



UNIVERSITÀ DEGLI STUDI DI MILANO

Milano, 24 Novembre 2022

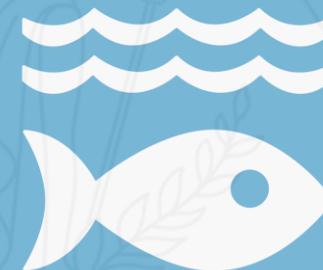


Fondazione
Planet Life Economy Foundation ETS
Alzaia Naviglio Pavese, 78/3
20142 Milano

SDG-14 Life under water

Obiettivo-14 per lo Sviluppo Sostenibile secondo Agenda ONU 2030: la vita nei mari

14 LIFE
BELOW WATER



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Obiettivo-14: Conservare e utilizzare in modo sostenibile gli oceani, i mari e le risorse marine

L'**inquinamento** e lo **sfruttamento eccessivo** degli oceani causano un numero sempre maggiore di problemi, come il **pericolo acuto** per la **diversità delle specie**, l'**acidificazione** dei mari e l'aumento dei **rifiuti di plastica**. Oltre alla **pesca** e allo **sfruttamento** a livello **industriale** delle risorse marine, anche i **mutamenti climatici** sono causa di una pressione sempre maggiore sugli ecosistemi. La **popolazione mondiale** in continuo aumento sarà in futuro ancora più **dipendente dalle risorse dei mari**.

L'obiettivo 14 mira a **ridurre in modo significativo** entro il **2025 tutti i tipi di inquinamento** marittimo e a portare a un livello minimo l'acidificazione degli oceani. Già entro il **2020** gli **ecosistemi marini** e costieri dovranno essere **gestiti e protetti in modo sostenibile**. Entro il **2020** anche la **pesca** dovrà essere **disciplinata in modo efficace**. Per porre un limite alla pesca eccessiva nei mari, le attività illegali e non regolamentate in questo campo nonché le **pratiche distruttive** dovranno essere **sradicate entro il 2020**. Inoltre, determinate forme di sovvenzioni alla pesca dovranno essere vietate.

Obiettivo 14: Conservare e utilizzare in modo sostenibile gli oceani, i mari e le risorse marine

14.1: Entro il 2025, prevenire e ridurre in modo significativo ogni forma di inquinamento marino, in particolar modo quello derivante da attività esercitate sulla terraferma, compreso l'inquinamento dei detriti marini e delle sostanze nutritive

14.2: Entro il 2020, gestire in modo sostenibile e proteggere l'ecosistema marino e costiero per evitare impatti particolarmente negativi, anche rafforzando la loro resilienza, e agire per il loro ripristino in modo da ottenere oceani salubri e produttivi

14.3: Ridurre al minimo e affrontare gli effetti dell'acidificazione degli oceani, anche attraverso una maggiore collaborazione scientifica su tutti i livelli

14.4: Entro il 2020, regolare in modo efficace la pesca e porre termine alla pesca eccessiva, illegale, non dichiarata e non regolamentata e ai metodi di pesca distruttivi. Implementare piani di gestione su base scientifica, così da ripristinare nel minor tempo possibile le riserve ittiche, riportandole almeno a livelli che producano il massimo rendimento sostenibile, come determinato dalle loro caratteristiche biologiche

P. Tremolada
Docente Ecologia

M. Sugni
Docente Zoologia



SDG-14: sito UFFICIALE DELLE NAZIONI UNITE

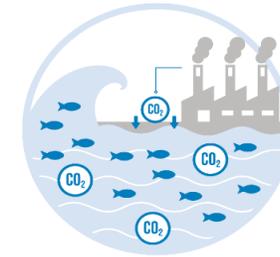
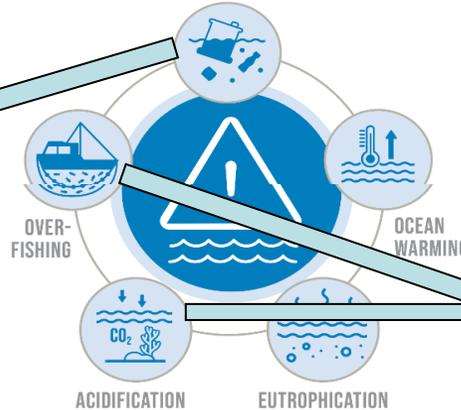
<https://sdgs.un.org/goals/goal14>



14 LIFE BELOW WATER CONSERVE AND SUSTAINABLY USE THE OCEANS, SEA AND MARINE RESOURCES FOR SUSTAINABLE DEVELOPMENT

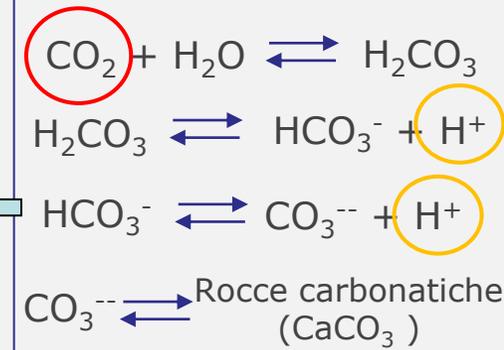
OUR OCEAN THE PLANET'S LARGEST ECOSYSTEM IS ENDANGERED

PLASTIC/MARINE POLLUTION



**INCREASING ACIDIFICATION
IS THREATENING MARINE LIFE AND
LIMITING THE OCEAN'S CAPACITY
TO MODERATE CLIMATE CHANGE**

THE OCEAN ABSORBS AROUND 1/4
OF GLOBAL ANNUAL CO₂ EMISSIONS



ACIDIFICAZIONE DEGLI OCEANI

INQUINAMENTO MARINO
E INQUINAMENTO DA
PLASTICA

**PLASTIC POLLUTION
IS CHOKING THE OCEAN**

**17+ MILLION METRIC TONS
OF PLASTIC ENTERED
THE OCEAN IN 2021**
PROJECTED TO DOUBLE OR
TRIPLE BY 2040



**90% OF THE
WORLD'S FISHERS
ARE EMPLOYED IN
SMALL-SCALE FISHERIES
WHO NEED ACCELERATED
SUPPORT DUE TO THE
PANDEMIC**

SOVRAPESCA ovvero
SOVRASFRUTTAMENTO
DELLE RISORSE ITTICHE

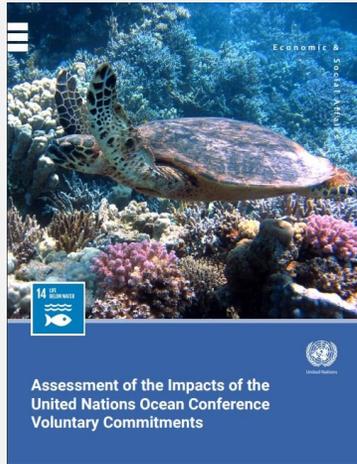


1. RISCALDAMENTO DEGLI OCEANI: REPORT INTERNAZIONALI

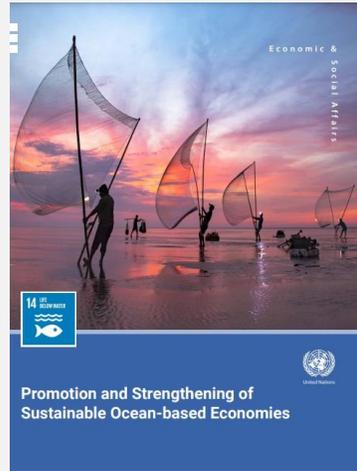
ONU: <https://sdgs.un.org/goals/goal14>

IPCC, 2021: <https://www.ipcc.ch/report/ar6/wg1/>

SPECIFICI SDG-14



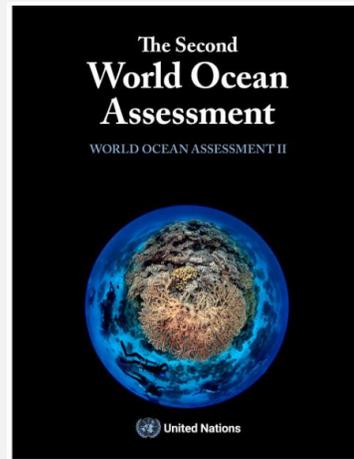
UN, 2021



UN, 2021

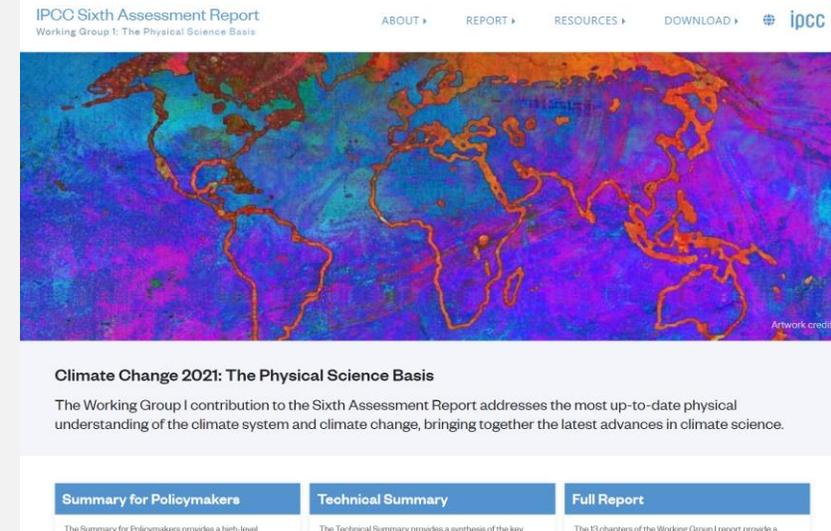


UNESCO, 2022



UN, 2021

GENERALI
CAMBIAMENTO CLIMATICO



LE BASI
FISICHE

IPCC, 2022: <https://www.ipcc.ch/report/ar6/wg2/>



RISCALDAMENTO GLOBALE: un po' di storia

EVIDENZE SCIENTIFICHE



1992

Conference ONU di Rio de Janeiro sullo Sviluppo sostenibile, «Conferenza di Rio» o «Summit della Terra»

- Dichiarazione di Rio: 27 principi (dimensione globale dei problemi ambientali)
- Agenda 21
- Convenzione sulla diversità biologica
- Principi sulle foreste
- Convenzione quadro ONU sul cambiamento climatico → Conference of the Parties (COP)



1997

COP3 a Kiōto: Protocollo di Kiōto

ciascun paese doveva ridurre le proprie emissioni per almeno il 5% rispetto alle sue emissioni al 1990, sarebbe entrato in vigore qualora fosse stato ratificato da un numero sufficiente di paesi che avessero rappresentato almeno il 50% delle emissioni globali



2015

COP21 a Parigi: Accordo di Parigi

i firmatari si sono impegnati a non superare un aumento di temperatura possibilmente non superiore a 1,5 °C e comunque non superiore a 2°C rispetto alle temperature medie globali del periodo 1850-1930.



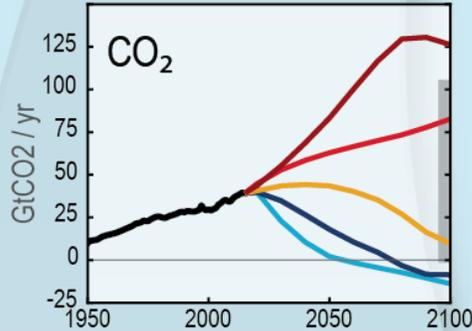
2022

COP27 a Sharm el-Sheikh, Egitto

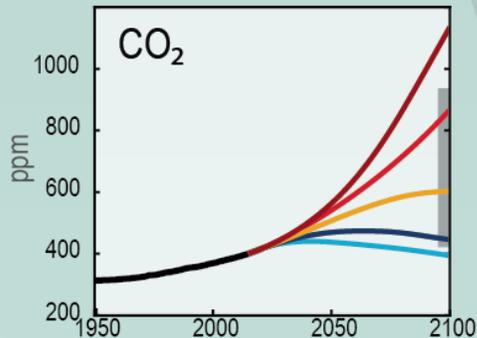


Riscaldamento globale: aumento delle temperature

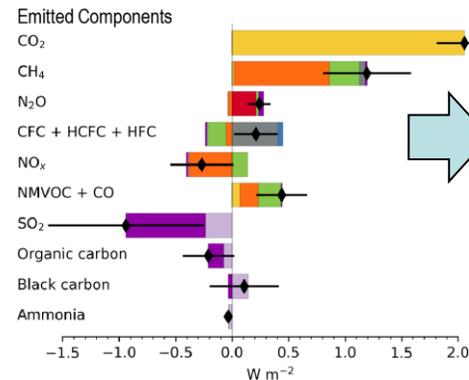
Emissions



Concentrations

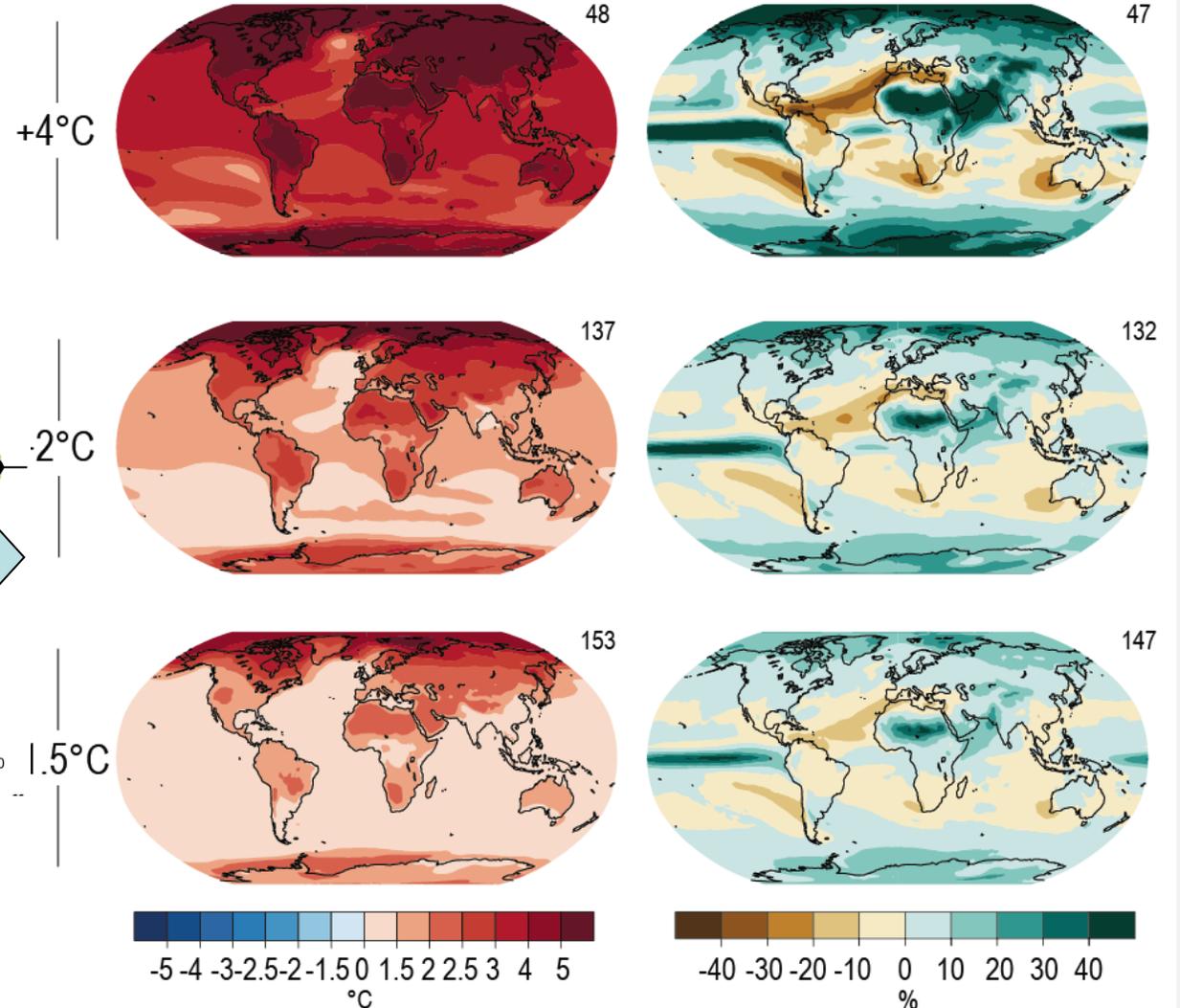


(a) Effective radiative forcing 1750 to 2019



Temperature change

Precipitation change

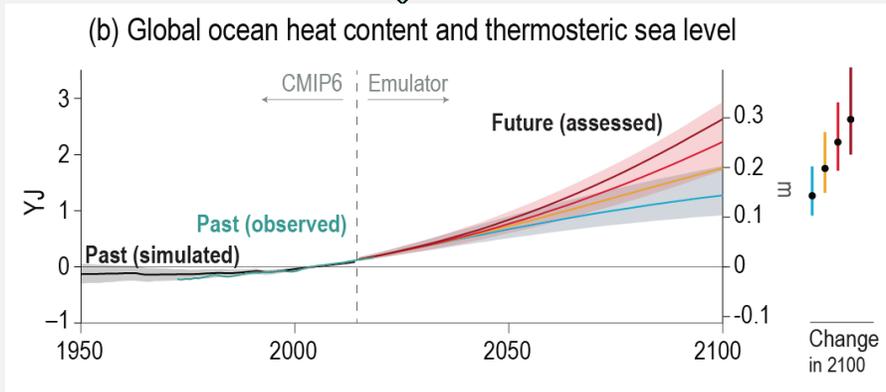


IPCC, 2021: Physical Science Basis:
<https://www.ipcc.ch/report/ar6/wg1/>



EFFETTI dell'aumento delle temperature negli oceani

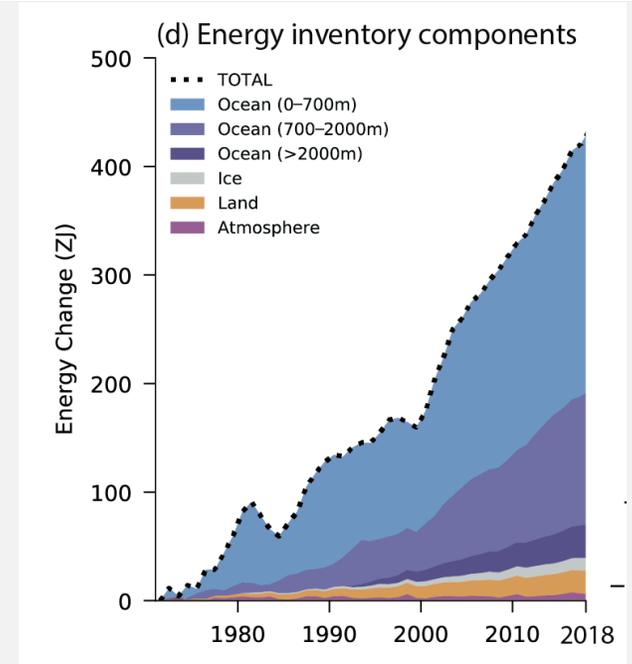
AUMENTO DEL LIVELLO DEI MARI



AUMENTO ENERGIA IMMAGAZZINATA



IPCC, 2021: Physical Science Basis: <https://www.ipcc.ch/report/ar6/wg1/>



IPCC, 2022: Impacts, Adaptation and Vulnerability <https://www.ipcc.ch/report/ar6/wg2/>

EFFETTI SUGLI ORGANISMI



(a) Historical coral reef



High coral cover and diversity; high physical complexity and reef growth; high fish biomass and diversity

(b) Low diversity reef



Moderate cover composed of few, heat-tolerant taxa; lower complexity and growth rate; lower fish diversity

(c) Degraded coral reef

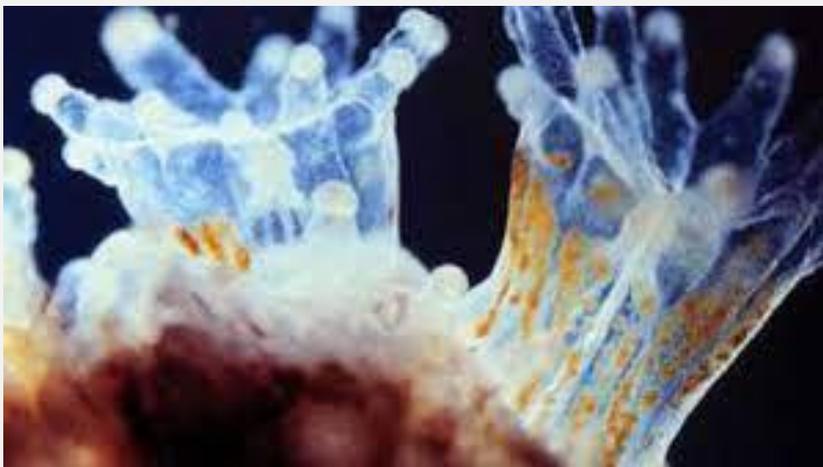


Limited cover with few species; low complexity with limited growth; low fish biomass and diversity



I coralli

Le zoozantelle (alghe endosimbionte) forniscono oltre il 95% delle esigenze metaboliche del corallo che le ospita, che è quindi in grado di mantenere un'elevata calcificazione.



Quando le temperature superano i massimi estivi da 1° a 2° C per 3 o 4 settimane, si ha l'espulsione delle zooxantelle e il fenomeno dello **sbiancamento dei coralli**, se prolungato può portare alla morte del corallo.

La causa principale del fenomeno è l'aumento delle temperature, **se le temperature non tornano alla normalità entro le 6-8 settimane, i coralli muoiono.**

Nel 2016, il 93% dei coralli della Grande Barriera Corallina è stato soggetto a sbiancamento, e il 22% è poi morto, con aree più colpite dal fenomeno dove la mortalità dei coralli ha raggiunto il 50-90%.

Coral Reefs Under Rapid Climate Change and Ocean Acidification

O. Hoegh-Guldberg,^{1*} P. J. Mumby,² A. J. Hooten,³ R. S. Steeneck,⁴ P. Greenfield,⁵ E. Gomez,⁶ C. D. Harvell,⁷ P. F. Sale,⁸ A. J. Edwards,⁹ K. Caldeira,¹⁰ N. Knowlton,¹¹ C. M. Eakin,¹² R. Iglesias-Prieto,¹³ N. Muthiga,¹⁴ R. H. Bradbury,¹⁵ A. Dubi,¹⁶ M. E. Hatzioioli¹⁷

Atmospheric carbon dioxide concentration is expected to exceed 500 parts per million and global temperatures to rise by at least 2°C by 2050 to 2100, values that significantly exceed those of at least the past 420,000 years during which most extant marine organisms evolved. Under conditions expected in the 21st century, global warming and ocean acidification will compromise carbonate accretion, with corals becoming increasingly rare on reef systems. The result will be less diverse reef communities and carbonate reef structures that fail to be maintained. Climate change also exacerbates local stresses from declining water quality and overexploitation of key species, driving reefs increasingly toward the tipping point for functional collapse. This review presents future scenarios for coral reefs that predict increasingly serious consequences for reef-associated fisheries, tourism, coastal protection, and people. As the International Year of the Reef 2008 begins, scaled-up management intervention and decisive action on global emissions are required if the loss of coral-dominated ecosystems is to be avoided.

Coral reefs are among the most biologically diverse and economically important ecosystems on the planet, providing ecosystem services that are vital to human societies and industries through fisheries, coastal protection, building materials, new biochemical compounds, and tourism (1). Yet in the decade since the inaugural International Year of the Reef in 1997 (2), which called the world to action, coral reefs have continued to deteriorate as a result of human influences (3, 4). Rapid increases in the atmospheric carbon dioxide concentration ($[CO_2]_{atm}$), driven

by global warming and ocean acidification, may be the final insult to these ecosystems. Here, we review the current understanding of how anthropogenic climate change and increasing ocean acidity are affecting coral reefs and offer scenarios for how coral reefs will change over this century. The scenarios are intended to provide a framework for proactive responses to the changes that have begun in coral reef ecosystems and to provoke thinking about future management and policy challenges for coral reef protection.

Warming and Acidifying Seas

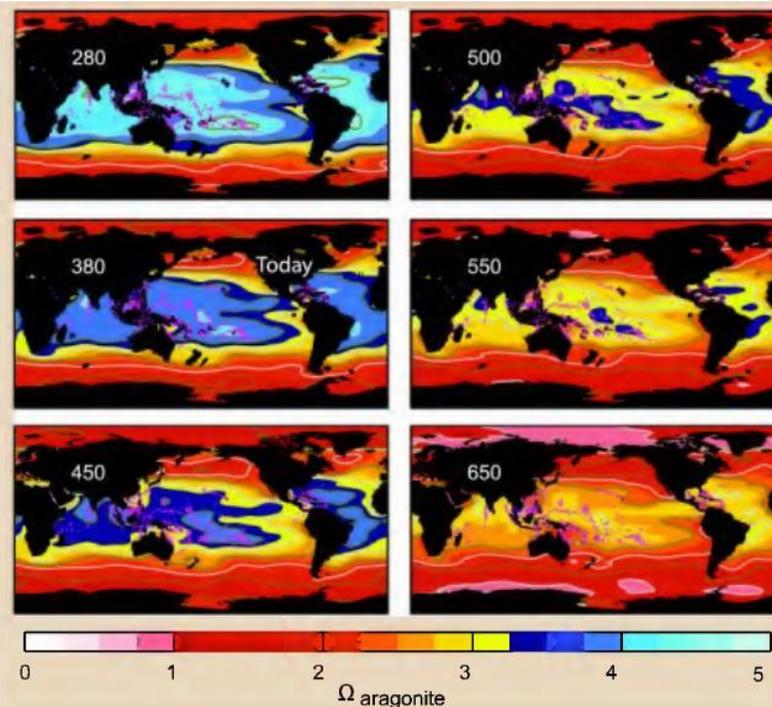
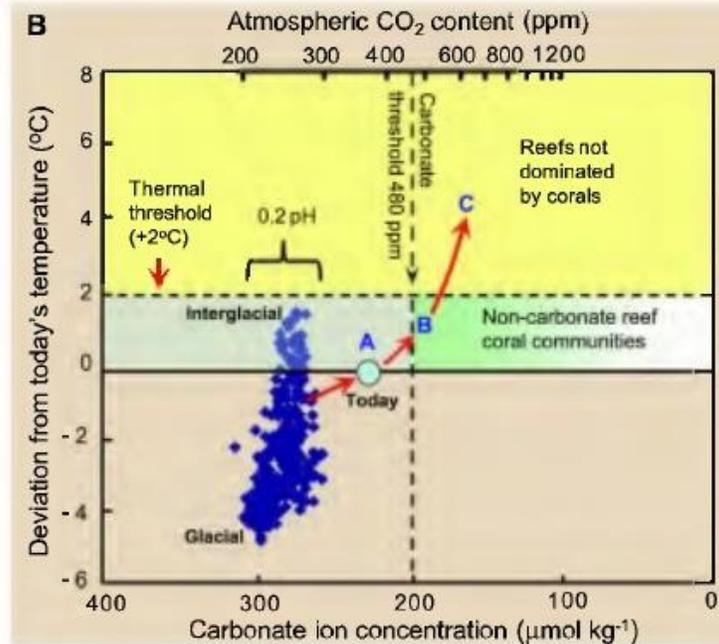
The concentration of carbon dioxide in Earth's atmosphere now exceeds 380 ppm, which is more than 80 ppm above the maximum values of the past 740,000 years (5, 6), if not 20 million years (7). During the 20th century, increasing $[CO_2]_{atm}$ has driven an increase in the global ocean's average temperature by 0.74°C and sea level by 17 cm, and has depleted seawater carbonate concentrations by $\sim 30 \mu\text{mol kg}^{-1}$ seawater and acidity by 0.1 pH unit (8). Approximately 25% (2.2 Pg C year⁻¹) of the CO_2 emitted from all anthropogenic sources (9.1 Pg C year⁻¹) currently enters the ocean (9), where it reacts with water to produce carbonic acid. Carbonic acid dissociates to form bicarbonate ions and protons, which in turn react with carbonate ions to produce more bicarbonate ions, reducing the availability of carbonate to biological systems (Fig. 1A). Decreasing carbonate-ion concentrations reduce the rate of calcification of marine organisms such as reef-building corals, ultimately favoring erosion at $\sim 200 \mu\text{mol kg}^{-1}$ seawater (7, 10).

We used global $[CO_2]_{atm}$ and temperature data from the Vostok Ice Core study (5) to explore the ocean temperature and carbonate-ion concentration (10) seen today relative to the recent past for a typical low-latitude sea maintain-

ing a mean temperature of 25°C during the past 420,000 years (Fig. 1B). The results show a tight cluster of points that oscillate (temperature $\pm 3^\circ\text{C}$; carbonate-ion concentration $\pm 35 \mu\text{mol kg}^{-1}$) between warmer interglacial periods that had lower carbonate concentrations to cooler glacial periods with higher carbonate concentrations. The overall range of values calculated for seawater pH is ± 0.1 units (10, 11). Critically, where coral reefs occur, carbonate-ion concentrations over the past 420,000 years have not fallen below $240 \mu\text{mol kg}^{-1}$. The trends in the Vostok ice core data have been verified by the EPICA study (6), which involves a similar range of temperatures and $[CO_2]_{atm}$ values and hence extends the conclusions derived from the Vostok record to at least 740,000 years before the present (yr B.P.). Conditions today ($[CO_2]_{atm} \sim 380$ ppm) are significantly shifted to the right of the cluster points representing the past 420,000 years. Sea temperatures are warmer ($+0.7^\circ\text{C}$), and pH (-0.1 pH units) and carbonate-ion concentrations ($\sim 210 \mu\text{mol kg}^{-1}$) lower than at any other time during the past 420,000 years (Fig. 1B). These conclusions match recent changes reported for measurements of ocean temperature, pH, and carbonate concentration (8). In addition to the absolute amount of change, the rate at which change occurs is critical to whether organisms and ecosystems will be able to adapt or accommodate to the new conditions (12). Notably, rates of change in global temperature and $[CO_2]_{atm}$ over the past century are 2 to 3 orders of magnitude higher than most of the changes seen in the past 420,000 years (Table 1). Rates of change under Panel on Climate Change (IPCC) emission scenarios are even higher, as are recent measurements of the rate of change of $[CO_2]_{atm}$ (9). The only possible exceptions are rare, short-lived spikes in temperature seen during periods such as the Younger Dryas Event (12,900 to 11,500 yr B.P.) (12). Given that recent and future rates of change dwarf even those of the ice age transitions, when biology at specific locations changed dramatically, it is likely that these changes will exceed the capacity of most organisms to adapt.

Ocean Acidification and Reef Accretion

Many experimental studies have shown that a doubling of pre-industrial $[CO_2]_{atm}$ to 560 ppm decreases coral calcification and growth by up to 40% through the inhibition of aragonite formation (the principal crystalline form of calcium carbonate deposited in coral skeletons) as carbonate-ion concentrations drop below $200 \mu\text{mol kg}^{-1}$ or becomes negative at aragonite saturation values of 3.3 in today's oceans (Fig. 4), which occurs when $[CO_2]_{atm}$ approaches 480 ppm and carbonate-ion concentrations drop below $200 \mu\text{mol kg}^{-1}$ in most of the global ocean (10, 13). These findings are supported by the observation that reefs with net carbonate accretion today (Fig. 4, 380 ppm) are restricted to waters where aragonite saturation



INQUINAMENTO CHIMICO E DA PLASTICA

Espansione da record per due aree ad alto rischio ecologico

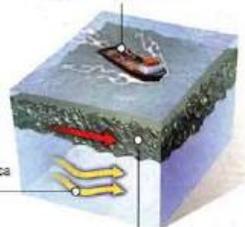
Un oceano di plastica

Pacifico: 100 milioni di tonnellate di rifiuti

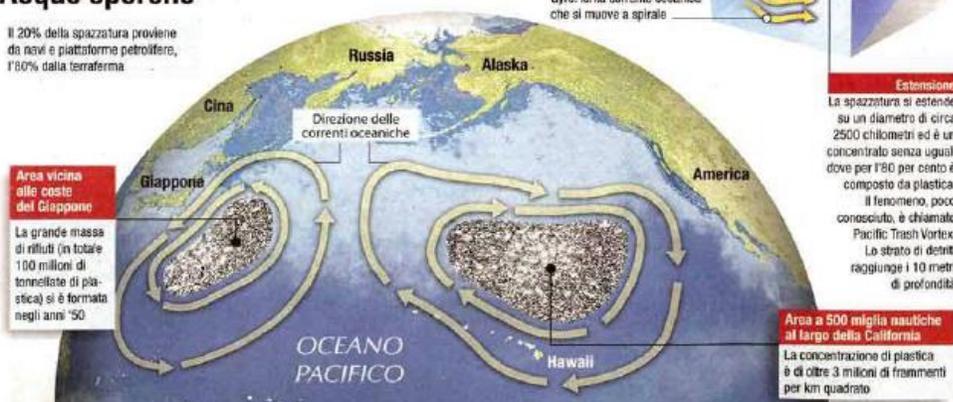
Acque sporche

Il 20% della spazzatura proviene da navi e piattaforme petrolifere, l'80% dalla terraferma

Il cistamarano Arguita, partito il 22 gennaio, sta raccogliendo campioni di rifiuti



PLASTICA



INGESTIONE



INTRAPPOLAMENTO



MACROPLASTICHE

MESOPLASTICHE

MICROPLASTICHE

NANOPLASTICHE



Le microplastiche: sono ovunque?

Environ. Res. Lett. 15 (2020) 023003

<https://doi.org/10.1088/1748-9326/ab6d7d>

Environmental Research Letters

TOPICAL REVIEW

The physical oceanography of the transport of floating marine debris

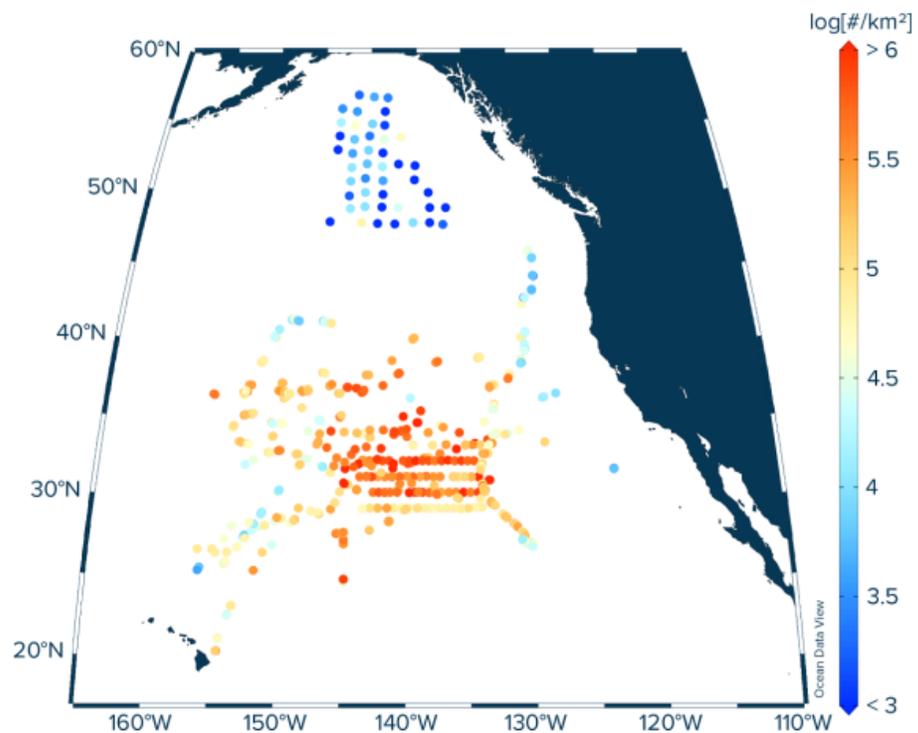
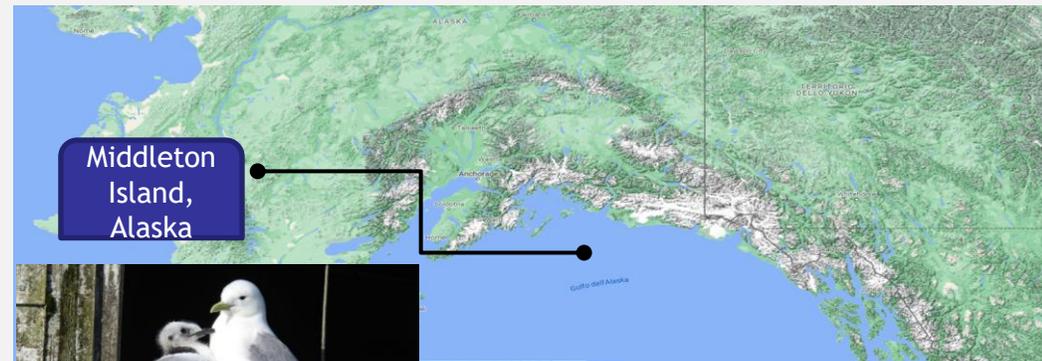
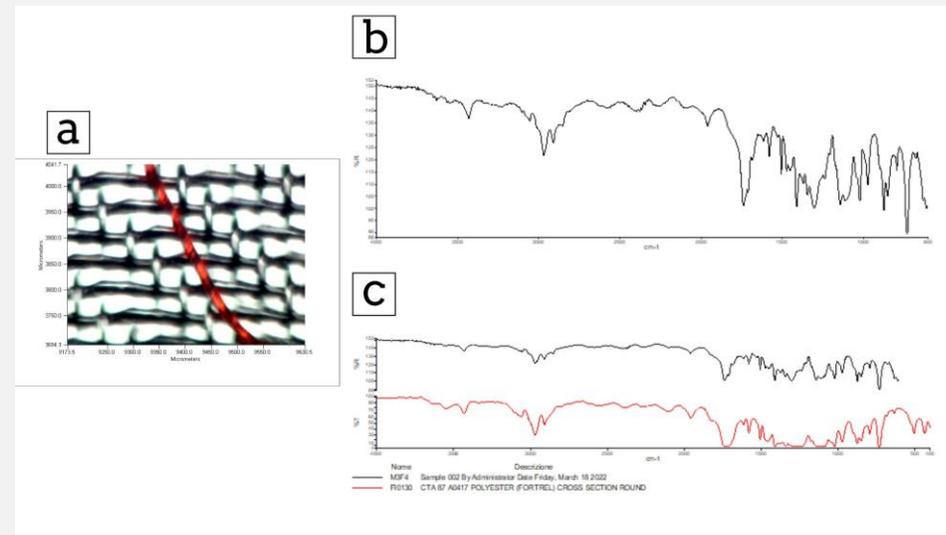


Figure 1. Neuston trawl deployment locations ($n = 679$) considered in this study and associated measured numerical concentrations of floating micro- and meso-plastic debris (i.e. 0.05–5 cm in size). See table 1 for details on expeditions and year of sampling.



Gabbiano zampe nere (*Rissa Trydactyla*)



INQUINAMENTO CHIMICO: CONTAMINATI ORGANICI PERSISTENTI: DA DOVE VENGONO?

Science of the Total Environment 452–453 (2013) 253–261



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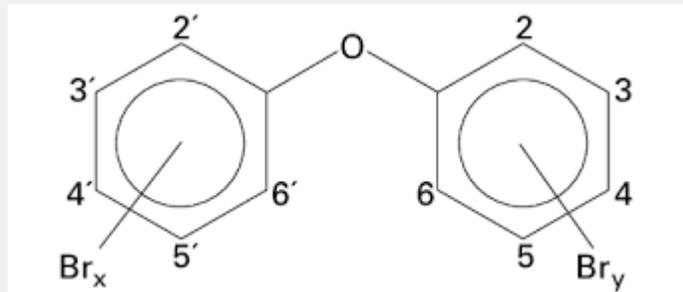
Background levels of polybrominated diphenyl ethers (PBDEs) in soils from Mount Meru area, Arusha district (Tanzania)

Marco Parolini ^{a,*}, Niccolò Guazzoni ^a, Roberto Comolli ^b, Andrea Binelli ^a, Paolo Tremolada ^a

^a Department of Biosciences, University of Milan, via Celoria 26, 20133 Milan, Italy

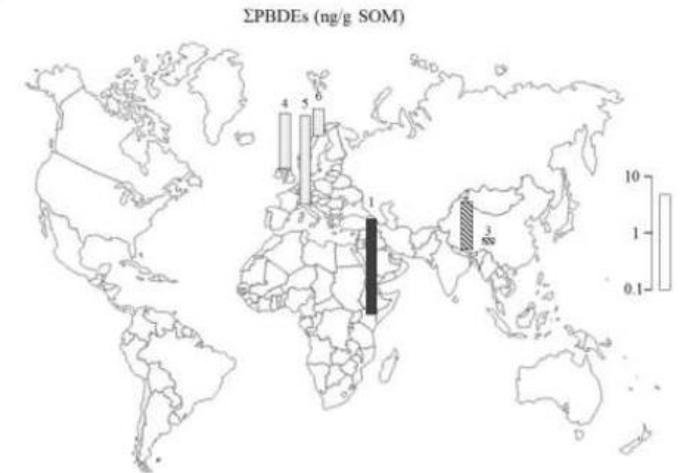
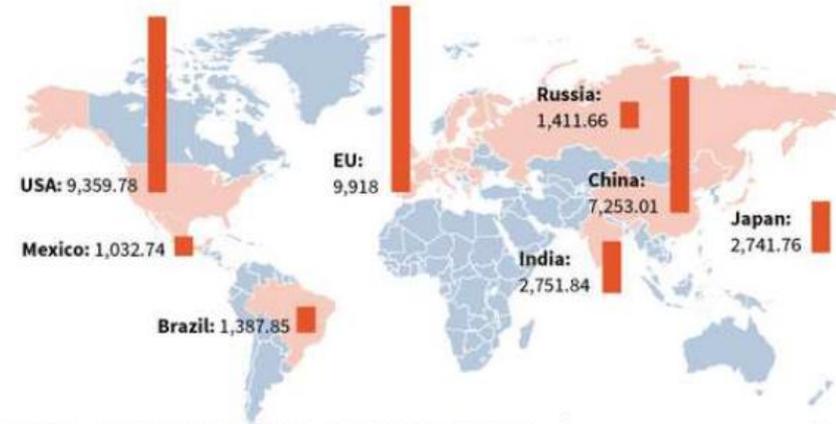
^b Department of Environmental and Landscape Sciences, University of Milano-Bicocca, Piazza della Scienza 1, Milan, Italy

Polibromodifenileteri (ritardanti di fiamma)



RAEE

E-WASTE GENERATED BY COUNTRY (2012, total metric kilotonnes)



INQUINAMENTO CHIMICO: CONTAMINATI ORGANICI PERSISTENTI

Persistent Organic Pollutants Burden, Trophic Magnification and Risk in a Pelagic Food Web from Coastal NW Mediterranean Sea

Javier Castro-Jiménez,* Daniela Bănar, Chia-Ting Chen, Begoña Jiménez, Juan Muñoz-Arnanz, Geneviève Deviller, and Richard Sempéré

Cite This: *Environ. Sci. Technol.* 2021, 55, 9557–9568

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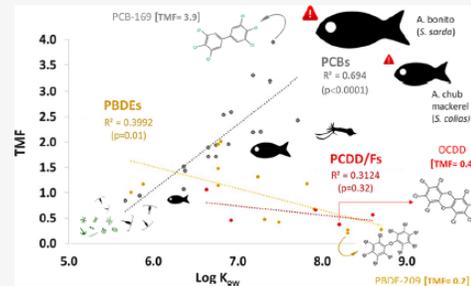
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ABSTRACT: The storage capacity, trophic magnification and risk of sixty-two POPs have been evaluated in a well-characterized pelagic food web (including phytoplankton, zooplankton, six fish, and two cephalopods species) from an impacted area in NW Mediterranean Sea. Our results show the high capacity of the planktonic compartment for the storage of polybrominated diphenyl ethers (PBDEs) and polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs), consistent with their estimated low trophic magnification factors (TMF) of 0.2–2.0 (PBDEs) and of 0.3–1.1 (PCDD/Fs). Σ PBDEs dominated in the zooplankton size-class 200–1000 μm ($\sim 330 \text{ ng g}^{-1}$ lw, median), whereas Σ PCDD/Fs accumulated preferentially in phytoplankton size-class 0.7–200 μm (875 pg g^{-1} lw, median). In contrast, polychlorinated biphenyls (PCBs) were preferentially bioaccumulated in the higher trophic levels (six fish species and two cephalopods) with TMFs = 0.8–3.9, reaching median concentrations of 4270 and 3140 ng g^{-1} lw (Σ PCBs) in Atlantic bonito (*Sarda sarda*) and chub mackerel (*Scomber colias*), respectively. For these edible species, the estimated weekly intakes of dioxin-like PCBs for humans based on national consumption standards surpassed the EU tolerable weekly intake. Moreover, the



La palamita
(*Sarda sarda*)

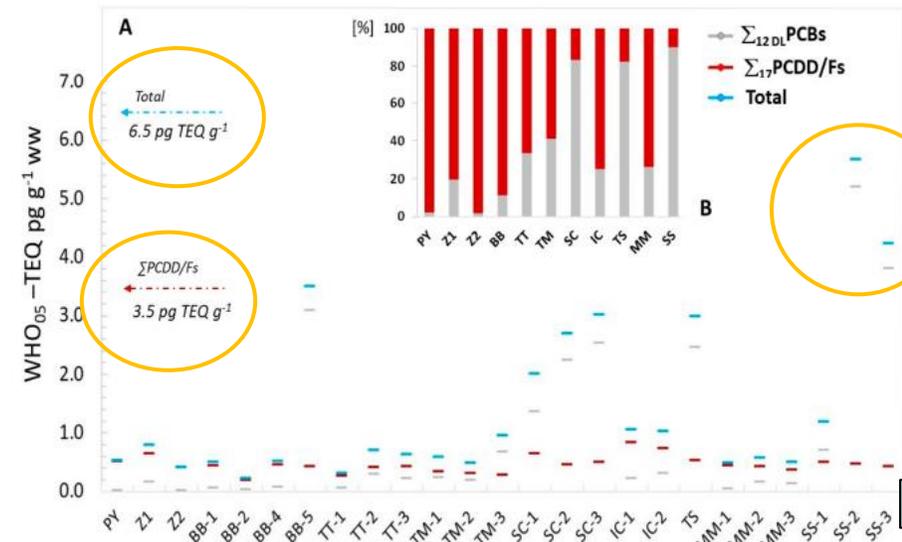


Figure 3. Calculated WHO₀₅-TEQ ($\text{pg g}^{-1} \text{ ww}$) in all samples from the pelagic food web in coastal NW Mediterranean Sea (A) and median relative contribution (%) of $\Sigma_{12\text{DL}}\text{PCBs}$ (gray) and $\Sigma_{17}\text{PCDD/Fs}$ (red) to the total WHO₀₅-TEQ (PCBs+PCDD/Fs) in blue (B), except for PY, Z1, Z2, and TS, which are single values. The horizontal dotted lines show the EU concentration thresholds in sea foodstuffs and wild fish (see text for details). PY = phytoplankton 0.7–200 μm ; Z1 = zooplankton 200–1000 μm ; Z2 = zooplankton >2000 μm ; BB = *B. boops*; TT = *T. trachurus*; TM = *T. mediterraneus*; SC = *S. colias*; IC = *I. coindetii*; TS = *T. sagittatus*; MM = *M. merluccius*; SS = *S. sarda*.

INQUINAMENTO CHIMICO: CONTAMINATI ORGANICI PERSISTENTI

Aumento delle concentrazioni in funzione del livello trofico

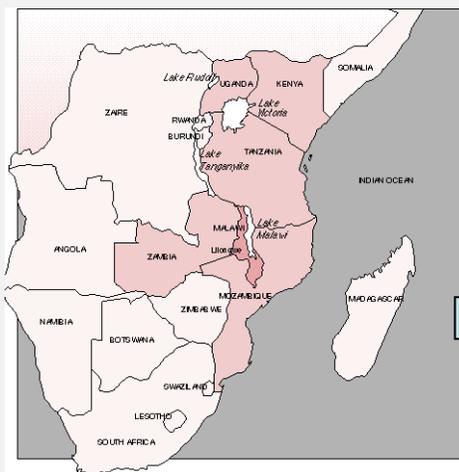
Biomagnification of DDT through the Benthic and Pelagic Food Webs of Lake Malawi, East Africa: Importance of Trophic Level and Carbon Source

KAREN A. KIDD,* HARVEY A. BOOTSMA,† AND RAYMOND H. HESSLEIN
 Department of Fisheries and Oceans, Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba, R3T 2N6 Canada

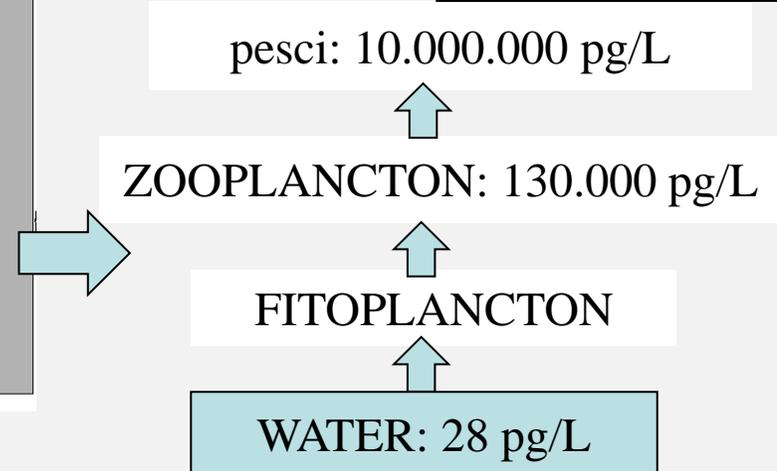
DEREK C. G. MUIR AND ROBERT E. HECKY†
 Environment Canada, National Water Research Institute, 867 Lakeshore Road, P.O. Box 5050, Burlington, Ontario, L7R 4A6 Canada

undergone dramatic evolutionary radiation in neurocranial morphology, and it is thought that this morphological diversity may allow them to have specific dietary habits and partition food resources and niches within the lake. Current estimates of the number of species of cichlids range from 700 to 1000 (1), with species densities being greatest in the nearshore rocky habitats. These nearshore areas of Lake Malawi are highly productive with C fixation rates of up to 1000 mg C m⁻² day⁻¹, and they can support more than 500 fish in a 50 m² area (2, 3). In contrast, the offshore pelagic food web is less species-rich and is based on much lower areal rates of algal photosynthesis.

Stable nitrogen and carbon isotope ratios of biota can be used to characterize an organism's trophic position and carbon source, respectively. These isotopic signatures integrate dietary habits over a period of months to years for slower-growing species (4). The enrichment of the heavier isotope of nitrogen from prey to predator (3–5‰ (5)) provides a continuous variable with which to quantify and contrast the biomagnification of organochlorines in aquatic food webs (6, 7). Little change in isotope ratios is observed when carbon is incorporated into a consumer from its diet, and, for this reason, these ratios are used to trace carbon flow from primary producers to tertiary consumers (8). In



BIOCONCENTRAZIONE
BIOMAGNIFICAZIONE

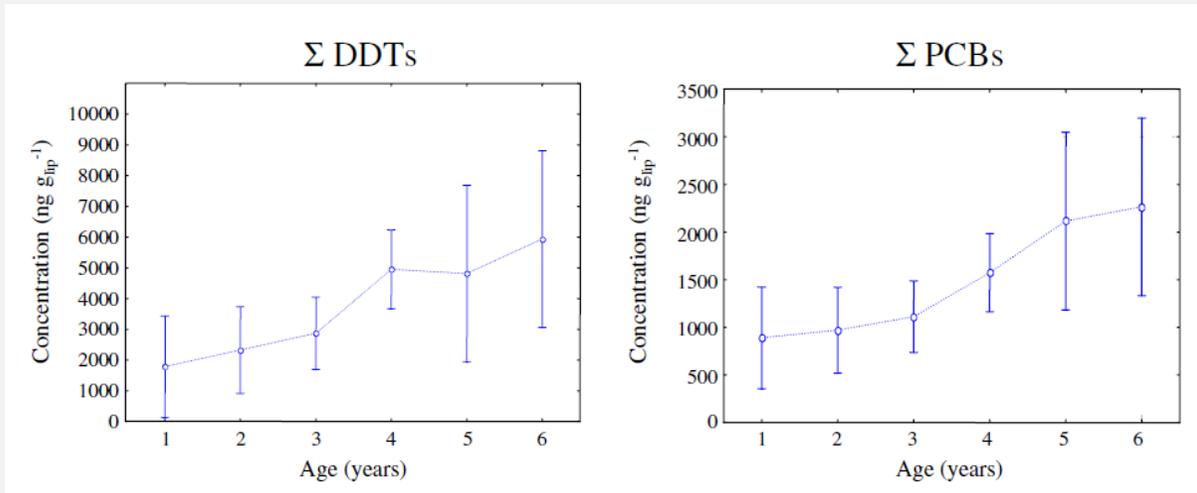


Aumento delle concentrazioni in funzione dell'età

Age-Dependent Bioaccumulation of Organochlorine Compounds in Fish and their Selective Biotransformation in Top Predators from Lake Maggiore (Italy)

Pietro Volta • Paolo Tremolada • Maria Chiara Neri • Gianluigi Giussani • Silvana Galassi

Water Air Soil Pollut (2009) 197:193–209
 DOI 10.1007/s11270-008-9803-z



INQUINAMENTO CHIMICO: CONTAMINATI ORGANICI PERSISTENTI: CHE COSA E' STATO FATTO?



<http://chm.pops.int/Home/tabid/2121/Default.aspx>

FIRMA → Stockholm, 22 maggio 2001

ENTRATA IN VIGORE → 17 maggio 2004



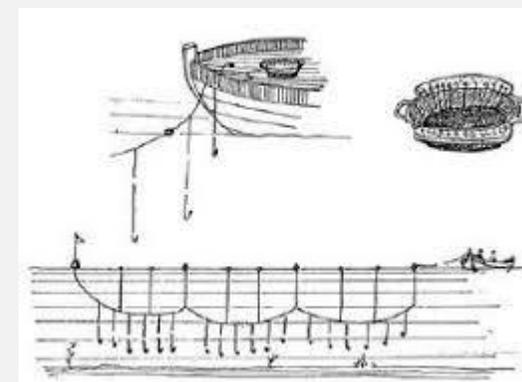
CHE COSA CI RESTA DA FARE?



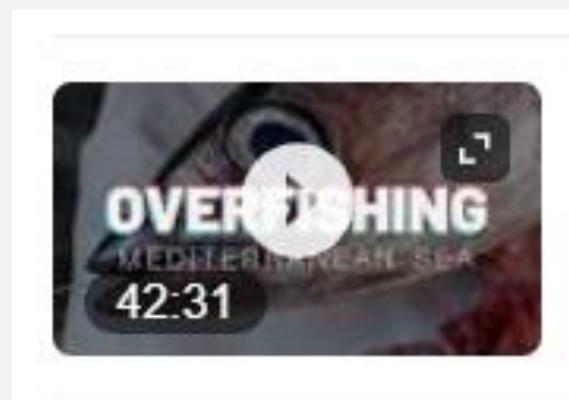
The screenshot shows the IUCN Italia website interface. At the top left is the IUCN logo and the text 'COMITATO ITALIANO WWW.IUCN.ORG'. To the right is the logo for 'MINISTERO DELLA TRANSIZIONE ECOLOGICA Federparchi EUROPARC'. Below the header is a navigation menu with 'Liste Rosse italiane' selected. The main content area displays 'Caretta caretta' with a red status indicator. A search box is visible on the right with the text 'Cerca nella Lista Rossa: (genere, specie o nome comune...)' and a 'Vai' button. A row of colored circles represents different conservation categories, with 'EN' (Extinct in the Wild) highlighted in orange.

Il palamito

lunga lenza di grosso diametro con pezzi di lenza più sottile con un amo ciascuno



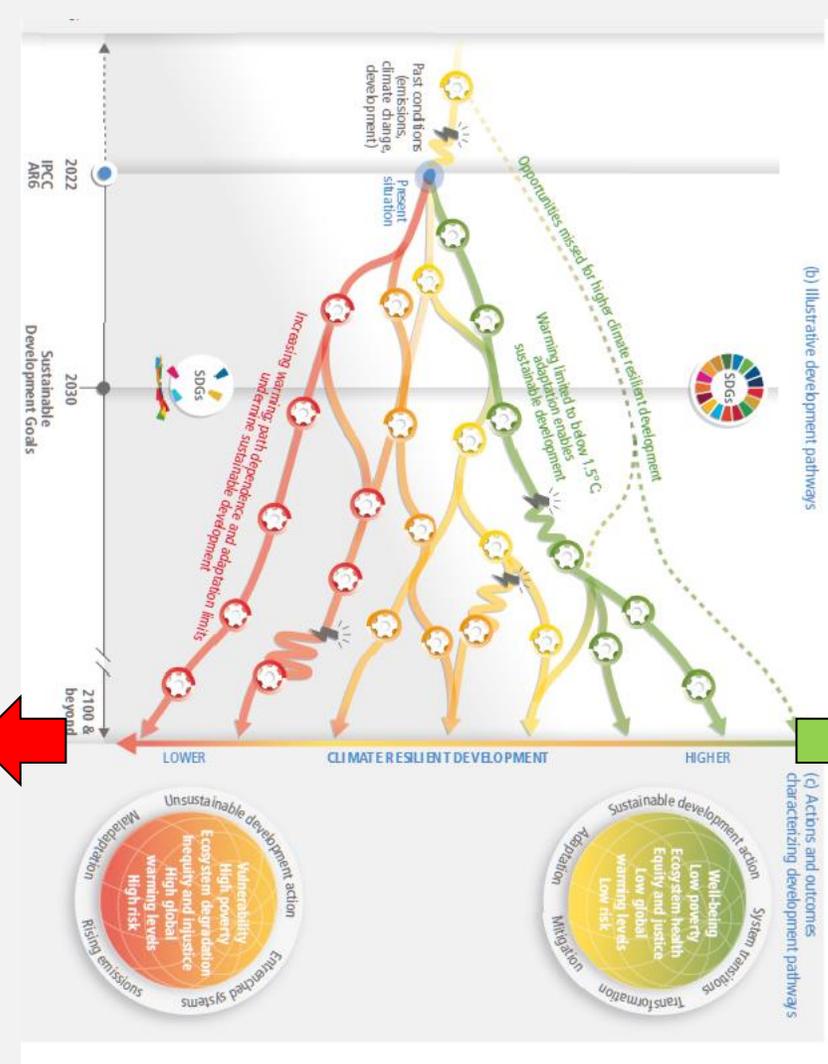
IUCN-Italia: <http://www.iucn.it/scheda.php?id=1108177324>



<https://www.youtube.com/watch?v=6lp-2m4awg4>



Le prospettive: oggi (2022), 2030 e 2100



IPCC, 2022: <https://www.ipcc.ch/report/ar6/wg2/>

