016) 166–173

Contents lists available at ScienceDirect

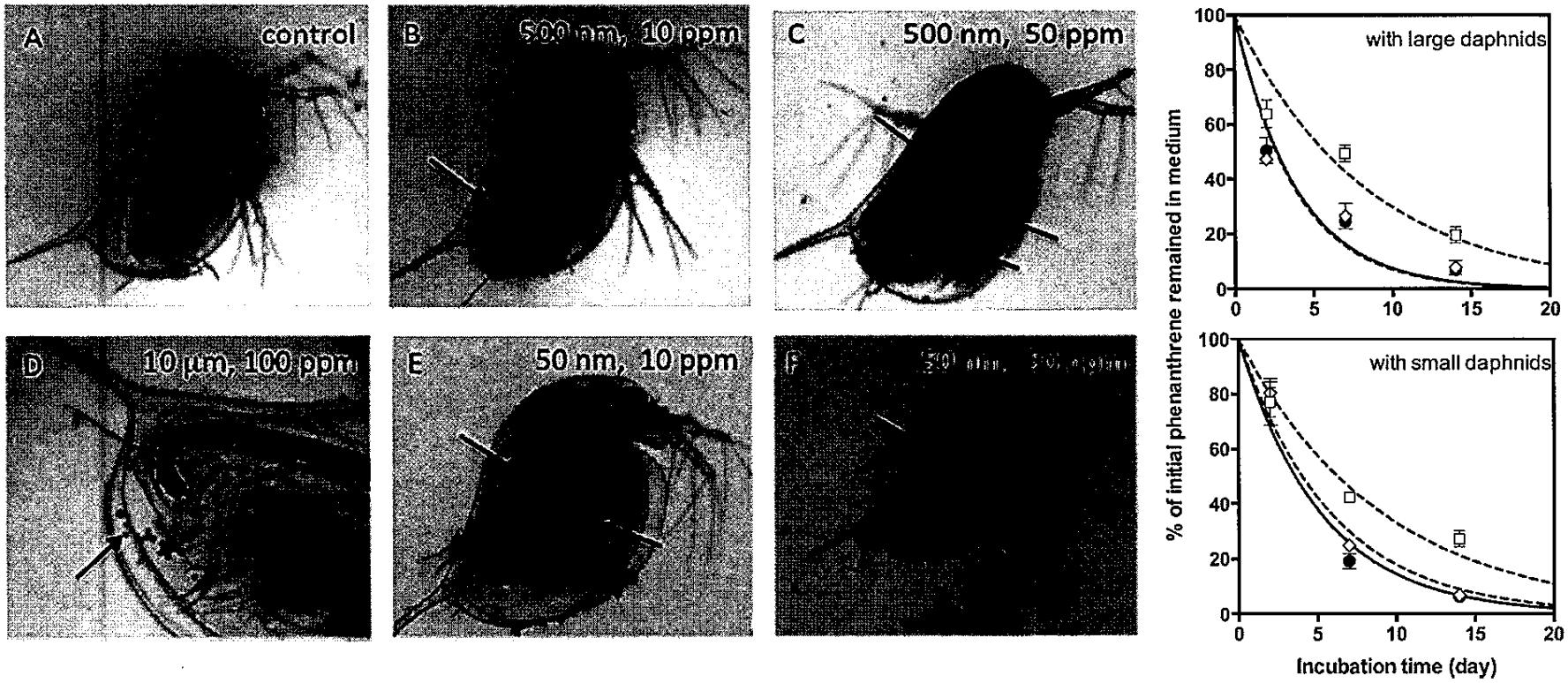
Environmental Pollution

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

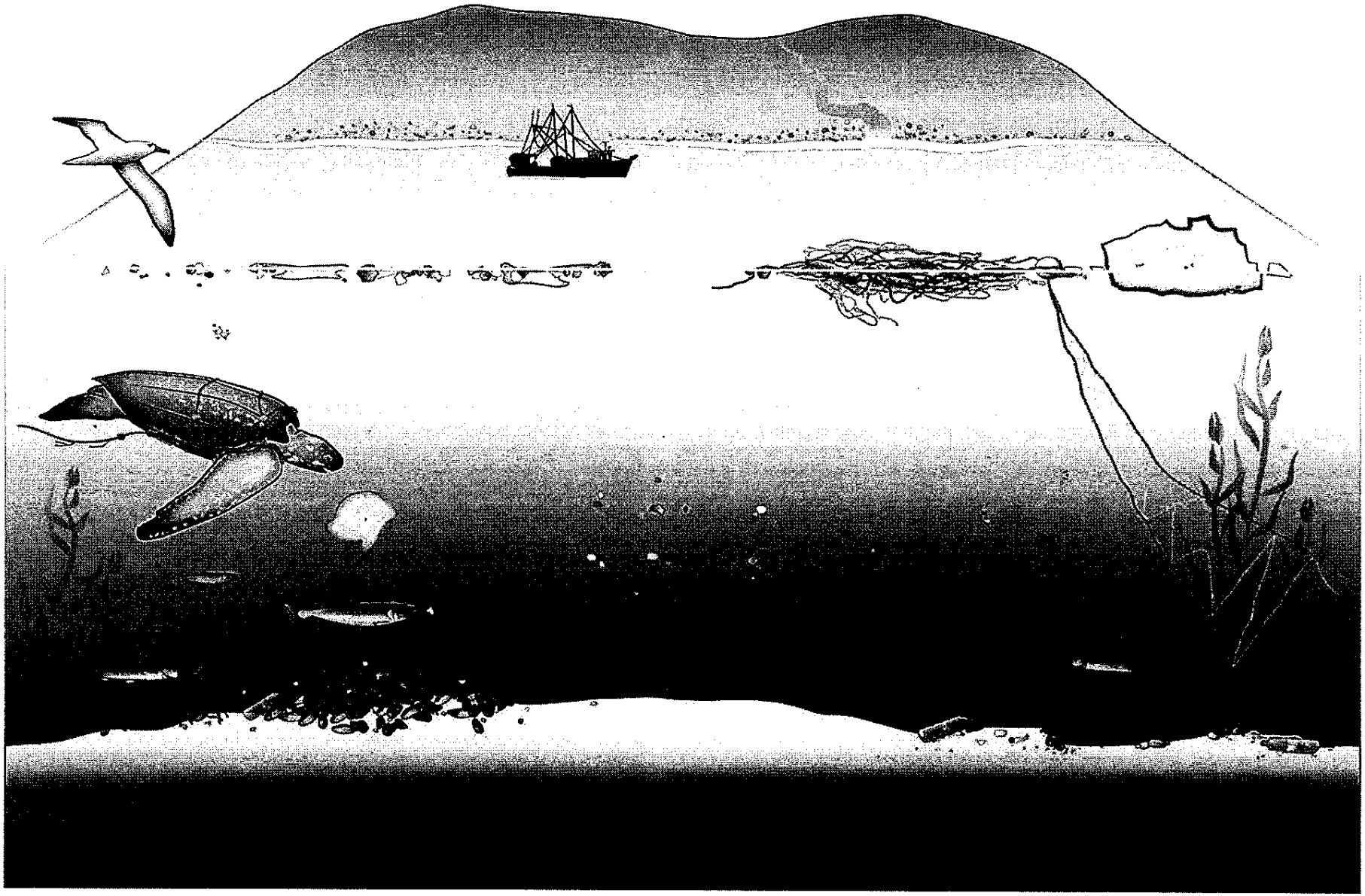
Effects of nanoplastics and microplastics on toxicity, bioaccumulation, and environmental fate of phenanthrene in fresh water☆

Yini Ma [a], Anna Huang [a], Siqi Cao [a], Feifei Sun [a], Lianhong Wang [a], Hongyan Guo [a], Rong Ji [a, b, *]

[a] State Key Laboratory of Pollution Control and Resource Reuse, School of the Environment, Nanjing University, 163 Xianlin Avenue, 210023 Nanjing, China
[b] Institute for Marine Science, Nanjing University, 163 Xianlin Avenue, 210023 Nanjing, China



Transfer through food chain



Science AAAS

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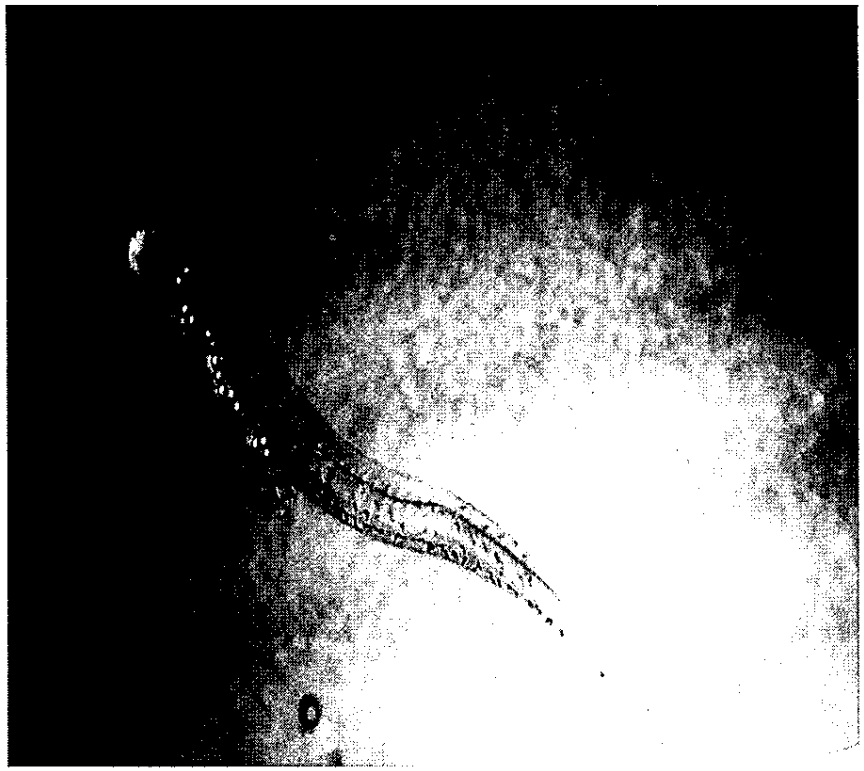
REPORT

Environmentally relevant concentrations of microplastic particles influence larval fish ecology

Lönnstedt & Eklöv, Science, 2016



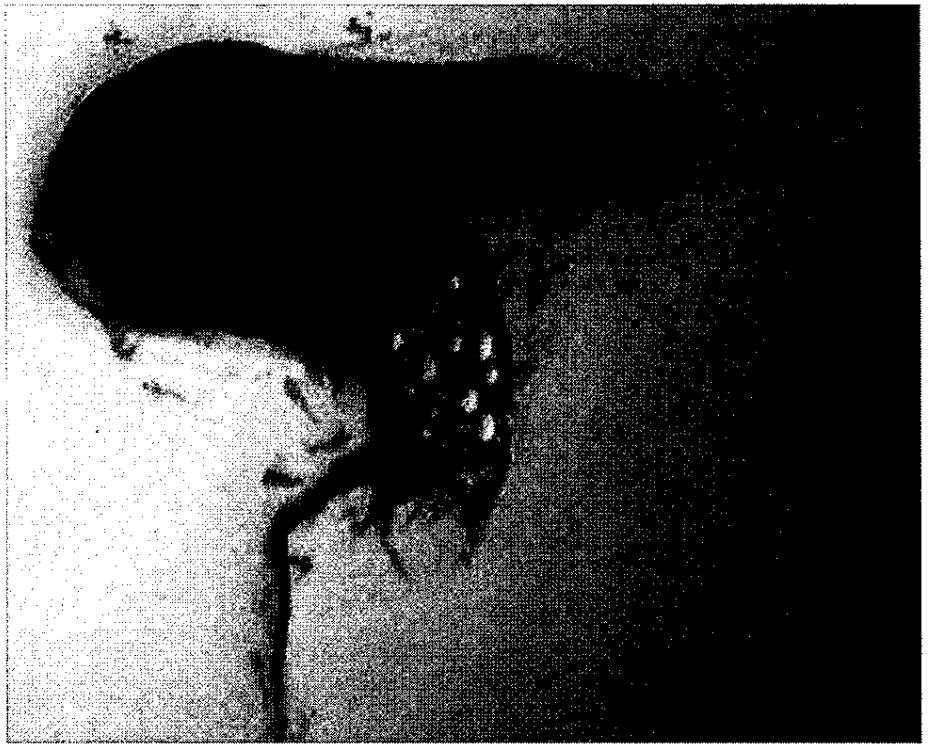
Proceedings of the National Academy of Sciences of the United States of America

CURRENT ISSUE ARCHIVE NEWS & MULTIMEDIA AUTHORS ABOUT COLLECTED ARTICLES

> Current Issue > vol. 113 no. 9 > Tamara S. Galloway, 2331–2333, doi: 10.1073/pnas.1600715113

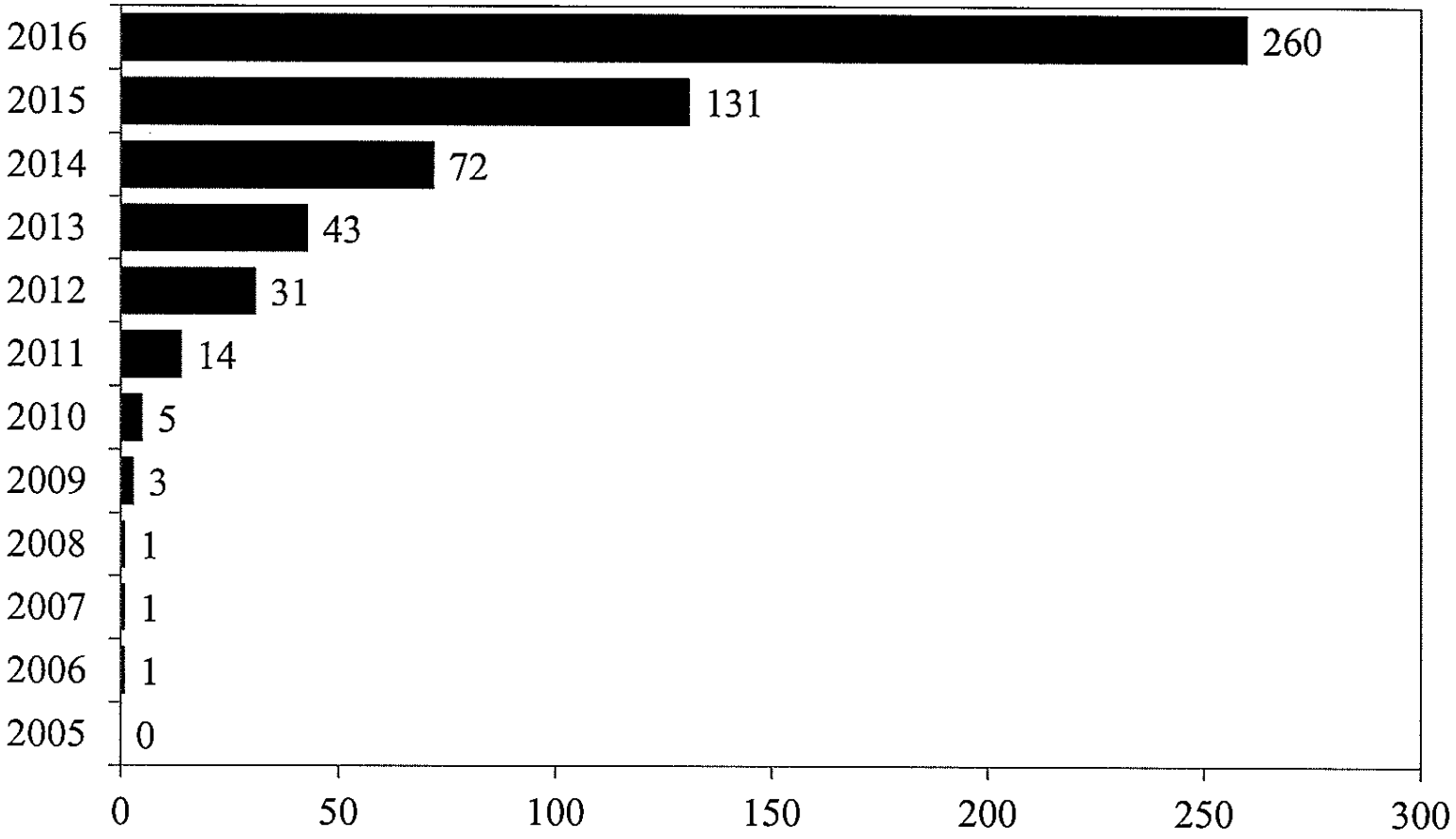
Marine microplastics spell big problems for future generations

Tamara S. Galloway[a,1] and Ceri N. Lewis[a]

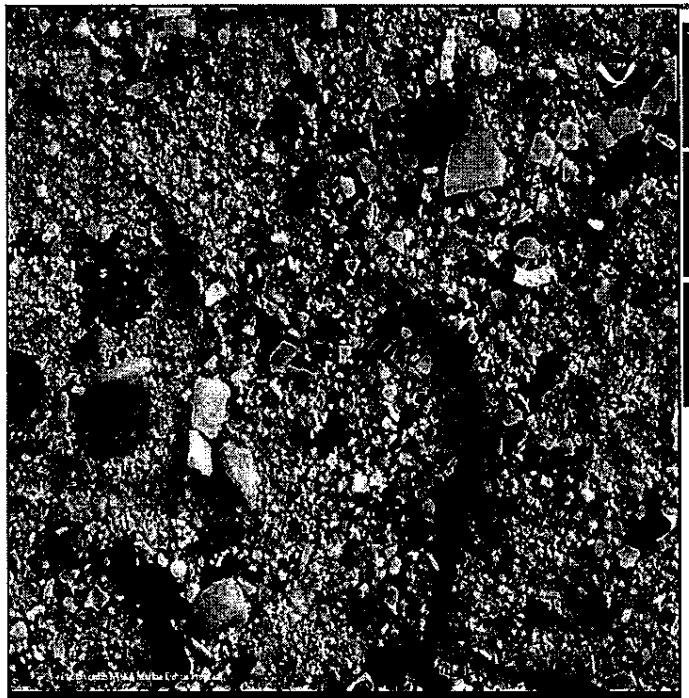


Related published papers

(Web of Science, updated till Sept. 2016)

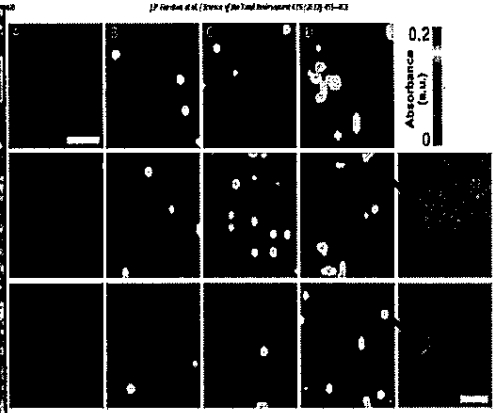


Standard monitoring, analysis and evaluation method?



Laboratory Methods for the Analysis of Microplastics in the Marine Environment:
Recommendations for quantifying synthetic particles in waters and sediments

NOAA Marine Debris Program
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Technical Memorandum NOS-OR&R-48
July 2015



Environmental Science: Processes & Impacts

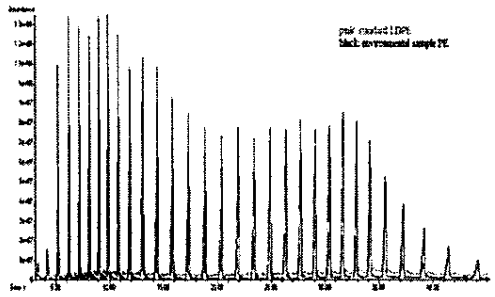
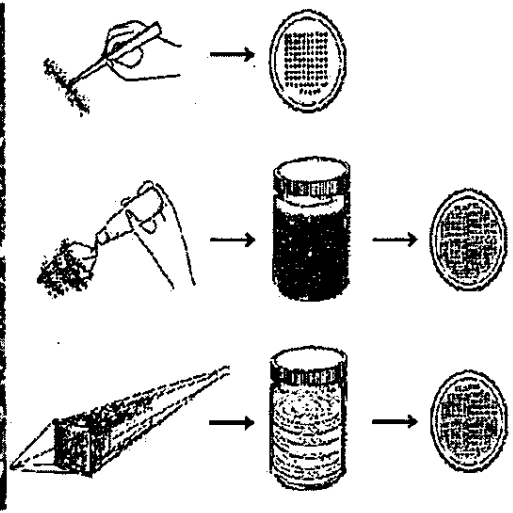
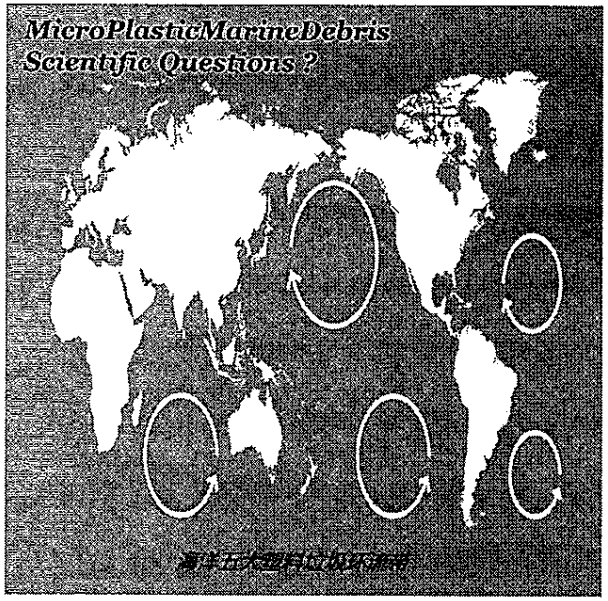
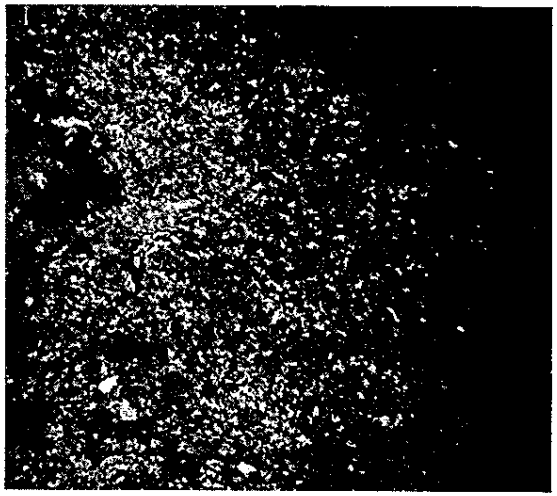


Fig. 4 Pyrogram of PE (black) found in the environmental microplastic overlayed by the pyrogram of a PE standard (pink).



Understanding of distribution, transfer pathway and detailed impacts?





2014_MPB_Strategy for mitigation of marine debris Analysis of sources and composition of marine debris in northern Taiwan

2014_MPB_Suspended MP in surface water of the Yangtze Estuary China First observations on occurrence, distribution

2015_EP_Accumulation of floating microplastics behind the Three Gorges Dam---三峡大坝

2015_EP_Microplastic in three urban estuaries, China

2015_EP_Microplastics in commercial bivalves from China

2015_EST_Microplastic Pollution in Table Salts from China

2015_MPB_Hong Kong at the Pearl River Estuary - A hotspot of microplastic pollution---香港

2015_MPB_Occurrence of microplastics in the coastal marine environment-First observation on sediment of China_南海

2015_MPB_Persistent organic pollutants carried on plastic resin pellets from two beaches

2015_Regional Studies in Marine Science_Characterization of small plastic debris on tourism beaches around

2015_科学通报_海岸环境中微塑料污染及其生态效应研究进展

2016_EP_Microplastic pollution of lakeshore sediments from remote lakes in Tibet plateau, China淡水

2016_EP_Microplastics in Taihu Lake, China

2016_EP_Occurrence of microplastics in the beach sand of the Chinese inner--渤海

2016_EST_Uptake and accumulation of polystyrene microplastics in zebrafish and toxic effects in liver

2016_Estuarine, Coastal and Shelf Science_Extraction, enumeration and identification methods for monitoring

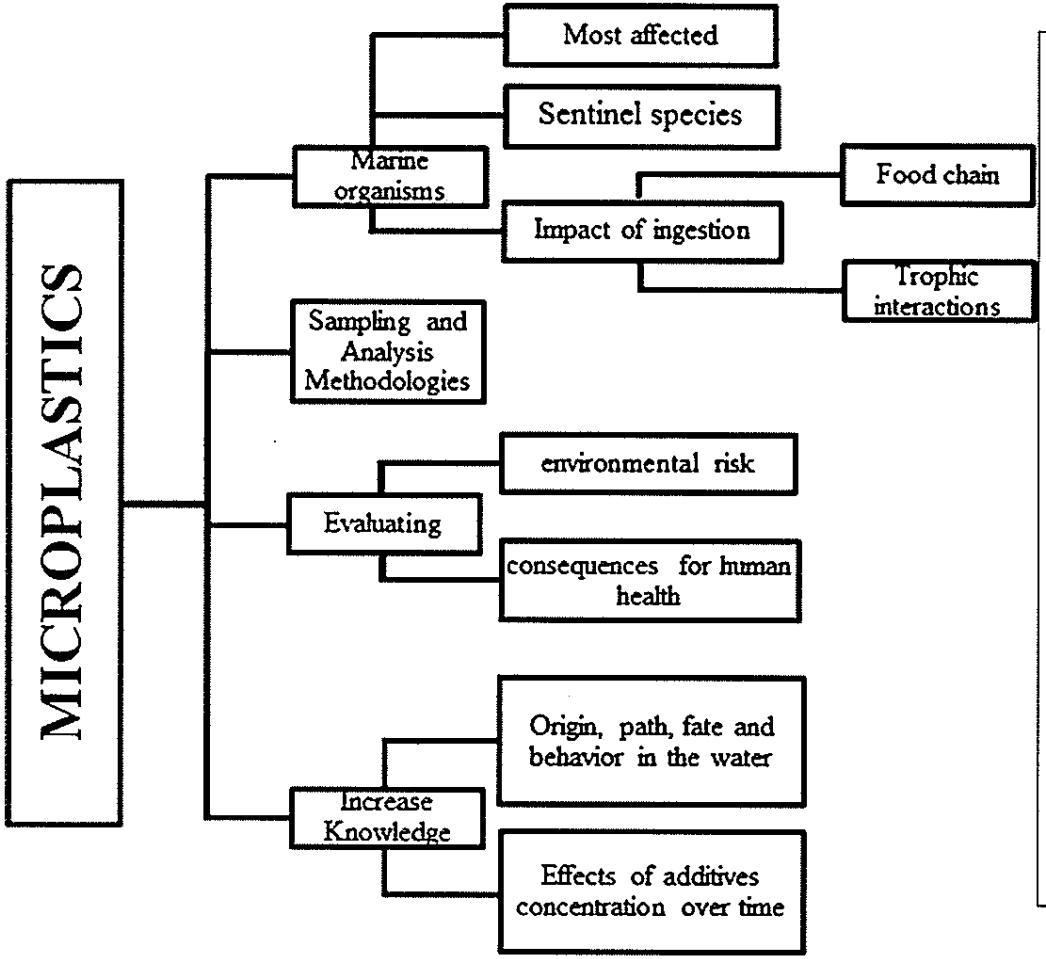
2016_Marine Environmental Research_The behaviors of microplastics in the marine environment

2016_Science of the Total Environment_Seasonal variation in the abundance of marine plastic debris in the estuary of HK

2016_Waste Mangement_Assessment of marine debris in beaches or seawaters around the China Seas and coastal provinces

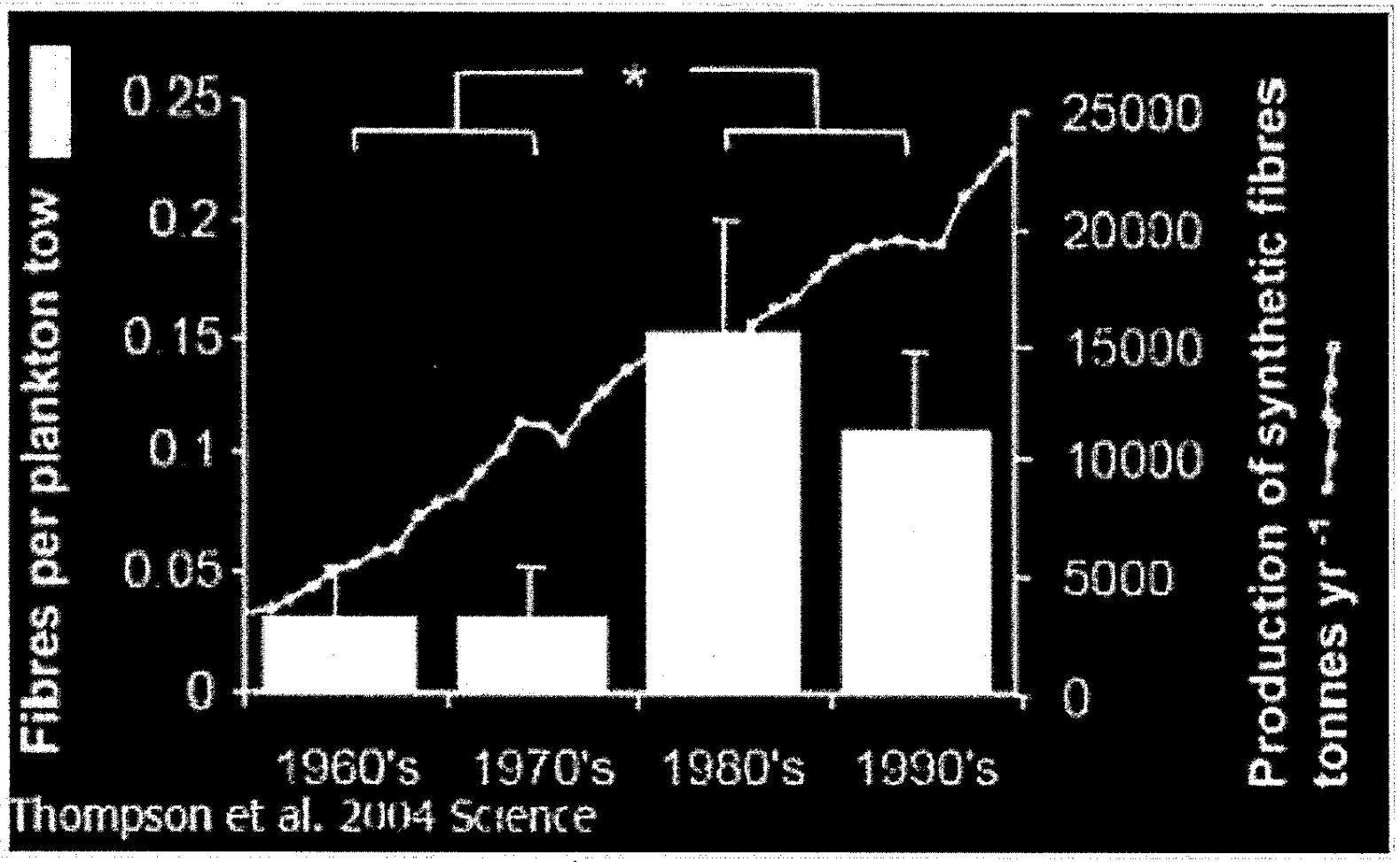
2016-Sci Total Environ_Microscopic anthropogenic litter in terrestrial birds from Shanghai,

Research aspects of interest future with regard to marine environment microplastics.

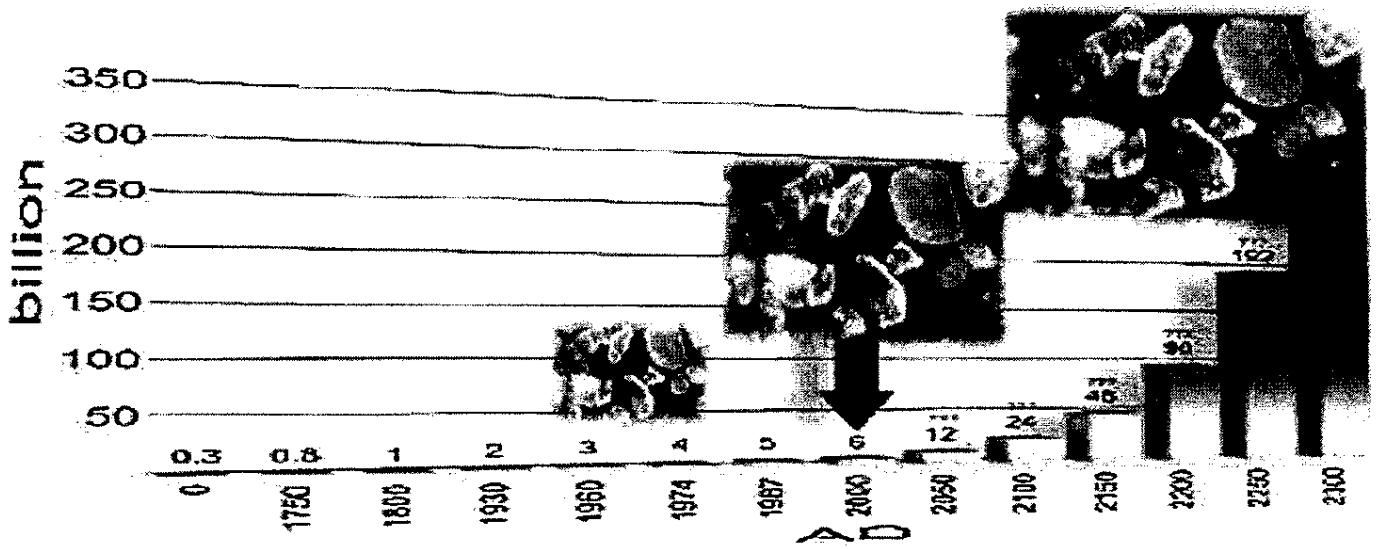


- **Detecting and monitoring**
  - Sampling and identification
  - Monitoring and distribution
- **Potential effects**
  - Which biota interact with microplastics
  - How do microplastics affect organisms
  - Potential for wider environmental impacts of microplastics
- **Policy development**

Eerkes-Medrano et al., 2015


Fibres per plankton tow
0.25
0.2
0.15
0.1
0.05
0
*
25000
20000
15000
10000
5000
0
Production of synthetic fibres
tonnes yr -1
1960's
1970's
1980's
1990's
Thompson et al. 2004 Science

A significant relationship between microplastic abundance and human population-density was found (Browne et al., 2011)



Thus as the human population continues to increase, the prevalence of microplastics will also most probably increase (Wright et al 2013)

ENVIRONMENTAL Science & Technology

Article

pubs.acs.org/est

Microplastic Pollution in Table Salts from China

Dongqi Yang,[†] Huahong Shi,[*,†] Lan Li,[‡] Jiana Li,[†] Khalida Jabeen,[†] and Prabhu Kolandhasamy[†]

[†]State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai 200062, China

[‡]Research Center for Analysis and Measurement, Donghua University, Shanghai 201620, China

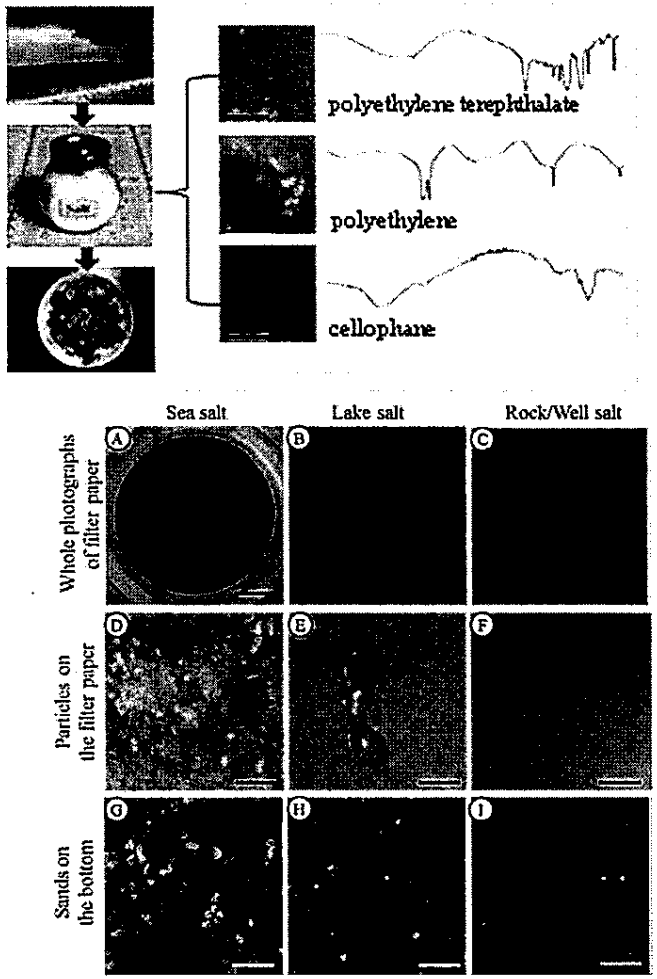
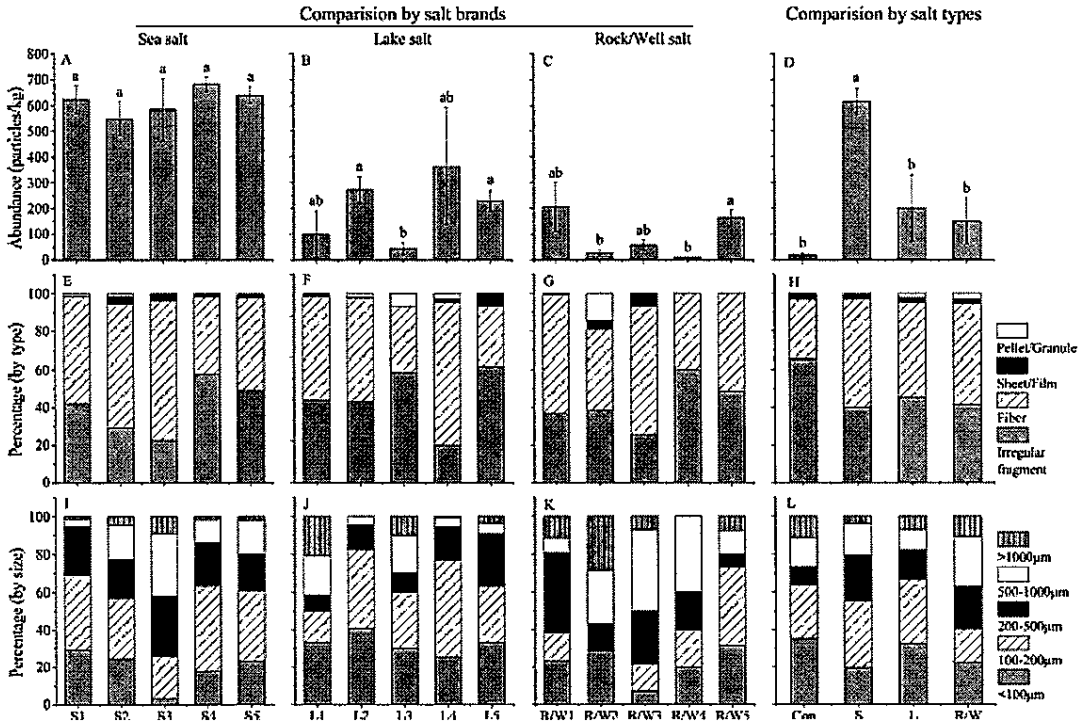
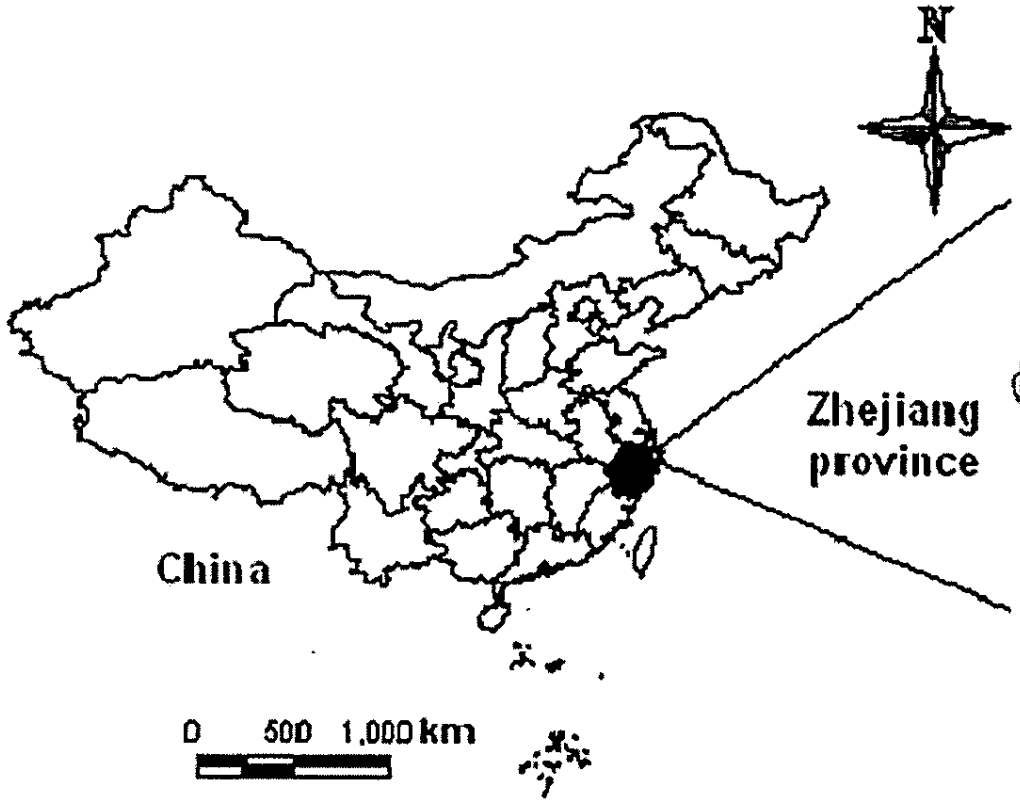
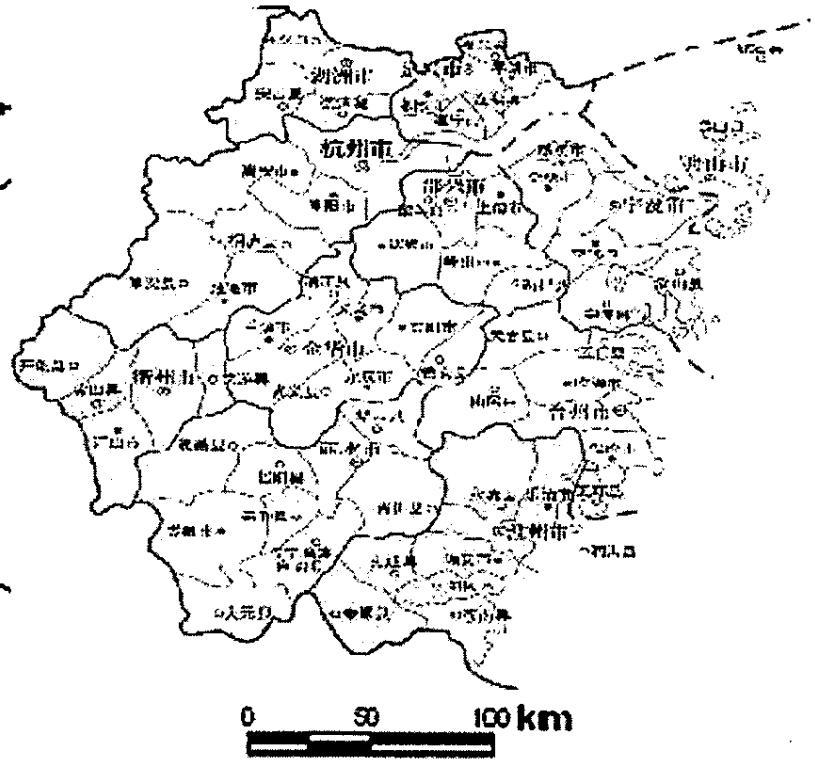
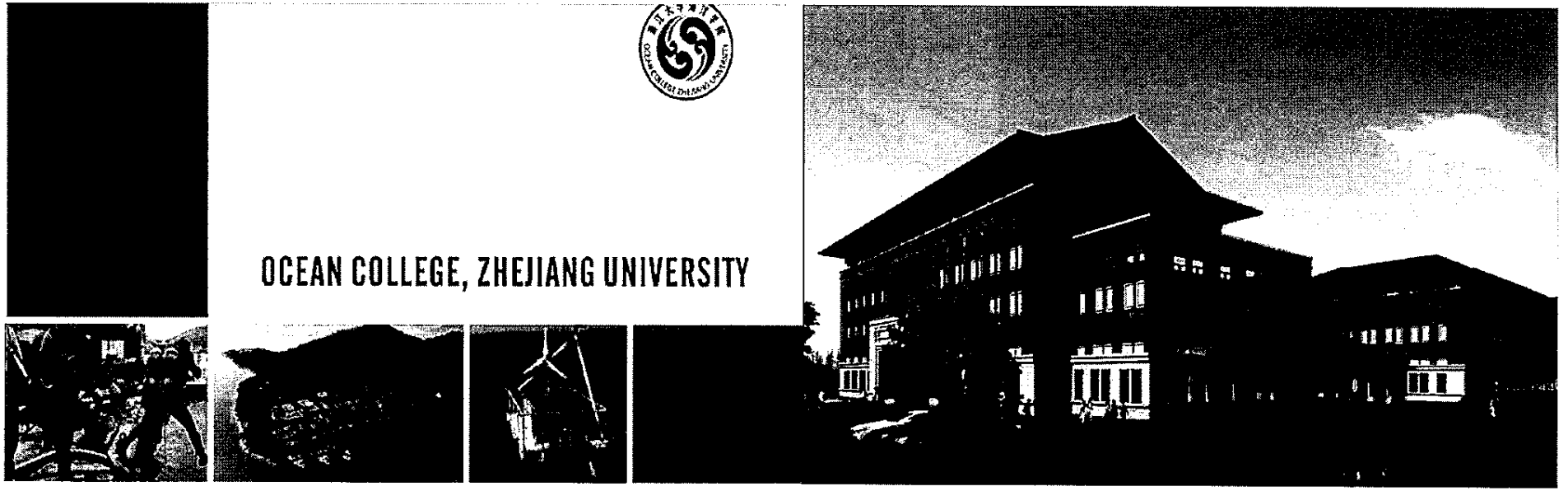


Figure 1. Photographs of the total particles isolated from table salts. A–C, the particles in the salt solution without separation; D–F, the particles in the supernatant of the salt solutions. More particles were observed in sea salts (D) than lake salts (E) and rock/well salts (F); G–I, the particles at the bottom of the bottle after removal of the supernatant. Scale bar = 10 mm (A–C) or 0.2 mm (D–I).

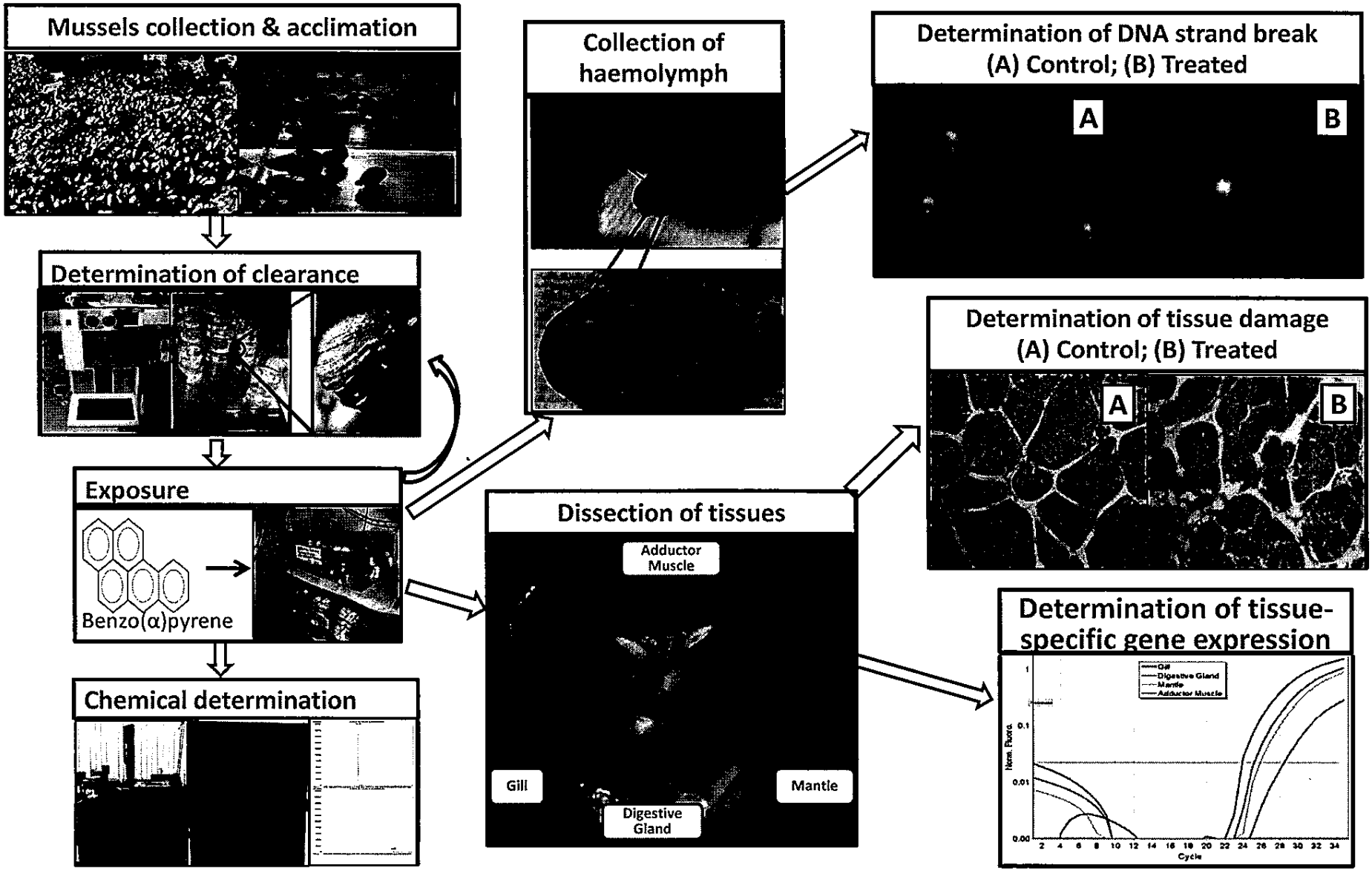


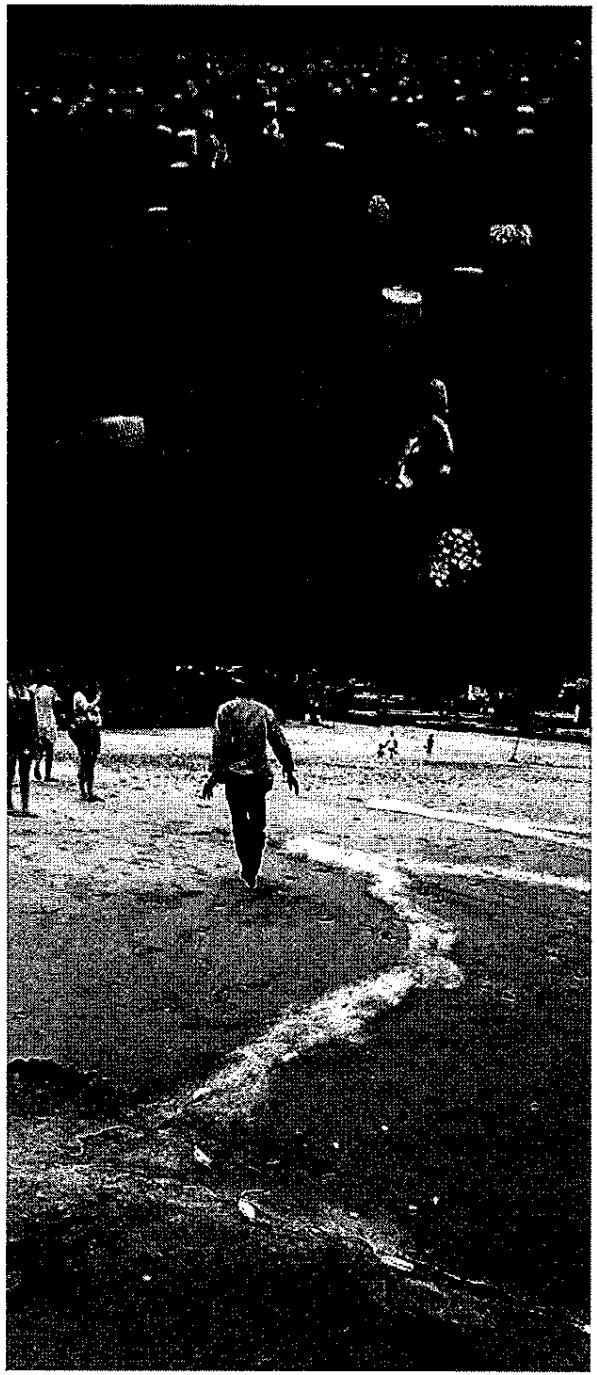

N
Zhejiang province
China
0 500 1,000 km

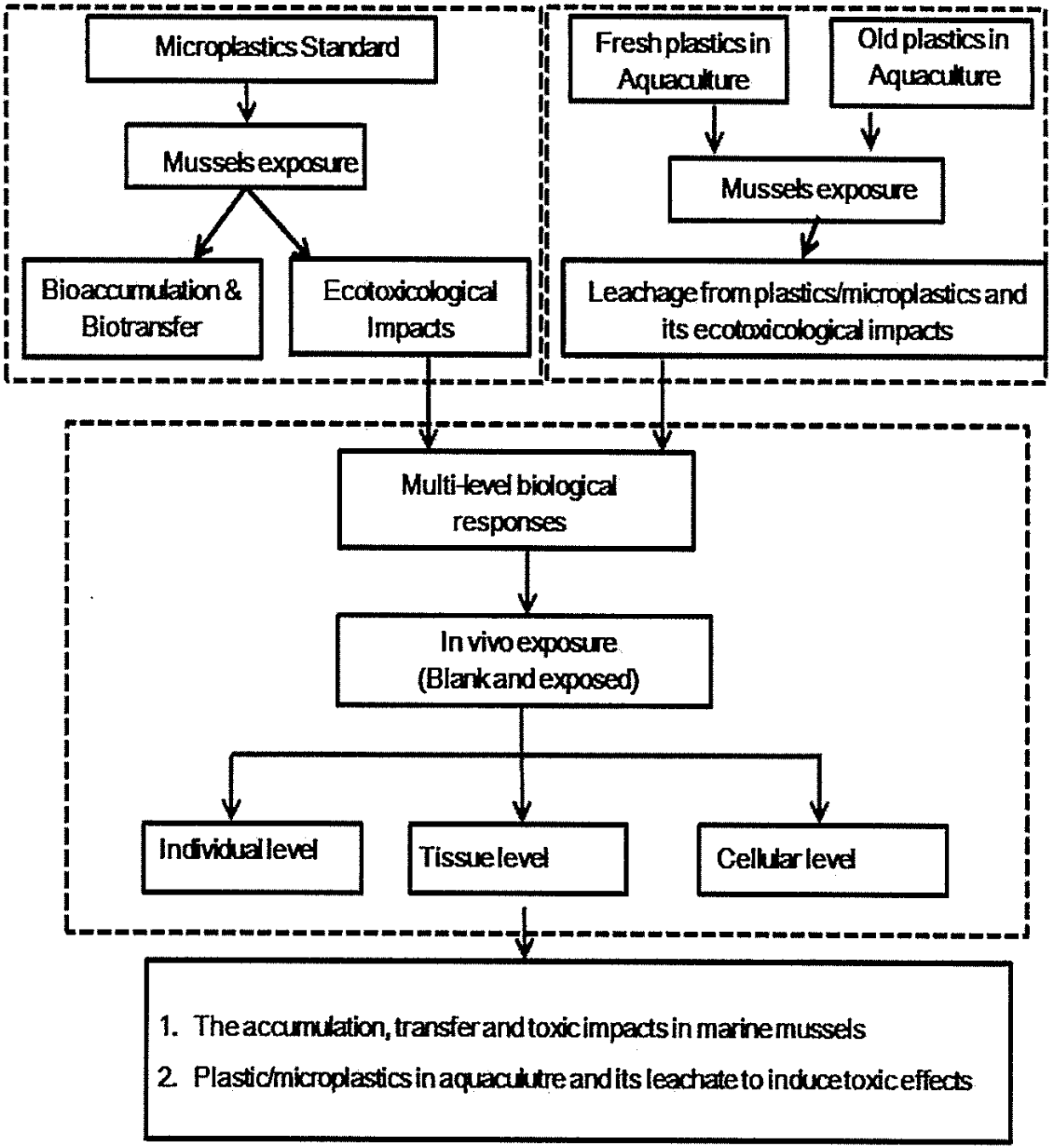

杭州市
0 50 100 km


OCEAN COLLEGE, ZHEJIANG UNIVERSITY

An integrated biomarker system in mussels to evaluate induced environmental stress






Microplastics Standard
Mussels exposure
Bioaccumulation & Biotransfer
Ecotoxicological Impacts
Fresh plastics in Aquaculture
Old plastics in Aquaculture
Mussels exposure
Leachage from plastics/microplastics and its ecotoxicological impacts
Multi-level biological responses
In vivo exposure (Blank and exposed)
Individual level
Tissue level
Cellular level
1. The accumulation, transfer and toxic impacts in marine mussels
2. Plastic/microplastics in aquaculutre and its leachate to induce toxic effects

The Microbial "Plastisphere"

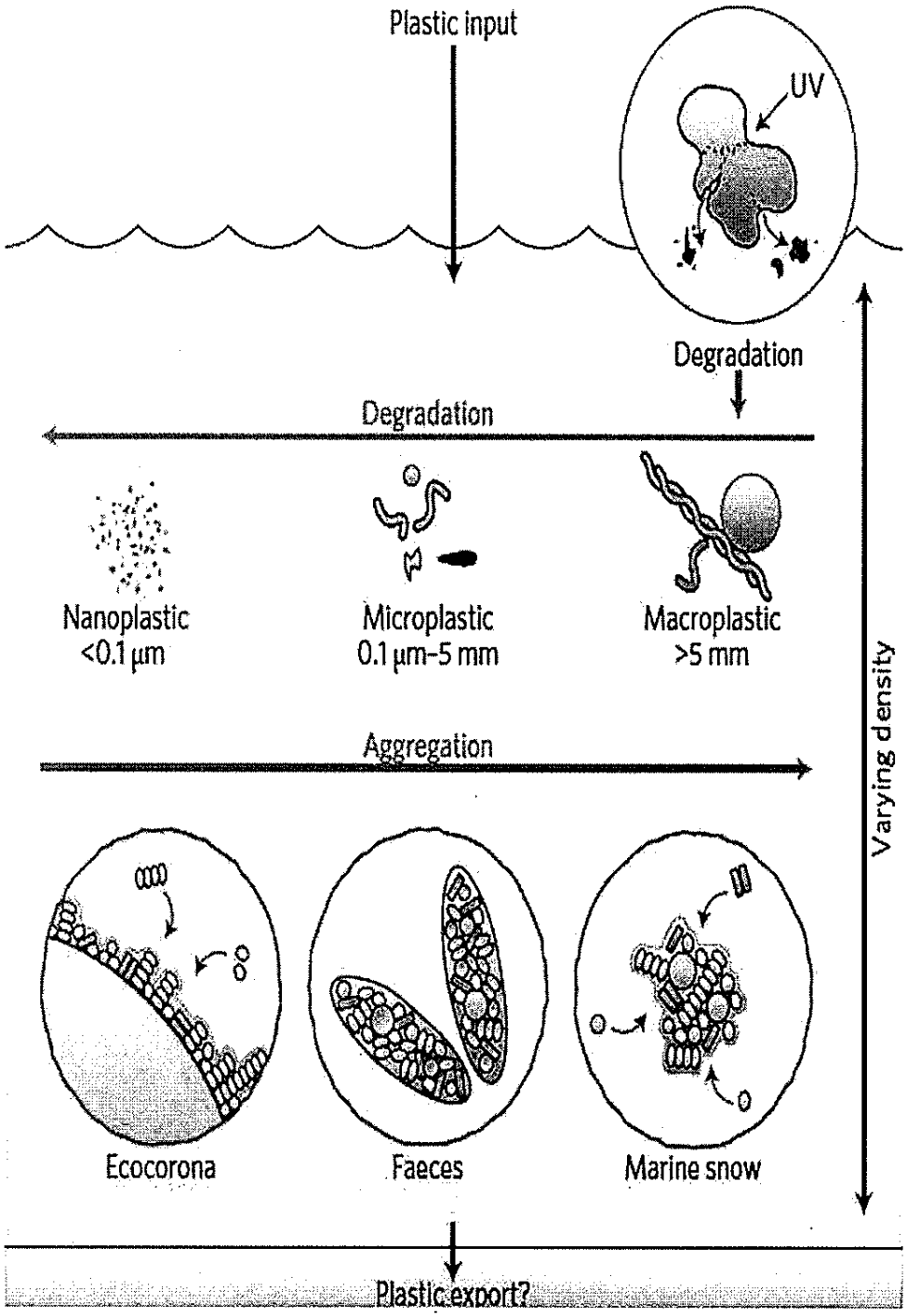
Method	Geographic Location	References
SEM	North Atlantic Ocean, North Pacic Gyre, Australia-wide coastal and ocean region, North Pacific and North Atlantic Ocean	Zettler 2013, Carson 2013, Reisser 2014, Amaral-Zettler 2015
DGGE	North Sea	Oberbeckmann 2014
Metagenomics	North Atlantic Ocean, North Pacific Ocean, North Atlantic Ocean Coast North Pacific, North sea	Zettler 2013, Amaral-Zettler 2015, Tender 2015, Bryant 2016, Oberbeckmann 2016,

are specific to plastic alone.

- This raises a number of intriguing questions concerning plastic-microbial interactions in marine systems:

1) Whether microbial biofouling contributes to plastic transport to deeper waters and sediments,

analogous to the concept of **marine snow**



Marine Snows:

1) Increase the relative size, chemical signature and density of the plastic particles. The density of a plastic particle will affect its position within the water column, potentially resulting in export to the seafloor.

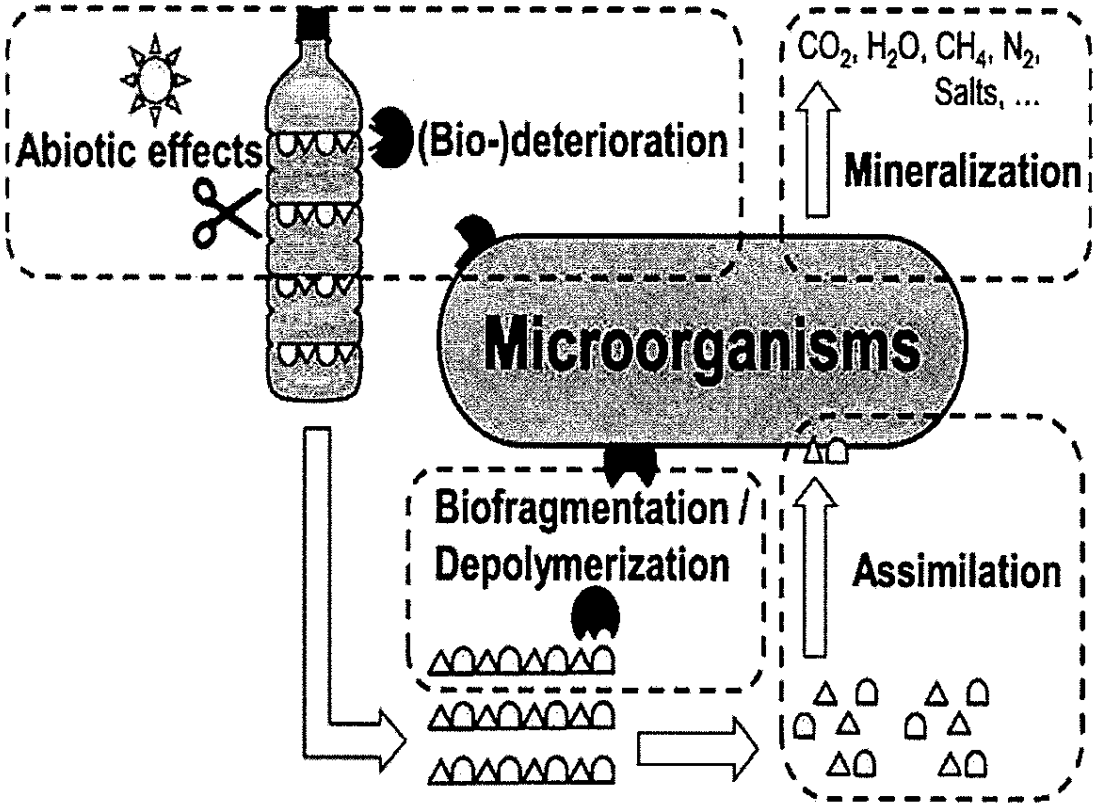
1) The release of quorum sensors by marine snow communities favours the formation of communities capable of degrading hydrocarbon polymers, allowing in time for degradation and mineralization of the plastics themselves?

Schematic illustration of the dynamic changes experienced by microplastic in the water column.

Microbes as plastic degraders

- As nature's biodegraders, microorganisms may already be ameliorating the accumulation of plastic and/or their associated co-pollutants within marine environments.

Plastic material	Microorganisms for degrading	References
Polystyrene	the actinomycete *Rhodococcus ruber*	Mor and Sivan, 2008
Polyethylene	the actinomycete *Rhodococcus ruber;* *Arthrobacter* sp. and *Pseudomonas* sp; *Kocuria palustris*, *Bacillus pumilus* and *Bacillus subtilis;*	Gilan, 2004; Sivan, 2006; Balasubramanian, 2010; Harshvardhan, 2013;



Microorganisms with the enzymatic machinery needed to degrade micro-plastics could serve as an environmental remediation strategy as well as a degradation and/or fermentation platform for biological recycling of plastic waste products.

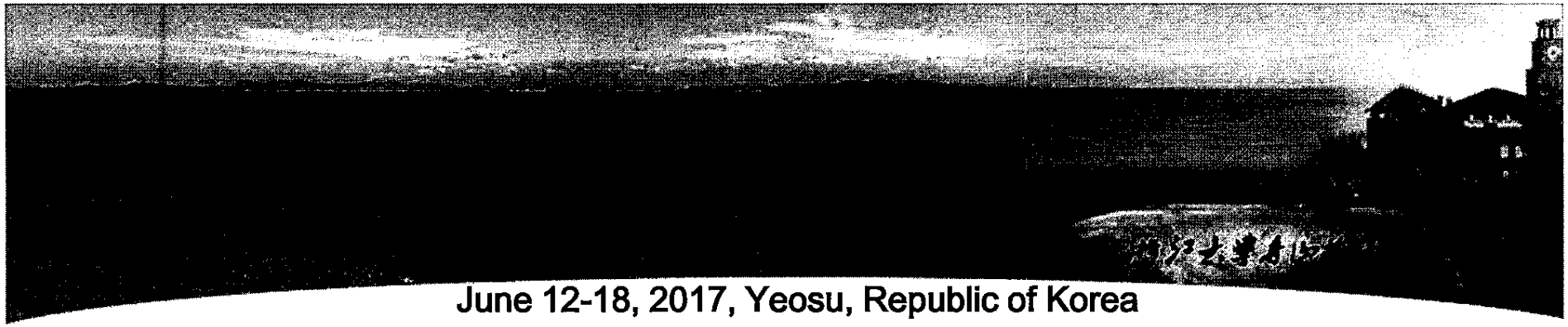
Schematic illustration of plastic biodegradation (Lucas et al., 2008).

Asia-Pacific
Economic Cooperation

Ministry of Oceans and Fisheries

KOEM
Korea Marine Environment Management Corporation

APEC Capacity Building for Marine Debris Prevention and Management in the APEC Region



June 12-18, 2017, Yeosu, Republic of Korea

Updates and Practices on Reducing Marine Debris Pollution

Hsin-Chen Sung
Senior Technical Specialist
Environmental Protection Administration
June 14, 2017

Outline

- Causes of marine debris and results of past beach cleaning programs
- Impacts on marine life
- Trends in international ocean governance
- Improving regulations
- Implementation of practices for marine protection
- Promoting interdisciplinary cooperation
- Conclusion

Causes of marine debris

The ocean itself produces zero waste. So-called "marine debris" mainly comes from land activities, including abandoned solid wastes flowing along rivers into the ocean and debris found on banks. Often human activities in the sea also result in depositing of waste.



Past beach cleaning programs

To reduce the pollution problem of marine debris caused by land activities, the EPA has carried out national beach cleaning programs since 1998. Meanwhile it mobilized the public, business units and environmental groups to join the programs. The amount of marine debris collected has reached 43,231 tons on 2001.

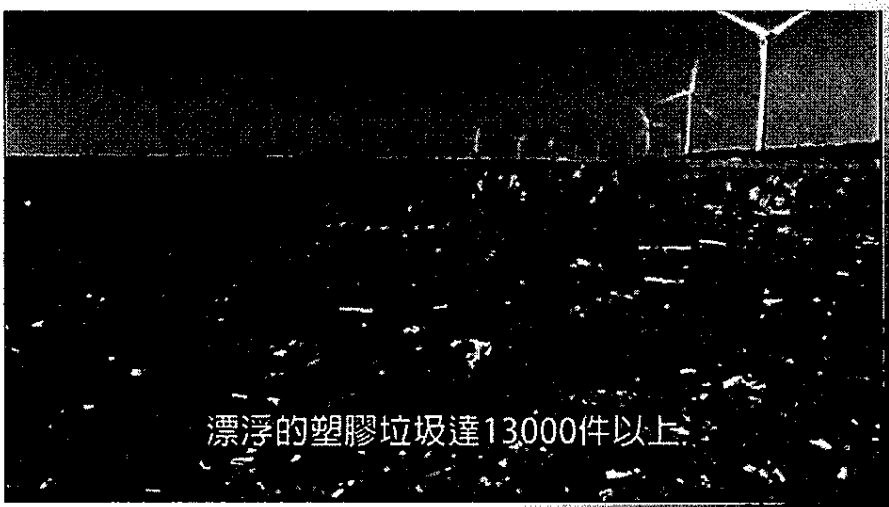

Impacts on marine life

- Recently, awareness has grown about, cases of marine animals mistakenly eating marine debris (mostly plastic bags and plastic waste), leading to their deaths.
- There has also been much news on discarded fishing nets causing the decline of marine life and coral reefs, greatly impacting marine ecology.

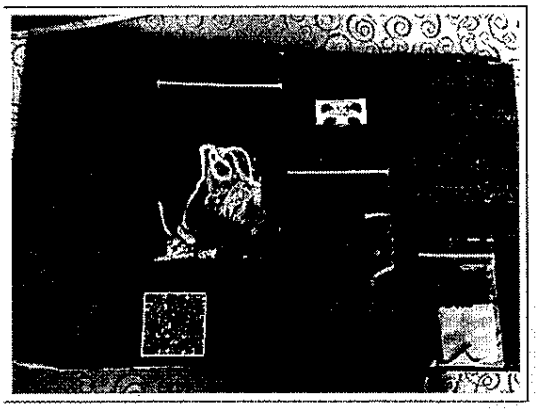


Environmental Protection Bureau of Pingtin County

Impacts on marine life



Impacts on marine life



Trends on international ocean governance

Report of the Secretary-General

- 2017：effects of climate change on oceans.
- 2016：marine debris.
- 2015：sea area, international shipping activities, maritime safety of sailors, maritime security, sustainable development of the oceans, climate change and ocean acidification, the establishment of a legal regime for the implementation of a marine legal system, and the strengthening of international cooperation and coordination.
- 2014：the role of seafood in global food security.
- 2013: ocean acidification.
- 2012: marine renewable energy.
- 2011: marine pollution, IUU fishing, shipping and oil pollution caused by shipping activities, waste disposal, land-based activities pollution marine activities (submarine cable, sightseeing, aquaculture, renewable energy, etc.) and other issues (marine debris, invasion of alien species, climate change, ocean noise).

Trends on international ocean governance

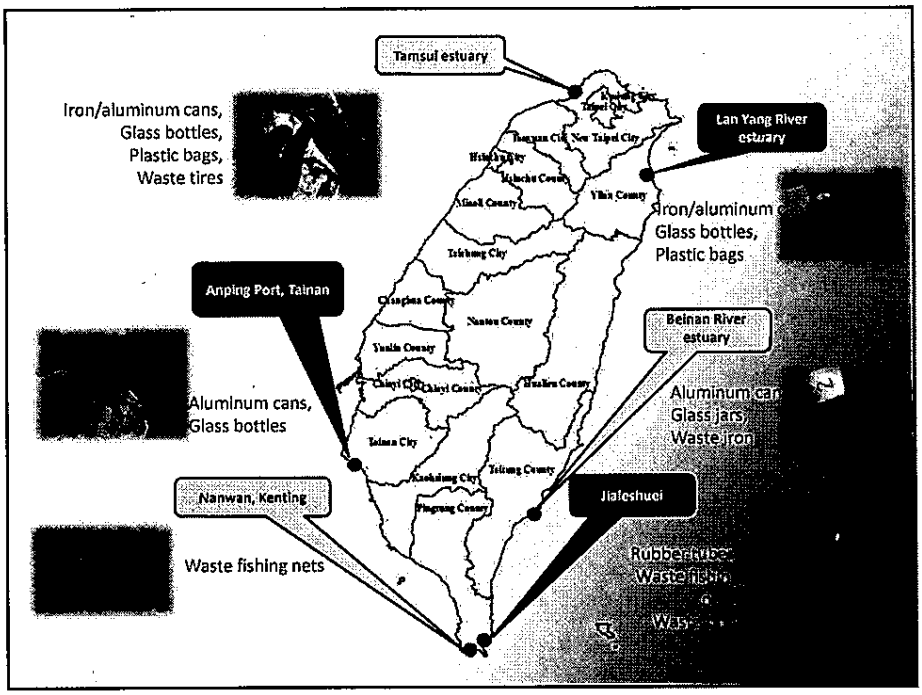
Oceans and the Law of the Sea
Report of the Secretary-General

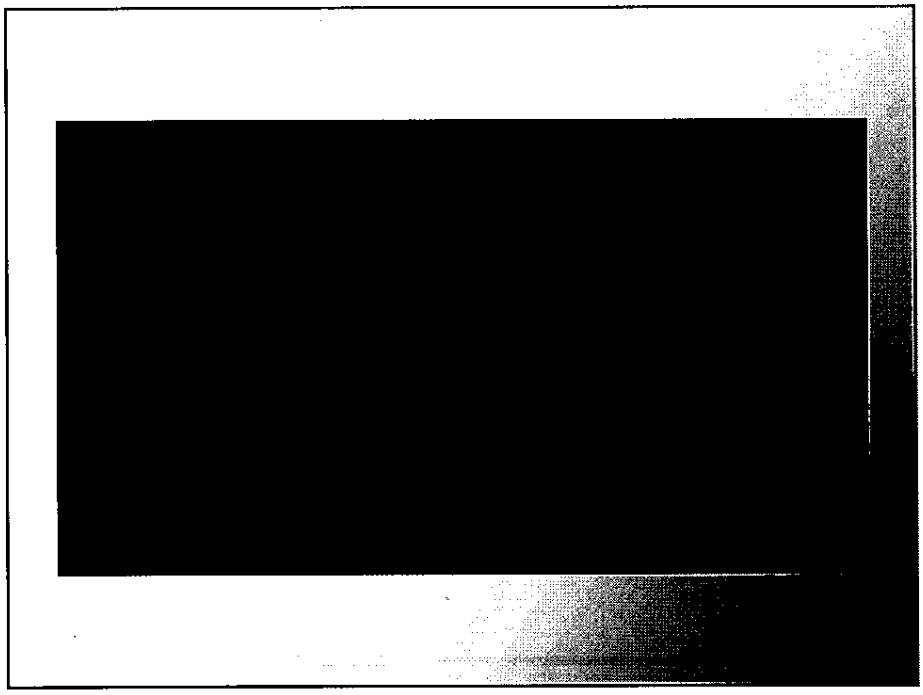
- General Assembly resolution 70/235 was adopted on 23 December 2015, with a view to facilitating discussions on the topic of "Marine debris, plastics and microplastics".
- The report is also being submitted to the States party to the United Nations Convention on the Law of the Sea, pursuant to article 319 of the Convention.
- In the light of the multifaceted nature of the topic and the page limitation established by the General Assembly, the report does not purport to provide an exhaustive synthesis of available information. It is built on information reported in 2005 by the Secretary-General on ma... and takes into account the contributions received from S... intergovernmental organizations.

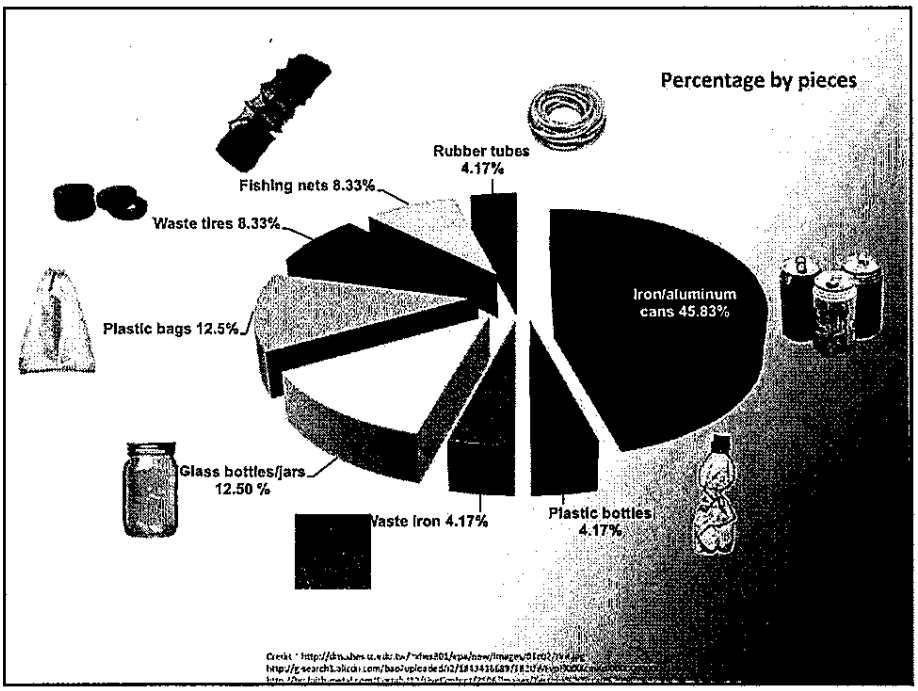
Improving regulations and implementation practices for marine protection

◆**Preliminary investigation:**

To investigate the current status of seabed debris in key areas, investigators carried out diving missions in ports, estuaries, coral reef areas and reef areas from March to May, 2015.

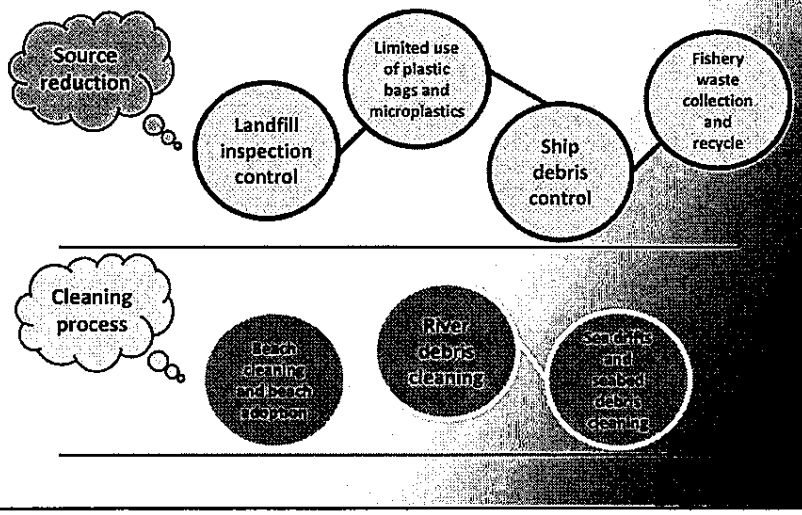

Tamsui estuary
Iron/aluminum cans,
Glass bottles,
Plastic bags,
Waste tires
Lan Yang River estuary
Iron/aluminum
Glass bottles,
Plastic bags
Anping Port, Tainan
Aluminum cans,
Glass bottles
Beinan River estuary
Aluminum can
Glass jars,
Waste iron
Nanwan, Kenting
Waste fishing nets
Jiafeshuei
Rubber tube
Waste fish
Was





Improving regulations and implementation practices for marine protection

◆Action Plan for Combating Marine Debris Pollution



Improving regulations

◆Limited use of plastic.

	Objects	Means of implementation
Current regulation (announced and implemented on 9 June, 2006)	7 categories including public sector, public and private schools, department stores and shopping centers, outlets, supermarkets, convenience stores, fast food restaurants.	Thin plastic bags are prohibited

Improving regulations

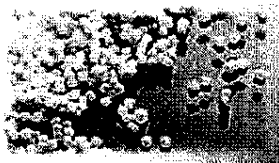
◆Limited use of plastic bags on particular objects.

	Items	Means of implementation	Implementation date
Plan to expand the control items (preview on 9 April, 2017)	14 categories: in addition to the 7 categories, pharmacies and drug stores, medical equipment stores, home appliances photography and information communications equipment retailers, bookstores and stationery retailers, laundry shops, beverage shops, bakeries are added in.	Restrictions on plastic shopping bags (purchase only)	1 January, 2018

Improving regulations

◆ Restrictions on the manufacture, import and sales of cosmetics and personal hygiene products (including toothpaste) which contain microplastics.

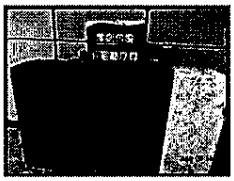
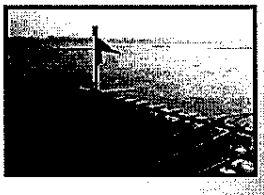
	Items	Means and dates of implementation
New regulation (second preview on 8 December, 2016)	● Shampoos, shower gels/body washes, facial cleansers, soaps ● Toothpastes	● From January 1, 2018 cosmetics and personal hygiene products containing microplastics shall not be manufactured domestically. ● Banning the sale of those products by July 1 2018


Fishery Waste Control

◆Self-governance articles of shallow oyster farming management made by Tainan fishery agency

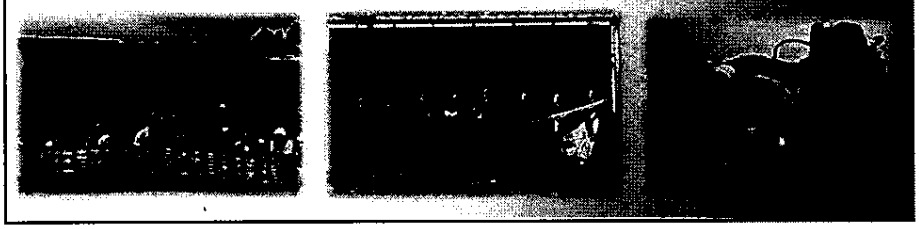
- The control of total numbers of oyster rafts
- Strictly prohibited and penalty management of oyster raft declaration and recycling
- Oyster rafts are prohibited from July to September
- Using uncoated styrofoam floats are prohibited


Improvement of strategies and implementation practices

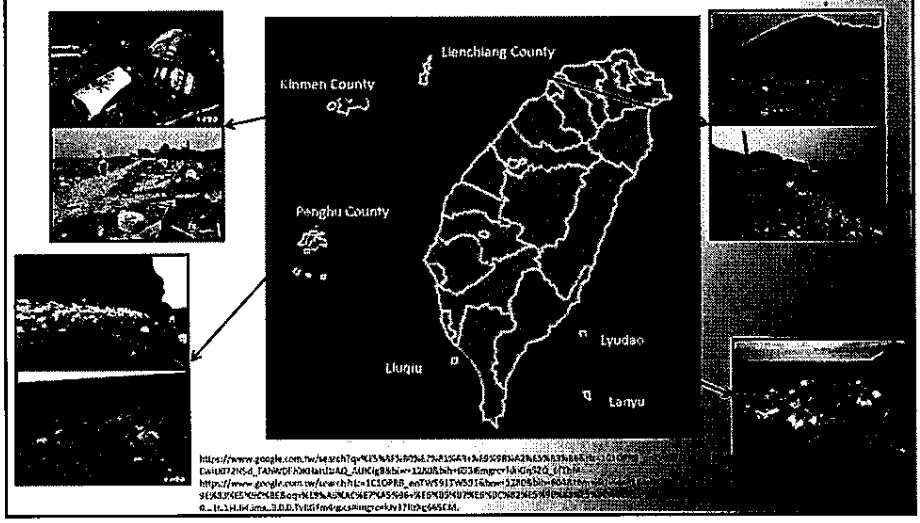
◆ Around the island- 2016 Seabed Drifts and Debris Cleaning Program

- Taitung County
  - ➢ Time：October, 2016
  - ➢ Location：Jiamuzih Bay, Shinlan Fish Port
  - ➢ Results：94 volunteers, 72 kilograms of drifts and debris, 98kilograms of recycled objects.
- Pingtung County
  - ➢ Time ：November, 2016
  - ➢ Location ： Baishawan, Kenting
  - ➢ Results ：475 volunteers, 765 kilograms of debris (including recycled objects).



Implementation practices for marine protection

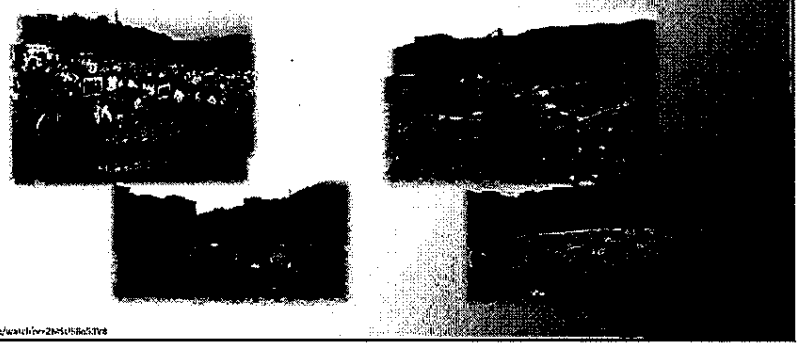
◆ Kinmen County, Lianjiang County, Penghu County, LyudaoTownship



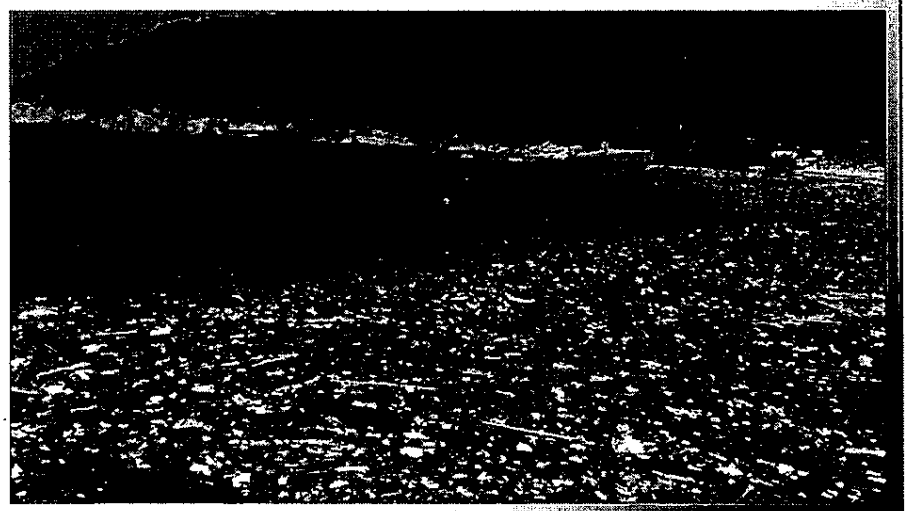
Implementation practices for marine protection

◆ 2016 Seabed Drifts and Debris Cleaning Program

- Kinmen County
  - Results：359.2 tons of drifts and debris.
- Lianjiang County
  - Results ：532 tons of drifts and debris.
- Penghu County
  - Results ：645 tons of drifts and debris.



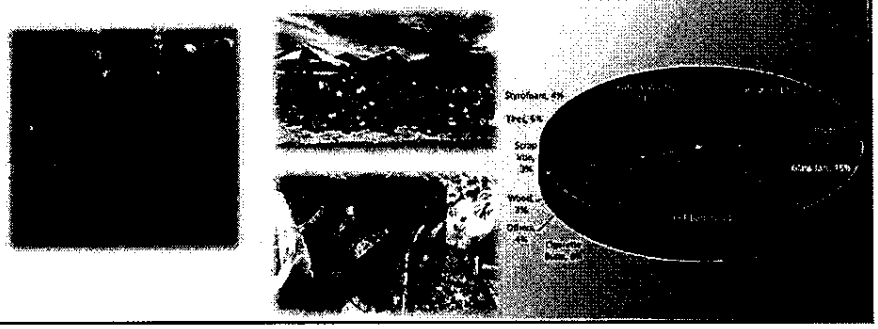
Marine Debris of Lianjiang County



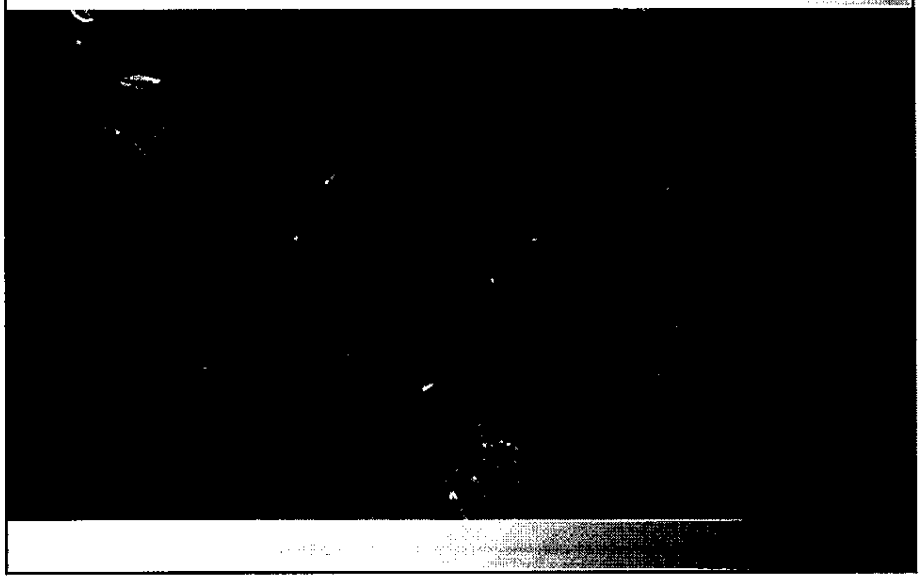
Implementation practices for marine protection

◆ 2016 Seabed Drifts and Debris Cleaning Program

- Lyudao Township, Taitung County
  - Time：June 2016
  - Results：150 volunteers. 137 kilograms in total, including 54 kilograms of debris and 83 kilograms of recycled objects.



Removing Seabed Debris of Lyudao Township



Implementation practices for marine protection

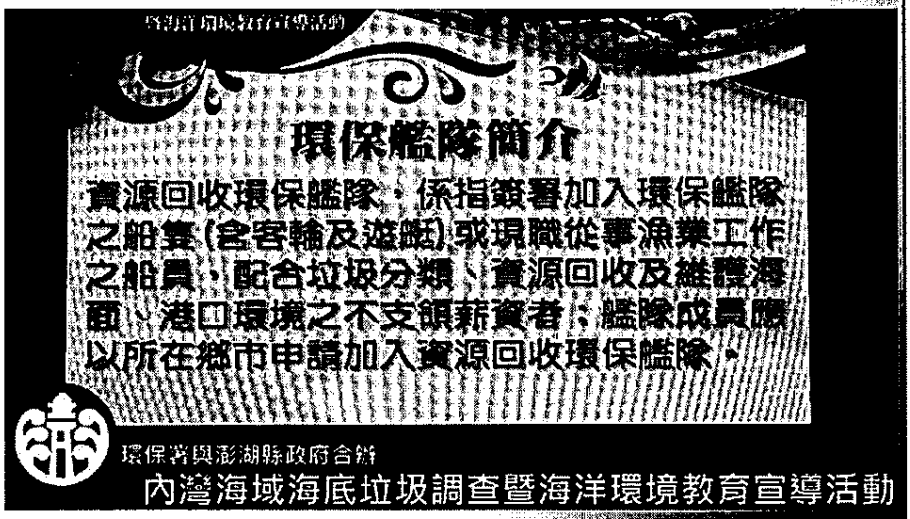
◆ 2016 Seabed Drifts and Debris Cleansing Program

- Penghu County sets up environmental protection fleet
  - Authorized on 23 August, 2016
  - Formed by 77 fishing vessels
  - Plastic bottles, glass bottles, plastic containers including recycled objects, plastic bags, waste fishing nets and fishing gears were brought back to shore to be proper treated.

Innovation



Flag Ceremony of Environmental Protection Fleet



Implementation practices for marine protection

◆The Seabed Debris Cleaning Program for World Oceans Day on 4 June, 2017

In line with the 2017 World Oceans Day.
" Our Ocean, Our Future."

Implementation practices for marine protection

◆ Description of the program

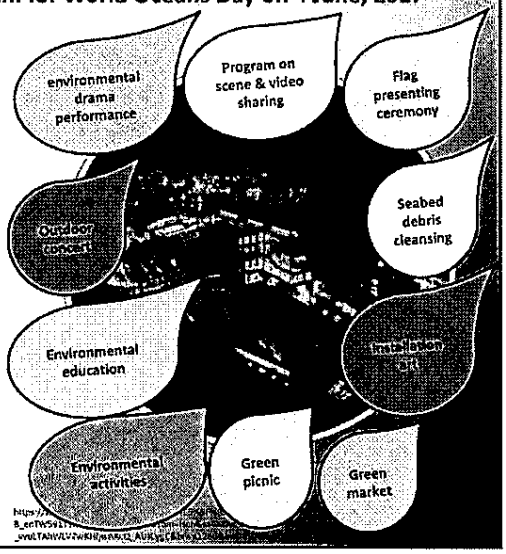
- **The Seabed Debris Cleaning Program for World Oceans Day plan to be held on 4 June, 2017. 19 seafront cities and counties all attended the program.**
- The concept of the program is to promote marine environmental education and display the results of the beach and seabed debris cleaning (specifically on plastic wastes).

- **An Environmental protection fleet was set up in 19 cities and counties, recycling redemption reward mechanism also had been introduced to encourage the organizing of the fleets.**

Implementation practices for marine protection

◆ **The Seabed Debris Cleaning Program for World Oceans Day on 4 June, 2017**

Time	Description of the program
09：30 ~10：15	Program opening - environmental drama performance and environmental protection oath .
10：15 ~10：25	Flag presention to environmental protection fleet.
10：25 ~10：50	on scene sharing video of ocean debris cleaning program.
10：50 ~12：00	Talk: Marine Debris
13：00 ~15：00	Talk: Coral Reef Experience and Walking on the Coastline
15：00 ~16：00	Tour activity of installation art by the marine debris. No plastic, plastic-free green market.
16：00 ~19：00	Family green picnic. Outdoor concerts. Ecological outdoor cinema.

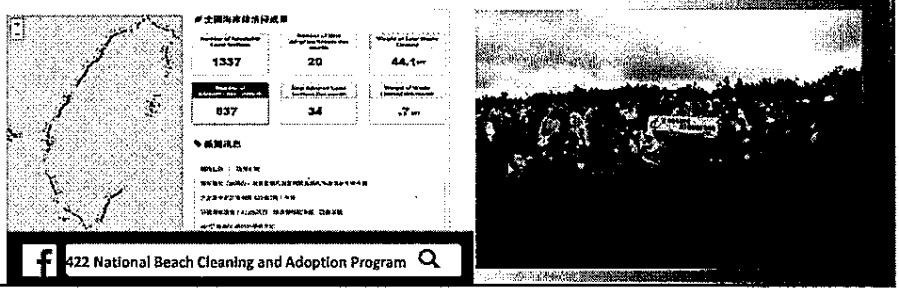


Implementation practices for marine protection

422 National Beach Cleaning and Adoption Program

- **The EPA invited city and county governments, enterprises, religious groups, academic organizations and institutions, volunteers and the public to join the program on 22 April, 2017 in 40 different areas.**
- **At least 35,000 people were cleaning beaches along a 350-kilometer long coastline nationwide. Approximately 123 tons of garbage was collected.**

Different from a one-time beach cleaning activity in the past, a national joint beach cleaning program will converted into long-term beach cleaning adoption program.



Implementation practices for marine protection

◆ Beach Cleansing Adoption Program

The Beach Cleaning Adoption Program System has been established. Enterprises, religious groups, and public groups who have joined the program can apply for a specific coastline and report the cleaning results on the online system.

National coastline cleaning results (May 23, 2017 statistics)

Number of Adoptable Coast Sections	Number of New Adoption Groups this month	Weight of Total Waste Cleaned
1337	20	44.1 MT
Number of Adopted Coast Sections	**New Adopted Coast Sections this month**	**Weight of Waste Cleaned this month**
637	34	.7 MT

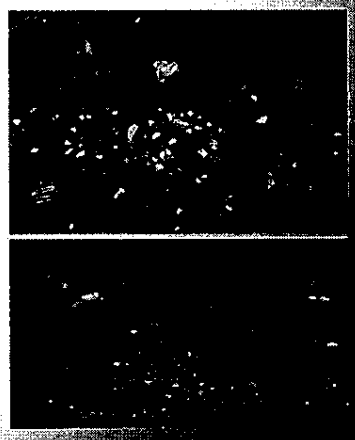
Coastline adoption website：https:// ecolife.epa.gov.tw/coastal/de

Implementation practices for marine protection

◆ Eco-friendly Beach Cleaning Program

- In addition to garbage, bird egg shells can also be found on the beach.
- The program should be held in a non-bird-breeding season.

- To explore and leave marks.
- Stay out.
- Remove marks.



Implementation practices for marine protection

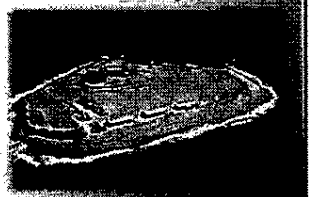
◆Enhancement of marine debris density investigation

- **Do**：Analyze debris cleaned up from the cleaning program using ICC records.
- **Goal**：Understanding the distribution of marine debris hot spots and density, in addition to analyzing marine debris composition.
- **How**：Rapid reviews and development of reduction practices.

Implementation practices for marine protection

◆International Workshop on "the Most Beautiful Bays in the World (MBBW)"

- **Will be held from 1 to 5 October, 2018.**
- **The EPA is planning to hold the Marine Pollution Prevention Response and Practices International Workshop and the Beach Cleaning Program in Penghu, promoting commitment to environmental protection around the world.**



Promoting interdisciplinary cooperation

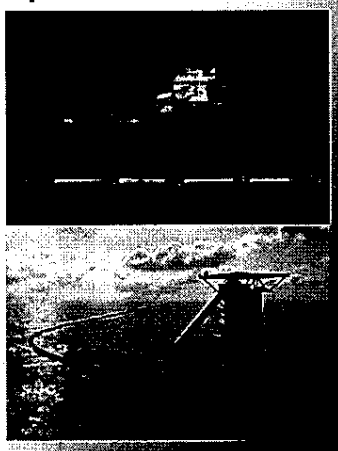
◆Active participation in solving the global ocean plastic problem with the Ocean Cleanup Foundation

- Mr. Boyan Slat was invited by the Ministry of Economic Affairs to attend the President's Innovation Award in November, 2016 for the "Innovation-Sustainability-Action" keynote speech.
- During his speech, Mr. Slat stressed the importance of the complementary actions of both cleaning up existing ocean plastics and preventing new plastic waste from entering the ocean.

Promoting interdisciplinary cooperation

◆Active participation in solving the global ocean plastic problem with the Ocean Cleanup Foundation

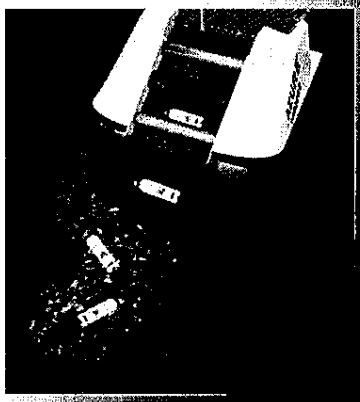
- We already has effective and efficient plastic collection and recycling system in place and would like to go a step further to be a part of the global ocean plastic solution.
- The Water Resources Agency is in contact with the Ocean Cleanup Foundation for opportunity to jointly-develop innovative and practical solution to the ocean plastic problem.

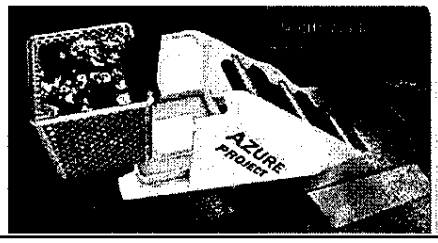


Promoting interdisciplinary cooperation

◆Young research team develops a sea drift collector "East Diving"

The "Leave No Trace" project team developed the sea drift collector "East Diving", hoping to salvage and collect marine debris instead of hiring workers or cleaning vessels, in order to enhance the removal of marine debris efficiency.





Credit: News report on [illegible] presentation slides [illegible]

Comparison of Solutions

	Sea Drifts Collector	Manpower Salvage	Cleaning Boat
			
	1	3-4	3-4
	Smart Notification	Depending on the Amount of Waste	3 Days/Week
	Sea Drifts + Oil Pollution	Sea Drifts	Sea Drifts
	0-3 m	0-1.5 m	Moving With the Boat
	Relatively Safe	Potential Risk of Falling into the Sea	Potential Risk of Falling into the Sea
	Environmental Monitoring Vehicle	N/A	N/A

Conclusion

- Marine debris management: in addition to strengthening reduction of land waste sources, other regulations such as restrictions on plastics and microplastics, holding seabed debris cleaning programs can reduce marine debris and improve environmental sustainability.
- Enhancement of marine environmental education by holding public activities. To encourage local governments to organize environmental fleets so that marine debris can be reduced.
- Keep focusing attention on innovative research and development of marine debris collection equipment from the private sector in order to enhance the efficiency of marine debris removal.



End of presentation

Thanks for listening