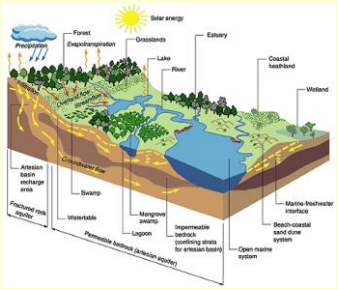
Conserving aquatic systems

Soggy issues

Why aquatic systems?

- Humans are terrestrial
- Depths are hidden from easy view
- Gravity



Major issues in aquatic conservation

- Habitat alteration
- Invasive species
- Overharvesting
- Eutrophication
- Other pollutants

Adventure Falls, Surfside Beach

Habitat alteration

- Degradation of benthic habitats due to dredging and trawling
- Shoreline development and riparian zone alteration
- Dams

Trawling (1)

Gulf of Alaska

Table 3. Mean density of invertebrate groups in 8 trawl and 8 reference transects in the eastern Gulf of Alaska, and individual probability levels (p) for Wilcoxon's signed-ranks test. Asterisk denotes significance at $p \leq 0.05$ level, after Bonferroni correction for multiple tests using the method of Hochberg (1988). Density values indicate only undamaged organisms

Group	Mean density (no. 100m^{-2}) Trawl	Reference	p
Sessile groups			
Finger sponges	71.4	119.1	0.3125
Anthozoans	5.7	13.2	0.0156*
Morel sponges	0.1	1.1	0.0156*
Vase sponges	1.0	3.7	0.0078*
Motile groups			
Asteroids and ophiuroids	17.1	20.0	0.7422
Holothurians	3.3	3.6	0.3672
Arthropods	2.4	1.3	0.0781
Molluscs	1.6	0.6	0.0547
Echinoids	9.5	18.7	0.0391

Freese et al. (1999)

Bottom trawling scrapes

Trawling (2)

Global analysis of depletion and recovery of seabed biota after bottom trawling disturbance

Jan Geert Hiddink[a,1], Simon Jennings[b,c,2], Marija Sciberras[a], Claire L. Szostek[a], Kathryn M. Hughes[a], Nick Ellis[d], Adriaan D. Rijnsdorp[e,1], Robert A. McConnaughey[f], Tessa Mazor[g], Ray Hilborn[g], Jeremy S. Collie[h], C. Roland Pitcher[d], Ricardo O. Amoroso[i], Ana M. Parma[j], Petri Suuronen[k], and Michel J. Kaiser[a]

2017; PNAS

1.9 to 6.4 years

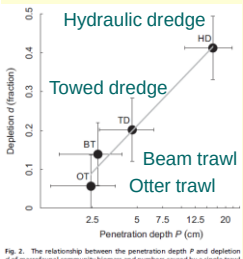


Fig. 2. The relationship between the penetration depth P and depletion d of macrofaunal community biomass and numbers caused by a single trawl pass for different trawl gears (means ± SD).

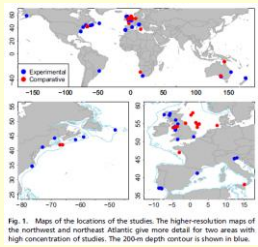


Fig. 1. Maps of the locations of the studies. The higher-resolution maps of the northwest and northeast Atlantic give more detail for two areas with high concentration of studies. The 200-m depth contour is shown in blue.

Shoreline alteration

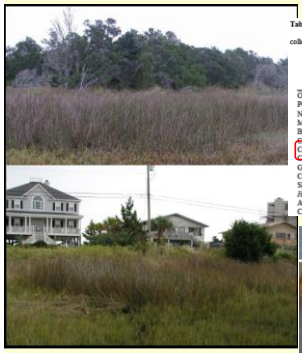
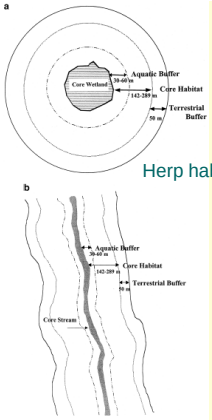


Table 3. Percent taxonomic composition identified from October 2004 infaunal samples collected at barrier and mainland developed and undeveloped locations in Murrells Inlet.

Taxa	Mainland Undeveloped	Mainland Developed	Barrier Beach Undeveloped	Barrier Beach Developed
Oligochaeta	60.5	38.9	51.4	34.2
Polychaeta	0.9	2.2	0.3	1.6
Nematoda	31.6	21.1	46.9	47.7
Mite	0.9	1.1	0.3	0.4
Bivalvia	0.0	11.1	0.1	0.0
Copepoda	2.9	9.6	0.0	3.5
Ceratopogonidae	4.4	19.4	0.0	13.2
Collembola	0.0	0.0	0.1	0.0
Gastropoda	0.0	0.0	0.0	0.0
Crab	0.0	0.0	0.0	0.4
Shrimp	0.9	0.0	0.0	0.4
Hexatoma	0.0	1.1	0.0	0.0
Amphipoda	0.0	1.1	0.0	0.0
Chironomidae	0.0	0.6	0.0	0.0

Walters et al. (2010)

Riparian zone degradation

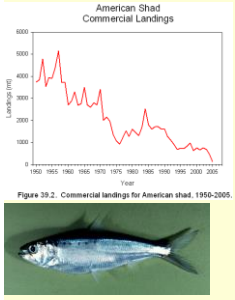


Herp habitat

Semlitsch & Bodie (2003)

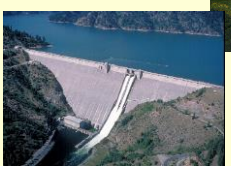
Dams

- Breaking upstream-downstream linkages



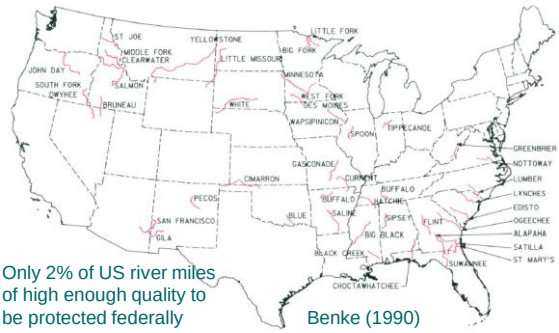
Espiritu Santo River, Puerto Rico

Xiphocaris elongata



Dam-Nation?

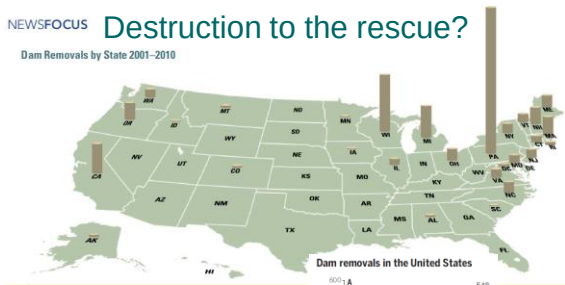
- Only 42 free-flowing streams >200 km long remaining in lower 48



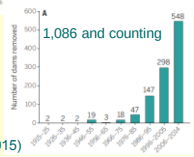
Only 2% of US river miles of high enough quality to be protected federally

Benke (1990)

NEWSFOCUS Destruction to the rescue?



Science, 18 Nov 2011
Data source: American Rivers

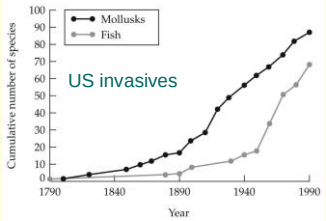


Boom + 1 year

O'Connor et al. (2015)

Major issues in aquatic conservation

- Habitat alteration
- **Invasive species**
- Overharvesting
- Eutrophication
- Other pollutants



Invasive species

Shoreline Development Drives Invasion of *Phragmites australis* and the Loss of Plant Diversity on New England Salt Marshes

BRIAN R. SILLIMAN* AND MARK D. BERTNESS

Department of Ecology and Evolutionary Biology, Brown University, Providence, RI 02912, U.S.A.

2004

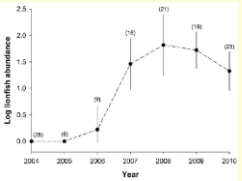
Another invader

Invasive Lionfish Drive Atlantic Coral Reef Fish Declines

Stephanie J. Green, John L. Akins, Aleksandra Maljković, Isabelle M. Côté

2012

Click



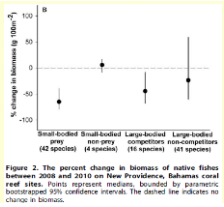


Figure 2. The percent change in biomass of native fishes between 2008 and 2010 on New Providence, Bahamas coral reef sites. Points represent medians, bounded by parametric bootstrapped 95% confidence intervals. The dashed line indicates no change in biomass.

Invader insights from Moyle & Marchetti (2006)

- 110 spp.; 43%
- **No** one set of characteristics always predict "success" of invaders, but 5 significant factors for CA fishes are:
  - Successful invasion elsewhere
  - Invading a habitat similar to native one
  - Invading species-rich areas
  - >100 individuals introduced repeatedly
  - Species-specific characteristics that aid success at multiple steps required for successful invasion

Multiple steps to invasion

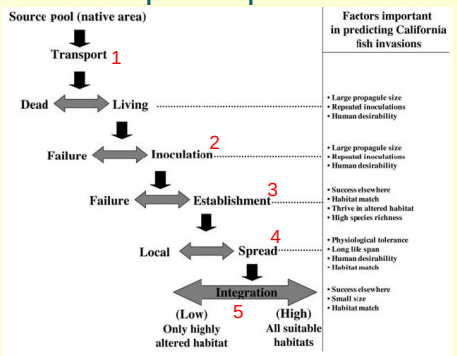


Figure 2. Diagrammatic view of the invasion process (not drawn to scale).

Moyle & Marchetti (2006)

Major issues in aquatic conservation

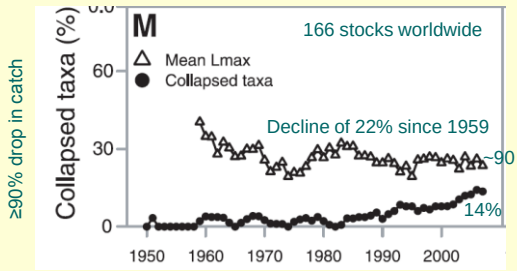
- Habitat alteration
- Invasive species
- **Harvesting**
- Eutrophication
- Other pollutants

Adventure Falls, Surfside Beach

Harvesting

- Over-harvesting
- By-catch

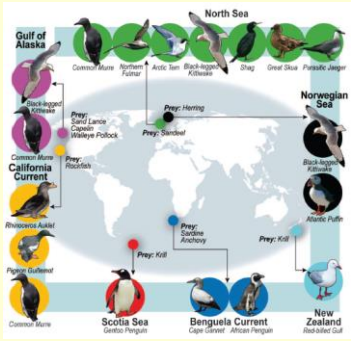
Over-harvesting of ocean fishes



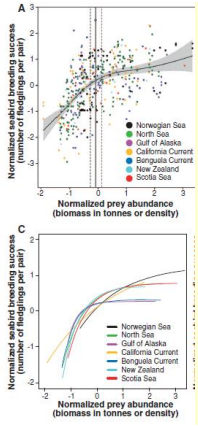
Uses all available data

Worm et al. (2009)

"one-third for the birds"

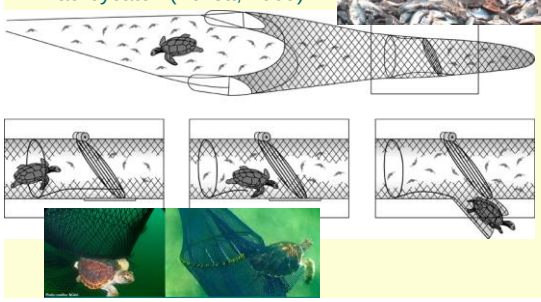


Cury et al. (2011)



Bycatch

- 39 of 49 commercial fisheries along East Coast had bycatch (Zollett, 2009)



Major issues in aquatic conservation

- Habitat alteration
- Invasive species
- Overharvesting
- **Eutrophication**
- Other pollutants

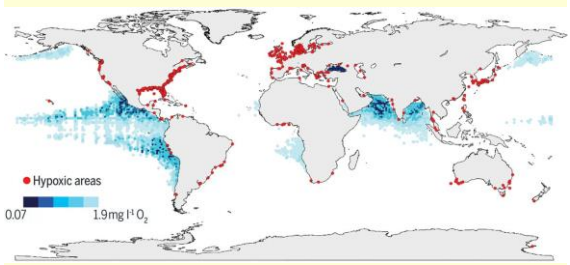
Adventure Falls, Surfside Beach

Eutrophication

- HABs, too

Dead zones on the rise

- Exponential spread since the 1960s



Breitburg et al. (2018)

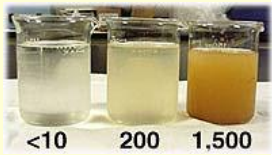
Major issues in aquatic conservation

- Habitat alteration
- Invasive species
- Overharvesting
- Eutrophication
- **Other pollutants**

Adventure Falls, Surfside Beach

Some other pollutants

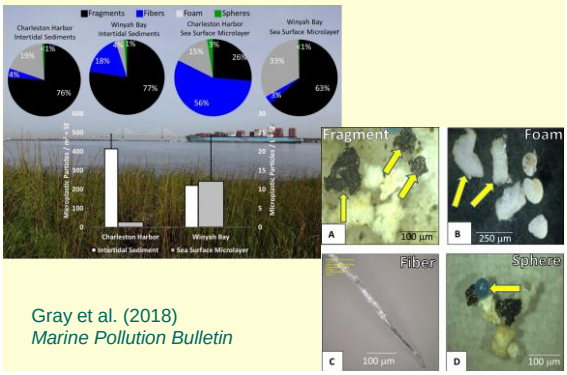
- Sedimentation
- Microplastics
- Pesticides
- Endocrine disruptors



Turbidity

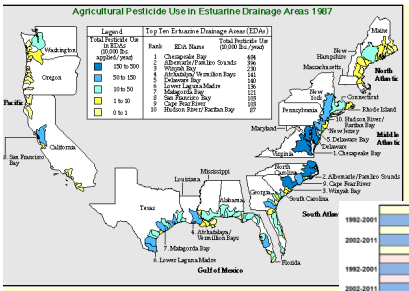
Tributary to the Chattahoochee River, GA

Microplastics



Gray et al. (2018)
Marine Pollution Bulletin

Pesticides



http://spo.nos.noaa.gov/projects/agchemuse/pesticide_use_

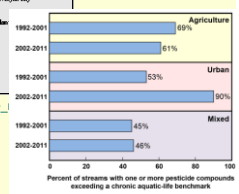


Figure 4. Proportion of streams with one or more pesticides that exceeded a chronic aquatic-life benchmark was very similar between 1992 and 2001 and 2002–2011 for agricultural and mixed-land-use streams, but much greater during 2002–2011 for urban streams.

Stone et al. (2014)

Endocrine disruptors

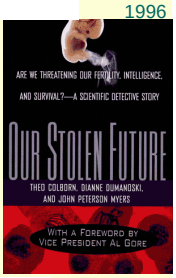
The Impact of Endocrine Disruption: A Consensus Statement on the State of the Science

1996

Bergman et al. (2013)
Environmental Health Perspectives

Talk

1927-2014



TEDX

Atrazine induces complete feminization and chemical castration in male African clawed frogs (*Xenopus laevis*)

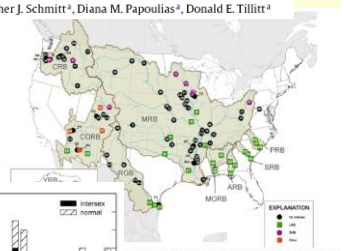
PNAS (2010)

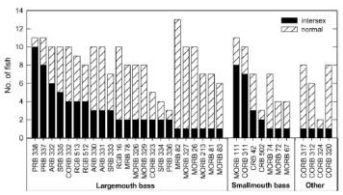
Tyrone B. Hayes[a,1], Vicky Khoury[a,2], Anne Narayan[a,2], Mariam Nazir[a], Andrew Park[a,3], Travis Brown[a], Lillian Adame[a], Elton Chan[a], Daniel Buchholz[b], Theresa Stueve[a], and Sherrie Gallipeau[a]

Widespread occurrence of intersex in black basses (*Micropterus* spp.) from U.S. rivers, 1995–2004 2009; *Aquatic Toxicology*

Jo Ellen Hinck[a,*], Vicki S. Blazer[b], Christopher J. Schmitt[a], Diana M. Papoulias[a], Donald E. Tillitt[a]

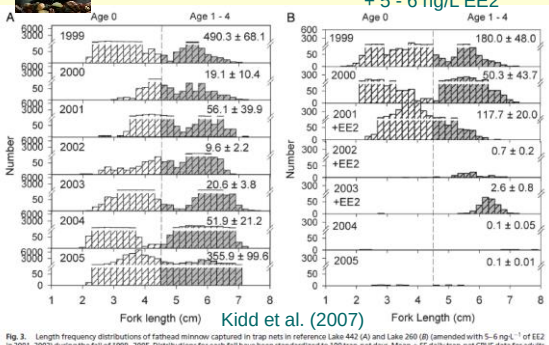
Locally?





Whole-lake experimental effects

+ 5 - 6 ng/L EE2

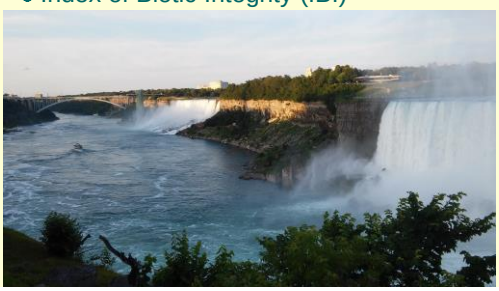


Kidd et al. (2007)

Fig. 3. Length frequency distributions of fathead minnow captured in trap nets in reference Lake 442 (A) and Lake 260 (B) (amended with 5–6 ng·L^{-1} of EE2 in 2001–2003) during the fall of 1999–2005. Distributions for each fall have been standardized to 190 trap-net days. Mean ± SE daily trap-net CPUE data for adults and juveniles for the fall catches are shown in the panels.

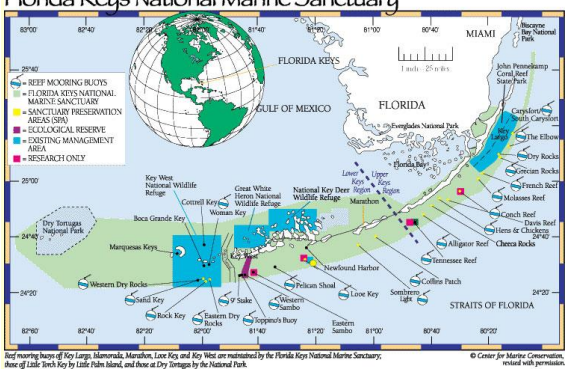
Some tools

- Marine sanctuaries
- Wild and Scenic Rivers+
- Index of Biotic Integrity (IBI)



Marine sanctuaries

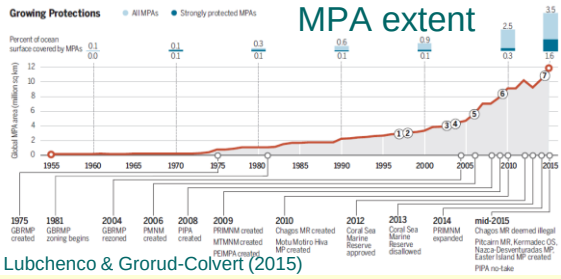
Florida Keys National Marine Sanctuary



Reef mooring buoys off Key Largo, Islamorada, Marathon, Looe Key, and Key West are maintained by the Florida Keys National Marine Sanctuary; those off Little Torch Key by Little Palm Island, and those at Dry Tortugas by the National Park.

© Center for Marine Conservation, revised with permission.

MPA extent



Lubchenco & Grorud-Colvert (2015)

Also see:

Global and regional priorities for marine biodiversity protection

Clinton N. Jenkins[a,*], Kyle S. Van Houtan[b,c,d]

Can they work?

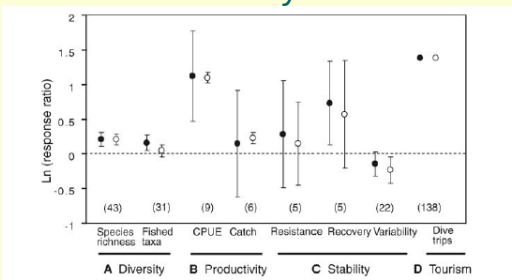


Fig. 4. Recovery of diversity and ecosystem services in marine protected areas and fisheries closures. Shown are the response ratios (inside versus outside the reserve or before and after protection ±95% CI) of (**A**) species diversity and (**B** to **D**) ecosystem services that correspond to fisheries productivity, ecosystem stability, and tourism revenue, respectively. Positive values identify increases in the reserve relative to the control; error bars not intersecting zero indicate statistical significance ($P < 0.05$). Solid circles represent unweighted averages; open circles are weighted by sample size (see supporting online methods for details). The number of studies is shown in parentheses. CPUE, catch per unit of effort.

Worm et al. (2006)

What does an MPA need?

- No take
- Law enforcement
- >10-years old
- > 100 km^2
- Isolated

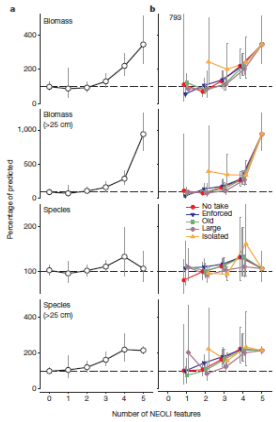


Figure 2 | Mean response ratios for MPAs with different numbers of NEOLI (no take, enforced, old, large, isolated) features. Mean ratio values have been back transformed from logs and expressed as percentages with 95% confidence intervals, with 100% equivalent to fished counts. Sites on fished coasts have 0 NEOLI features. **a**, Mean response ratios for four community metrics. **b**, Mean response ratios for community metrics where each NEOLI feature was included within the set examined. The 'no-take' plot with two features, for example, depicts the mean response for no-take MPAs with a single other NEOLI feature. 95% confidence limits that lie off-scale are shown by number. Samples sizes are shown in Extended Data Table 1.

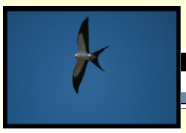
Edgar et al. (2014)

Wild and Scenic Rivers+

National Wild & Scenic Rivers System

"In a country where nature has been so lavish and where we have been so spendthrift of indigenous beauty, to set aside a few rivers in their natural state should be considered an obligation." - Senator Frank Church

New River Gorge National River
Grandview, WV



Swallow-tailed kite; Credit: Craig Sasser

U.S. Fish & Wildlife Service
Waccamaw National Wildlife Refuge

IBI vs. Impervious for Fairfax Co, VA

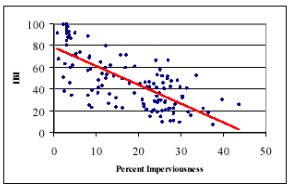


Figure 9. Trend line indicating that Biological integrity, as measured by an Index of Biotic Intetrity (IBI) for benthic macroinvertebrates, generally decreases with increasing percent imperviousness. Appendix B includes information on the statistical significance of the data presented.

Fairfax County Stream Protection Strategy: Baseline Study (2001)
http://www.co.fairfax.va.us/gov/DPWES/publications/sps/spsCH5.pdf