

Transitional Waters Sediment Contamination — Assessment and Management (Based on a review paper in press in Environment International doi: 10.1016/j.envint.2013.0209)

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Sediment contamination remains a global problem, particularly in transitional waters such as estuaries (fjords, river mouths, tidal creeks, the Arctic Ocean), coastal lagoons, fjords, and rias, all of which are the recipients of chemicals from multiple near- and farfield sources. Although transitional waters are highly productive ecosystems, approaches for assessing and managing sediment contamination are not as well developed as in marine and fresh waters. The following assessment techniques cannot be used similarly in transitional waters as they are used in fresh and marine waters: chemistry; toxicity tests; biological surveys; and, biomarkers of exposure and effect. Integrative risk assessments and management actions based on these and other techniques need to focus on ecosystem services.

Transitional Waters Are Complex

- Vertically stratified
- Vertically homogenous either consistently or at different time periods
- Sills can result in oxygen deficiency (hypoxia)
- Vary seasonally as freshwater flow increases or decreases: temporarily open/closed estuaries; inverse estuaries

- Three major natural water quality factors: dissolved oxygen; salinity; sedimentation
- Strong gradients in: temperature; pH; redox potential (Eh); nutrients
- Not steady-state systems; high natural variability chemistry and biota
- Change is the norm
- Need to understand seasonal and natural variability (i.e., stochasticity) and appropriately bound this variability

Transitional Waters Chemistry

No biogeochemical processes are unique to transitional waters; what is unique, is how these processes are influenced by and coupled to the exceptional dynamics of suspended particles and to changes in salinity.

Bioindicators – Toxicity Tests

Acute (survival) and sublethal endpoints (growth, reproduction) using at least two and ideally three or four appropriately sensitive, standardized sediment-dwelling and/or sediment associated test organisms reasonably similar to those found (or expected to be found) at a sediment site based on available data. Choose tests focusing on salinity and grain size tolerance, and test endpoints. Determine pore water salinities before choosing test organisms.

Bioindicators – Biological Surveys

Benthic infaunal communities in transitional waters can exhibit symptoms of disturbance without anthropogenic influence given the extreme physical and chemical stresses in such waters. Organisms burying into muddy sediments are not directly affected by overlying water salinities but rather by pore water salinities, which change much more slowly in muddy than in sandy sediments; seasonal variations in pore water salinities can result in seasonal shifts in benthic infaunal distributions.

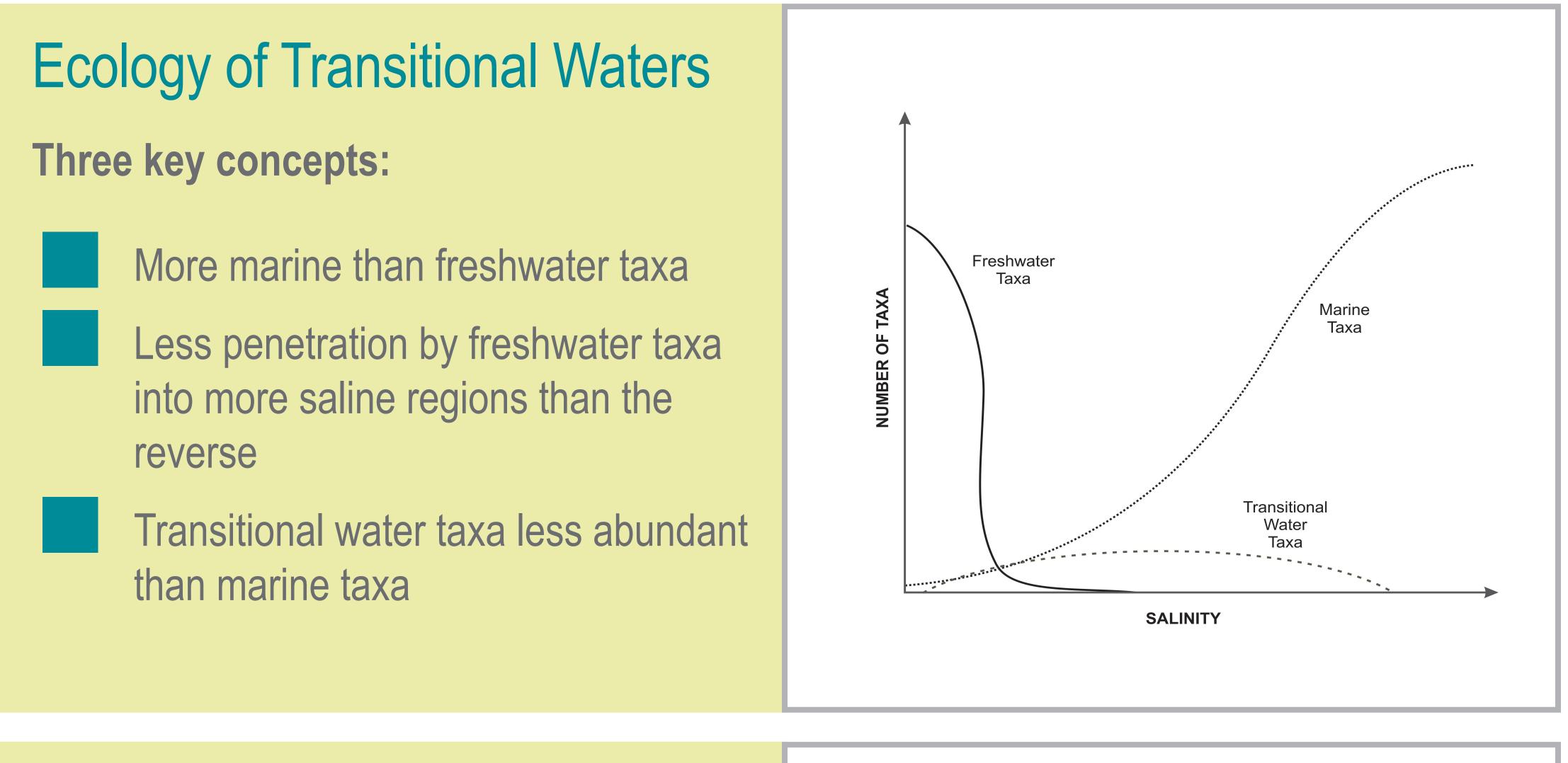
Integrative Assessments

Greatest weight to benthic infaunal data; chemistry and toxicity data have lower weight. Biomarkers assessed together with sediment chemistry and laboratory toxicity data.

Management Ecosystem Services

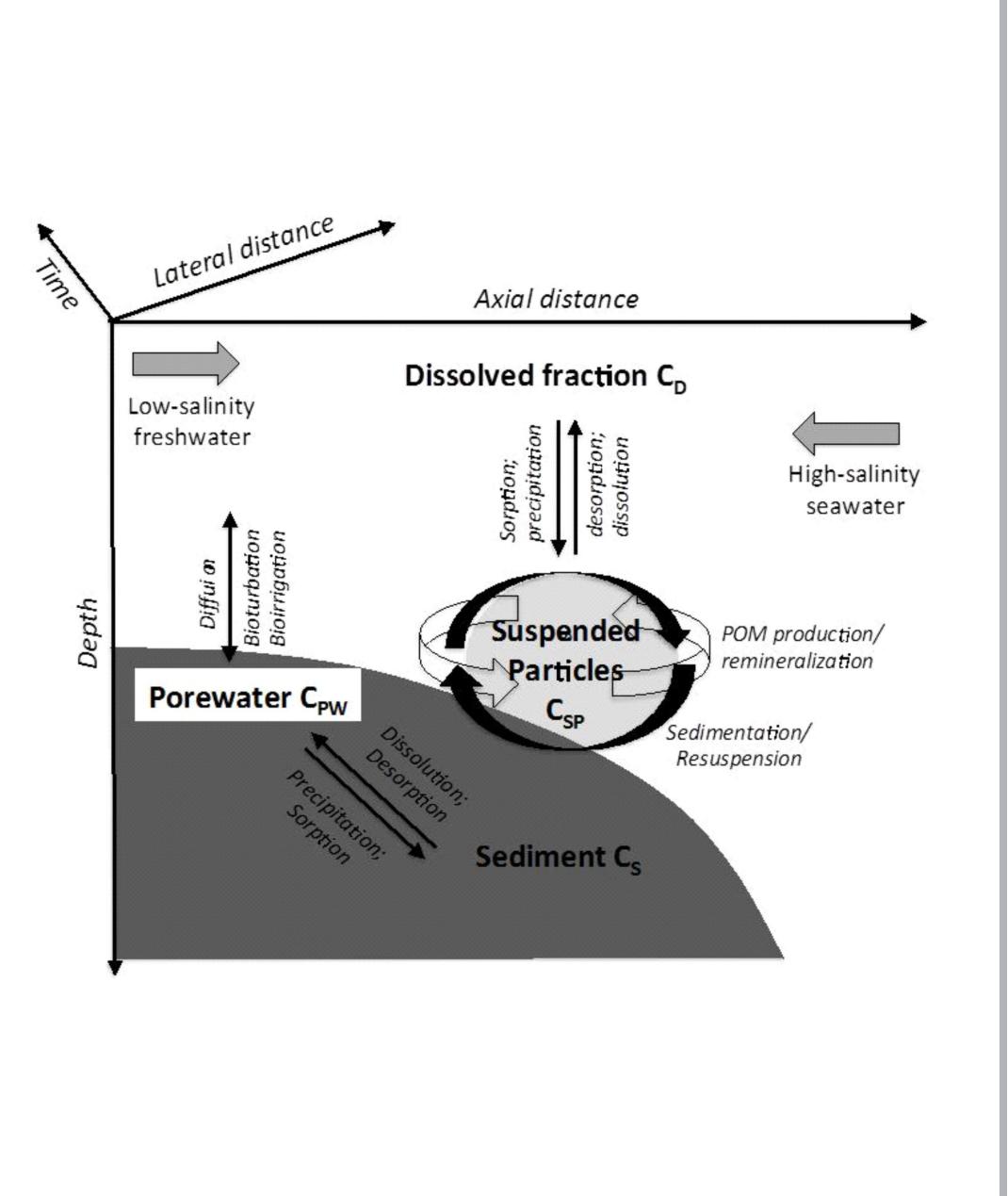
Clearly define the ecosystem services and their inter-relationships; develop conceptual models based on these services that include both geographic and temporal components (i.e., consider both space and time); formulate management questions as testable hypotheses; test these hypotheses to provide future management guidance; conduct appropriate ongoing monitoring and assessment; and, revise management actions with new cycles of learning.

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Chemical Transport and Partitioning Processes

Dissolved (C_{D}), suspended particles (C_{SD}) , bed sediments (C_{SD}) , sediment porewater (C_{DW}). Of critical importance: dynamics of suspended particles (sedimentation / resuspension, particulate organic matter (POM) production / remineralization), salinity gradients. "Sorption" and "desorption" include any processes that result in the association of the chemical to or removal from suspended particles, respectively. Not depicted are degradation of the chemicals and interactions with biota.



Biomarkers in Transitional Waters

(for screening and determining causation)

