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 macroinvertebrate groups in 6 trawl and 6 reference transects in the eastern Gulf of Alaska, and individual probability levels for Wilcoxon signed-ranks test. Asterisk denotes significance at p < 0.05 level, after Bonferroni correction for multiple tests using the method of Hochberg (1986). Density values indicate only undamaged organisms.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean density (ind. 100m²)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trawl</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Sessile groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportialopods</td>
<td>71.8</td>
<td>0.0129**</td>
</tr>
<tr>
<td>Annelid</td>
<td>5.7</td>
<td>0.0136*</td>
</tr>
<tr>
<td>Mollusca</td>
<td>0.3</td>
<td>0.0136*</td>
</tr>
<tr>
<td>Vertebrates</td>
<td>1.0</td>
<td>0.0093**</td>
</tr>
<tr>
<td>Masticariates</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Asteroids and ophiocomes</td>
<td>1.9 ± 0.8</td>
<td>0.7422</td>
</tr>
<tr>
<td>Holothurians</td>
<td>3.3</td>
<td>0.0972</td>
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<tr>
<td>Annelid</td>
<td>2.4</td>
<td>0.0091</td>
</tr>
<tr>
<td>Mollusca</td>
<td>3.6</td>
<td>0.0091</td>
</tr>
<tr>
<td>Echinodermes</td>
<td>0.9</td>
<td>0.0091</td>
</tr>
</tbody>
</table>

Freese et al. (1999)

Trawling (2)

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

Jan Geert Hallekær1, Simon Jønnes1,2, Marije Schierhorn1, Claire L. Szostak1, Kathryn M. Hughes3, Nick Enevoldsen3, Alexandre D. Rapoport4, Robert A. McConnaughey2, Tessa Mazza5, Ray Hilm6,7, Jeremy S. Cohen6, C. Roland Pitman6, Ricardo D. Antunes8, Ana M. Ferre8, Petri Saurola8, and Michel J. Kava9

2017, PNAS

1.9 to 6.4 years

Hydraulic dredge

Beam trawl

Towed dredge

Otter trawl

Fig. 1. The relationship between the production depth p and depletion of macroinvertebrate biomass (in units of mg dry weight) for different trawl gears (ind. 100m²).

Fig. 2. Maps of the location of the studies. The highest resolution maps of the seabed and bottom water properties used for two main environmental conditions: high concentration of sediments. The 250m depth contour is shown in blue.
Shoreline alteration

Riparian zone degradation

Dams

- Breaking upstream-downstream linkages

Espiritu Santo River, Puerto Rico

Xiphocaris elongata

Dams-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)

Destruction to the rescue?

Science, 18 Nov 2011

Data source: American Rivers

1,086 and counting

O’Connor et al. (2015)

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US invasives
Invader insight from Moyle & Marchetti (2006)

- 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

- Source pool (native area)
- Transport
- Dead ➔ Living
- Failure ➔ Inoculation
- Failure ➔ Establishment
- Local ➔ Spread
- Integration

Factors important in predicting California fish invasions

- High
- Moderate
- Low
- Not applicable

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

Major issues in aquatic conservation

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Adventure Falls, Surfside Beach

Harvesting

- Over-harvesting
- By-catch
Over-harvesting of ocean fishes

Worm et al. (2009)

- 166 stocks worldwide
- 20% drop in catch
- Decline of 22% since 1959

Bycatch

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

Major issues in aquatic conservation

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- Invasive species
- Overharvesting
- Eutrophication
- Other pollutants

Eutrophication

- HABs, too

Dead zones on the rise

- Exponential spread since the 1960s

Cury et al. (2011)

Adventure Falls, Surfside Beach

Breitburg et al. (2018)
Major issues in aquatic conservation

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Adventure Falls, Surfside Beach

Some other pollutants

- Sedimentation
- Microplastics
- Pesticides
- Other pollutants
- Endocrine disruptors

Tributary to the Chattahoochee River, GA

Microplastics

Gray et al. (2018)
Marine Pollution Bulletin

Pesticides

Stone et al. (2014)

Endocrine disruptors (1)

Bergman et al. (2013)
Environmental Health Perspectives

PNAS (2010)

Talk

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

Locally?

Whole-lake experimental effects

Kidd et al. (2007)

Some tools

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

Ecological Exposure
Research Division

Marine sanctuaries

Lubchenco & Grorud-Colvert (2015)

Can they work?

M Wangal (2009)

Also see:

Global and regional priorities for marine biodiversity protection

What does an MPA need?

- No take
- Law enforcement
- > 10 years old
- > 100 km²
- Isolated

Edgar et al. (2014)

IBI vs. Impervious for Fairfax Co, VA

Figure 8. Trend line indicating that biological integrity, as measured by an Index of Biotic Integrity (IBI) for benthic macroinvertebrates, generally decreases with increasing percent imperviousness. Appendix D 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/spsspsCH5.pdf