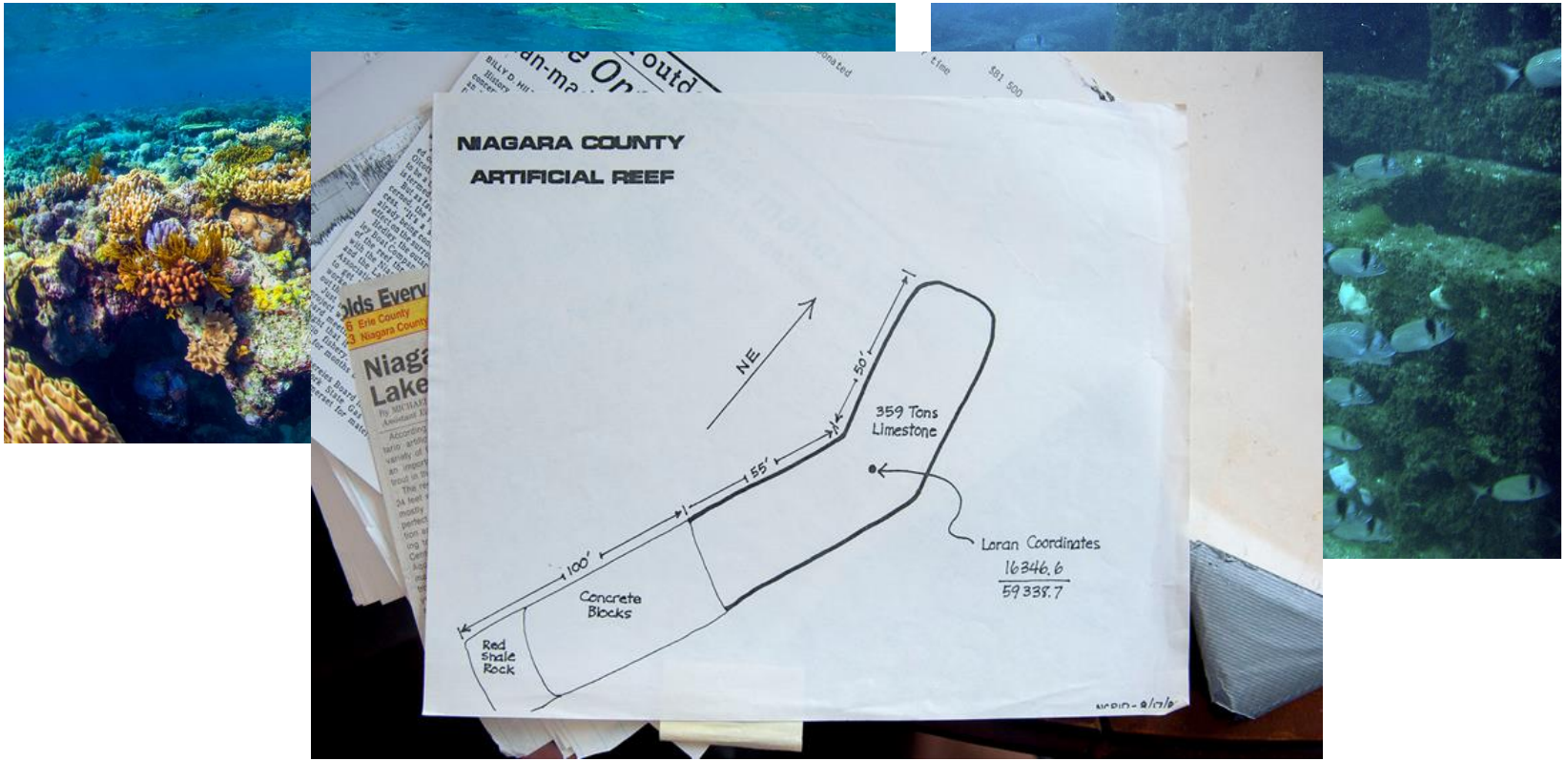
Artificial reefs as metapopulations?
Or, “What is the best way to configure artificial reef modules to attract the most abundant and diverse fish (and macroinvertebrate!) assemblages?”

How do matrix, area, distance effects apply?

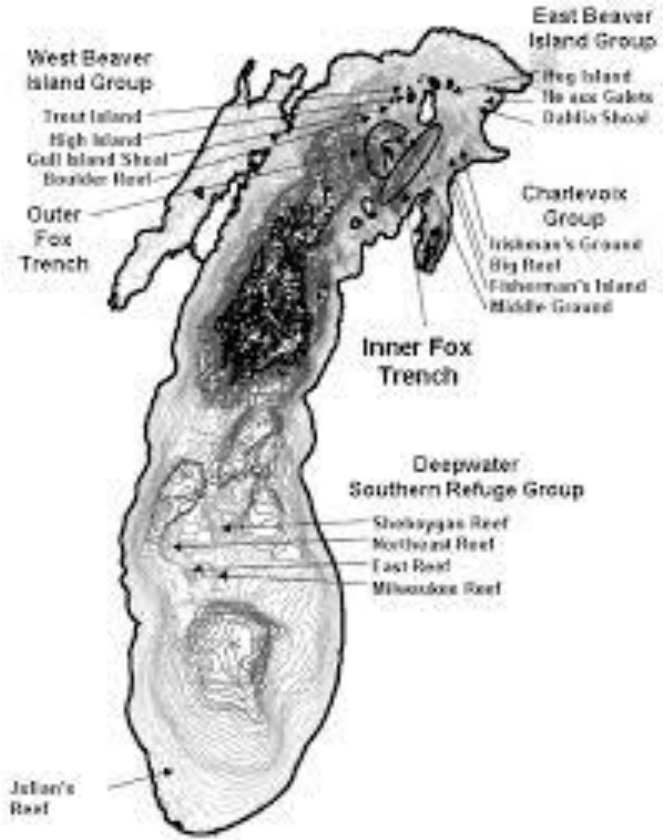
Kate Bailey

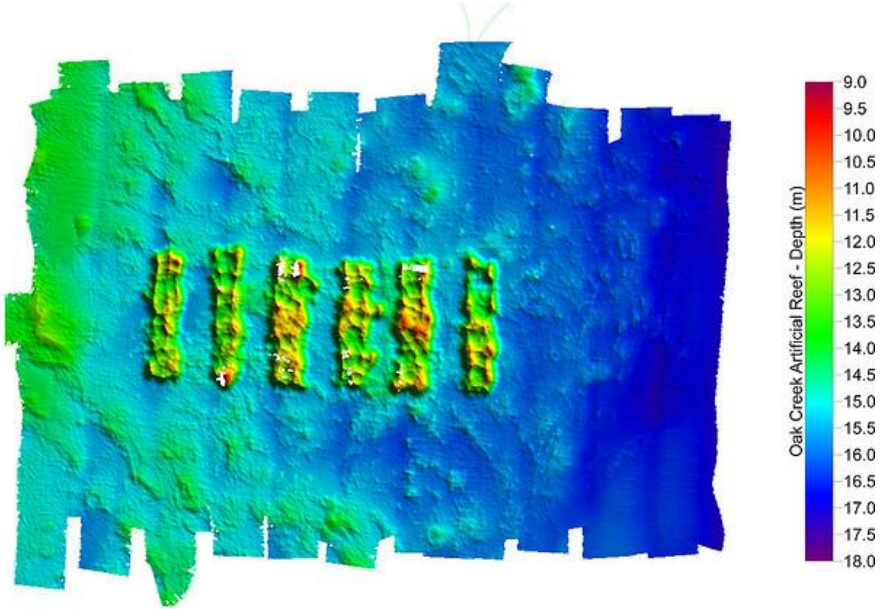
11/23/2015

When we think about reefs...



At least 38 ARs in Laurentian Great Lakes





Oak Creek Power Plant Artificial Reef, Lake Michigan, bathymetry map

Artificial reefs as “islands” versus terrestrial islands

Artificial Reef

- intentional or unintentional placement of natural or manmade structures in specific locations (habitat created)
- common stressors: invasive species, waves, currents, ice-scouring (Olcott Reef)
- matrix effect

Terrestrial habitat islands

- deliberate removal of vegetation/habitat (habitat lost)
- common stressors: wind, fire, invasive species, edge effect
- matrix effect

Factors to consider

materials used

amount of materials used

height, length, width

interstitial spaces

proximity to shore

depth

surrounding substrate type

goal (s) ?

Case study: Jordan et al. 2005

Fig. 1. An artificial reef module used in the present study.

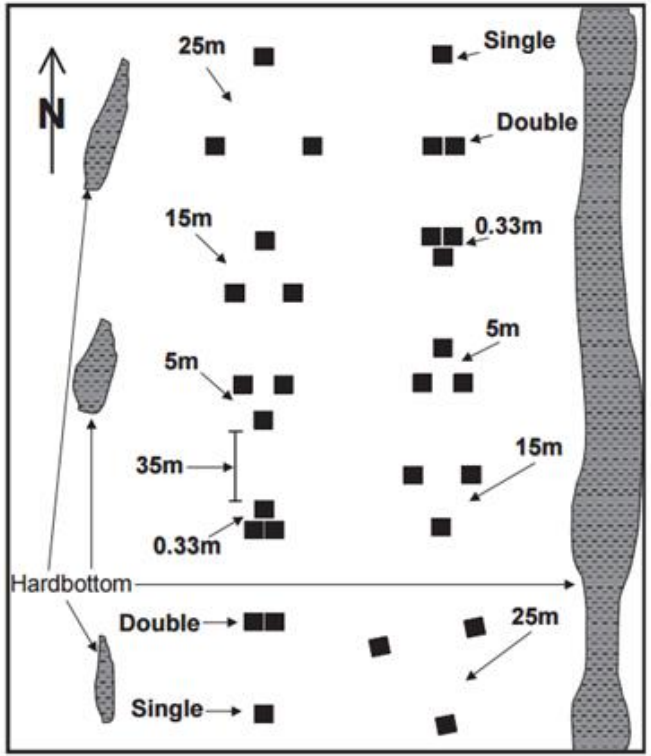


Fig. 3. Drawing of module configurations in the study site. Not to scale.

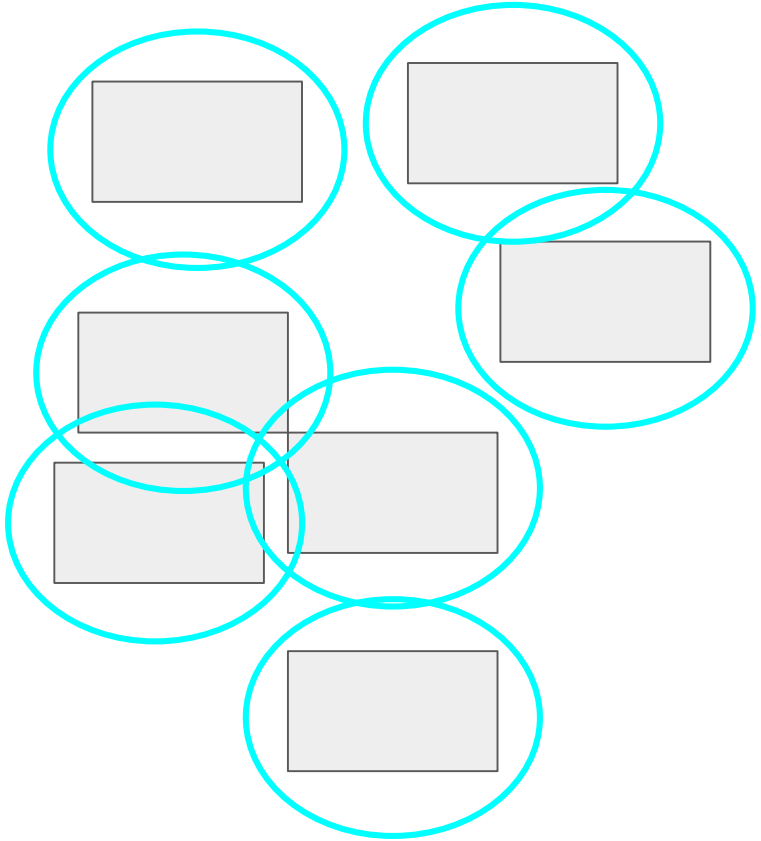
Jordan et al. (2005) investigated...

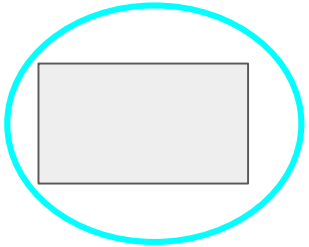
1. the effect of reef patch size
2. and the effect of different reef spacing between patches

Optimal foraging theory:

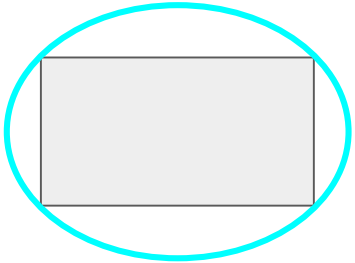
Decreased foraging time will increase net energetic gain and reduce the risk of predation====>consumption of prey items by fish predators close to a reef will occur more rapidly than further from the reef.

Optimal foraging theory





What about substrate???



Major findings Jordan et al. (2005)

isolation distance among reef modules can alter fish assemblages, BUT with specific responses from different species, trophic groups, and size classes

reef size effects: increase in amount of reef material increased fish abundance and species richness BUT not as identical multiplier

greater density of fish can exist on smaller reefs than larger reefs

several smaller reefs will have more fish than a larger one of equal volume

Application of TARGET EFFECT: fish larvae disperse and must settle on hard substrate

Reef modules

spacing = important component of understanding variations in assemblage structure in patchy environs

overall size; smaller reef may have higher fish density and more diverse assemblage per volume

reefs with patchy complexity could have higher fish richness and abundance than a much larger reef lacking patchiness

Zalmon et al. (2014): Infaunal communities

-what about sediments and hydrodynamics after reef module installation?

-grain-size decreased with increasing distance from reefs

-infauna responded strongly to variations in sediment grain-size; polychaete predators closer to reef in muddy sediments

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Putting it all together

- area and distance
- matrix = very important
  - grain-size distribution
- fish predation
- SLOSS debate applies underwater!
- different types of disturbance
  - hydrodynamics