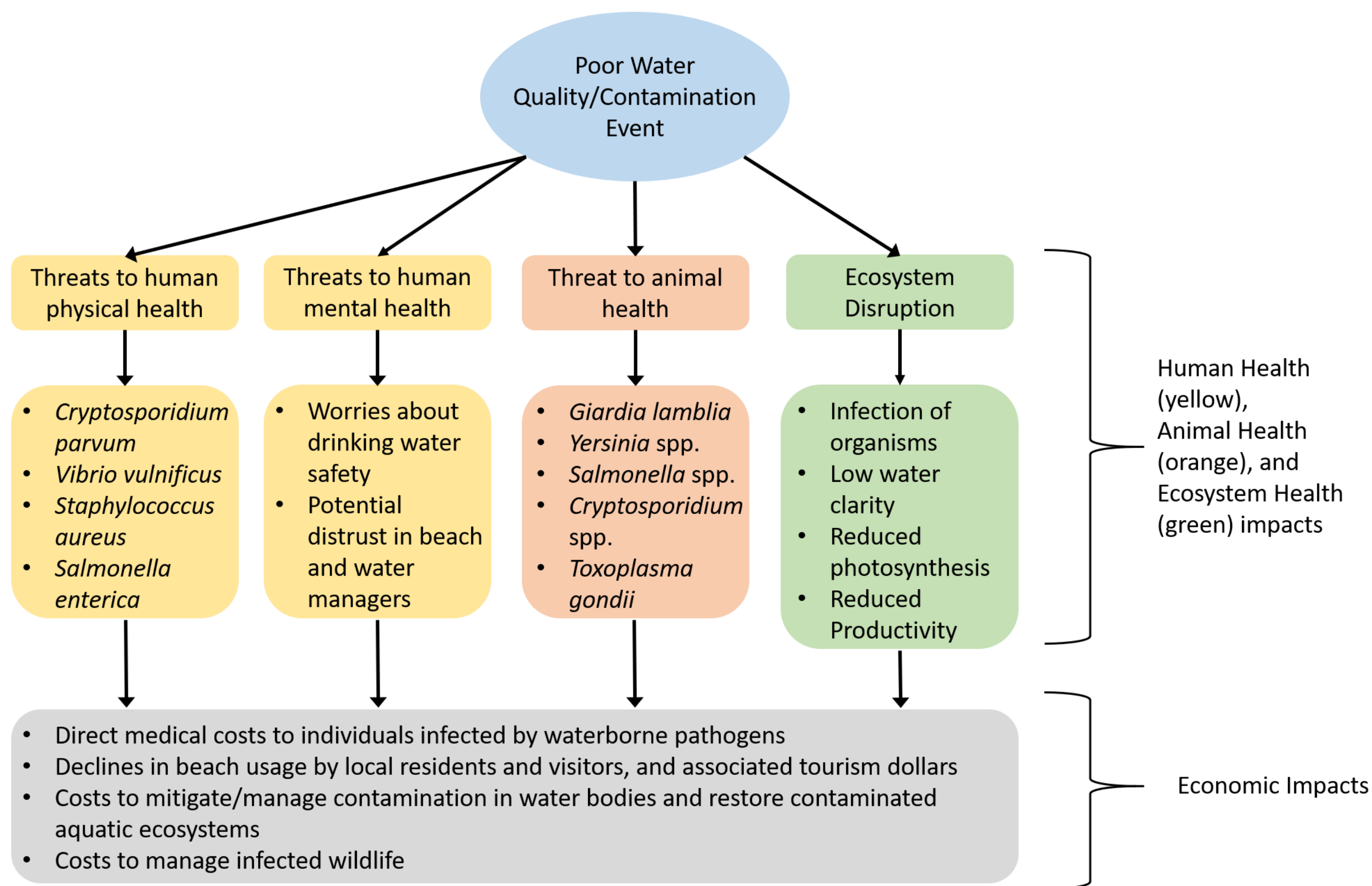


Incorporating Sand Dynamics into Beach Water Quality Science and Policy

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Introduction:

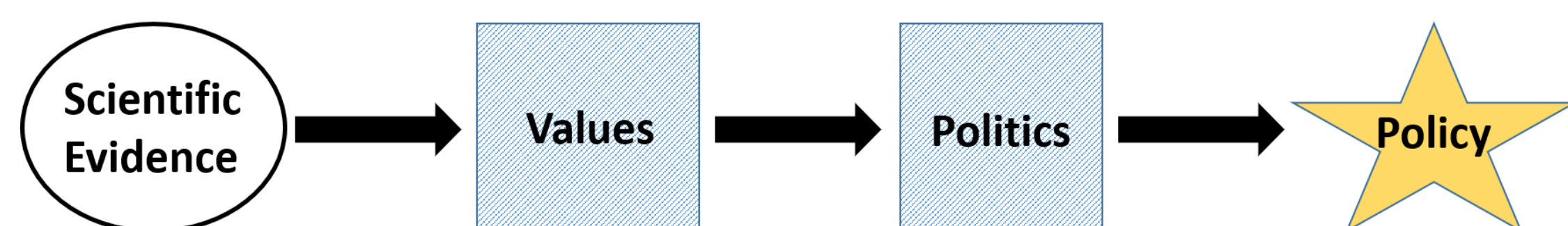
Beach health and recreational water quality is a textbook One Health concern:



Traditionally, recreational beach health has been almost exclusively associated with water quality¹. Recently, though, research has shifted focus to include the impacts of beach sand as a potential source of contamination^{2,3}.

Methods:

The first step toward changing existing recreational water quality policy is informing policy makers and beachgoers of the evidence.

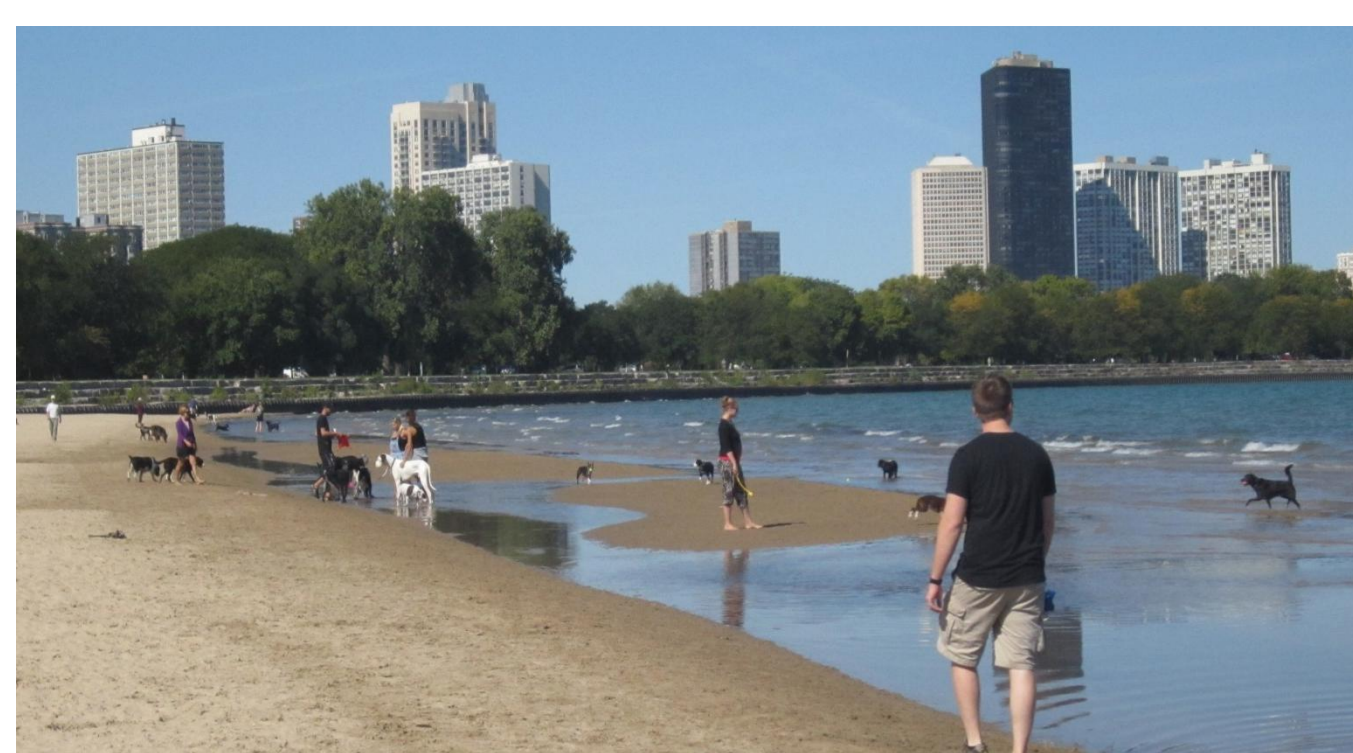


Here, we aim to present current knowledge and the state of international policy regarding the influences of the interface between beach sand and water on recreational water quality.

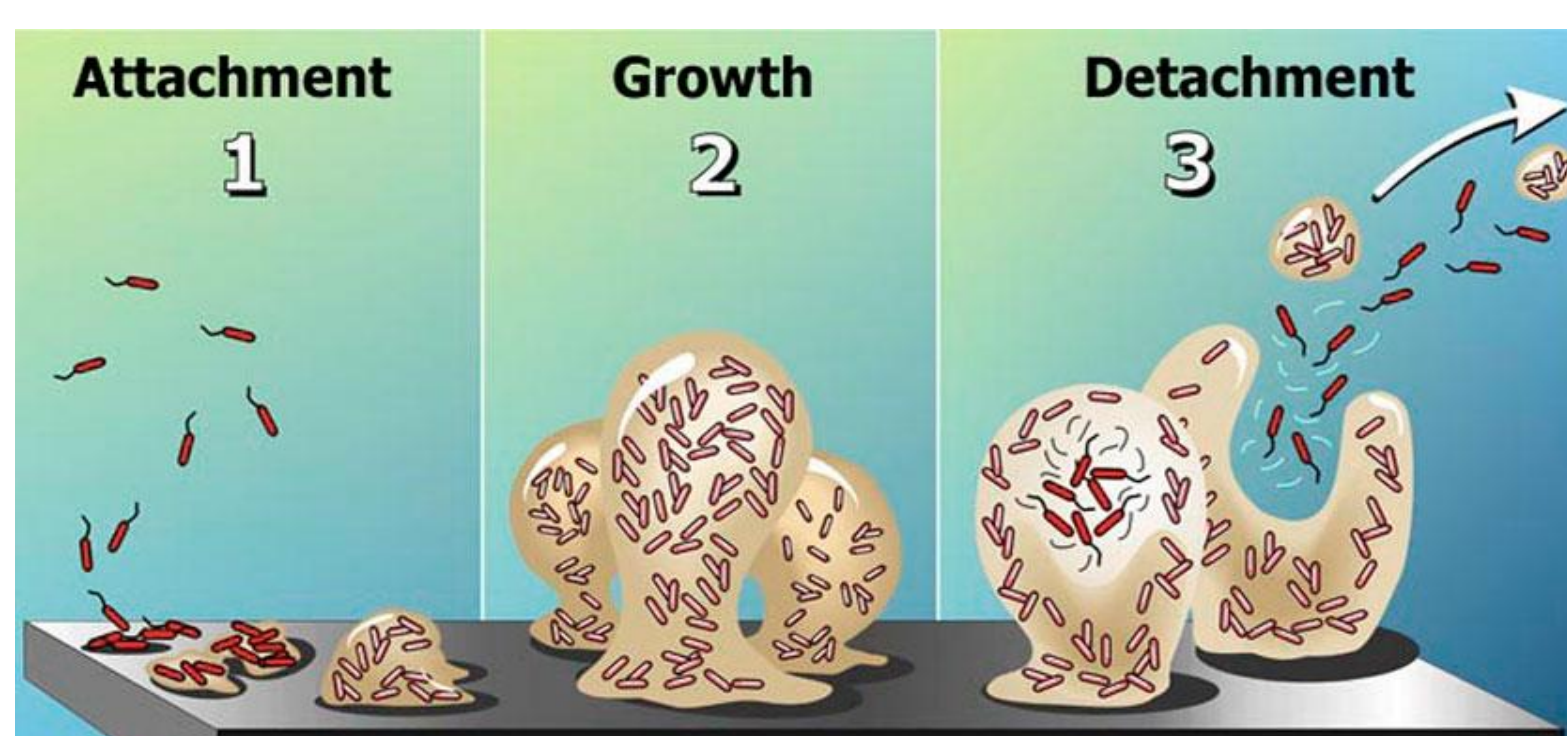
Results: Microbial Dynamics in Beach Sand

Microbial Pathways to the Beach:

1. Direct Inputs
 - a) Human skin shedding and restrooms
 - b) Wildlife, horse, dog, and gull feces
2. Stormwater and Tributary Inputs
3. Groundwater Inputs
 - a) Leaky sewage pipes or septic tanks



Reservoirs of Microbes at the Sand-Water Interface:



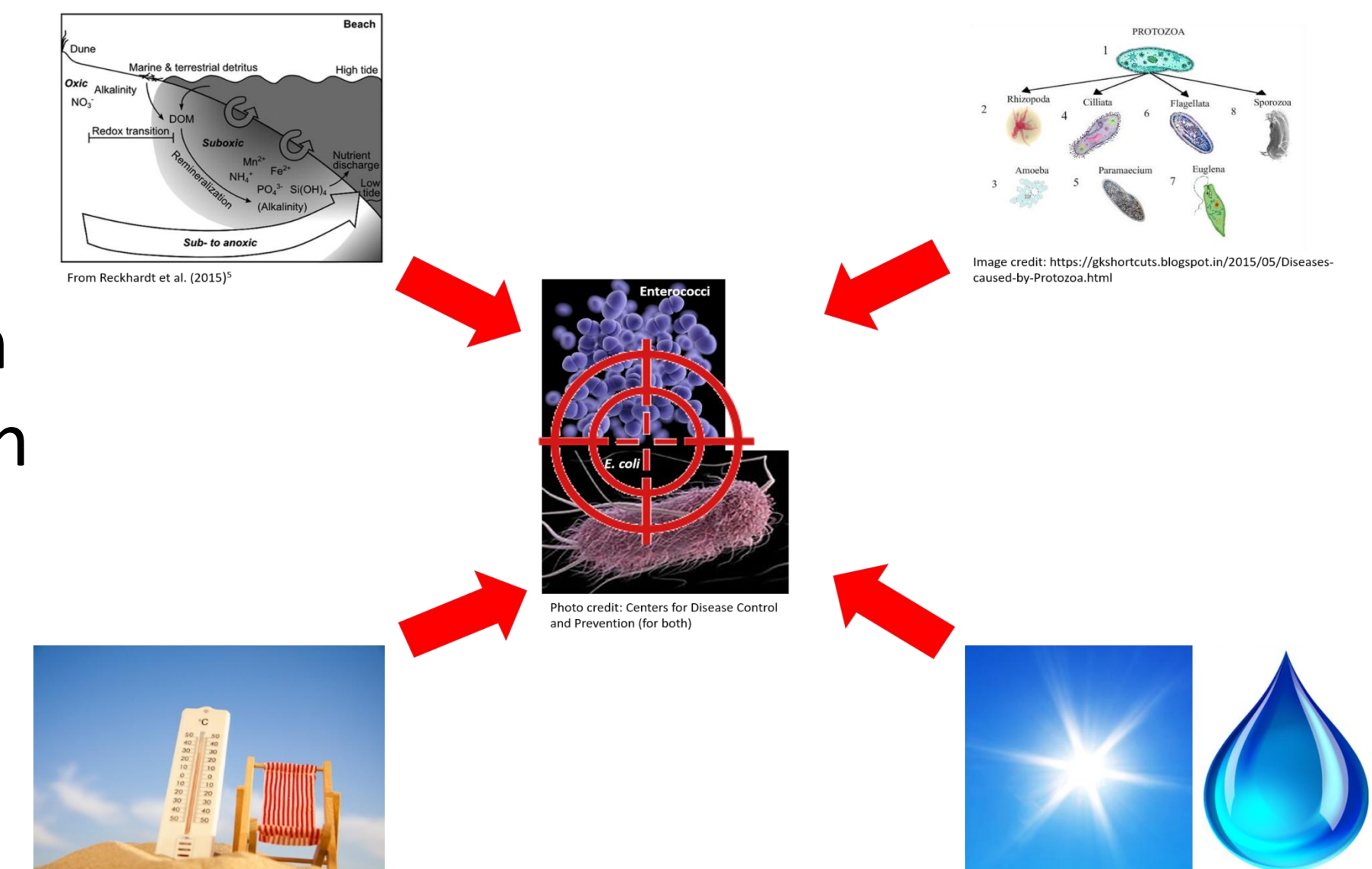
Many microbes can develop biofilms that can help concentrate nutrients and protect the microbial community⁴

Transport of Microbes at the Beach:

1. Through-beach transport
 - a) Vertical transport of microbes through the sand, from the surface to subsurface, after deposition at the surface
2. Over-beach transport
 - a) Erosion and accretion of sand associated with waves and tides, carrying microbial contaminants

Environmental Stressors on Beach Microbes:

1. Nutrient limitation
2. Moisture limitation
3. Solar radiation
4. Predators



Discussion: Current Recreational Water Policy

Countries like Canada, Argentina, and United States of America are beginning to recognize beach sand as a potential source of recreational water contamination. Currently, though, only Argentina mandates mitigation of sand contamination at beaches.



The World Health Organization is planning to integrate sand research into its upcoming 2020 review of their guidelines for safe recreational water environments as well, but progress on effective policies following sand results remains somewhat slow.

Conclusions:

1. Sand can be an important factor in recreational water contamination and beach health
2. Different beaches are subject to differing impacts on the sand and water microbial communities
3. Monitoring and modeling data can inform local recreational water quality policy, to mitigate contamination effects
4. Regulations that help prevent contamination events at beaches can have benefits across the One Health spectrum

References:

- ¹ Cabelli et al. (1982). Am. J. Epidemiol. 115(4)606-616.
- ² Whitman et al. (2003). J. Appl. Env. Micro. 69(9)5555-5562.
- ³ Solo-Gabriele et al. (2016). J. Marine Biol. Assoc. UK. 96(1)101-120.
- ⁴ University of Montana-Bozeman Center for Biofilm Engineering
- ⁵ Reckhardt et al. (2015). Estuar. Coast. Shelf S. 159(2015)1-14.