Working toward a Strategic Environmental Management Plan in the Atlantic

SEMPIA

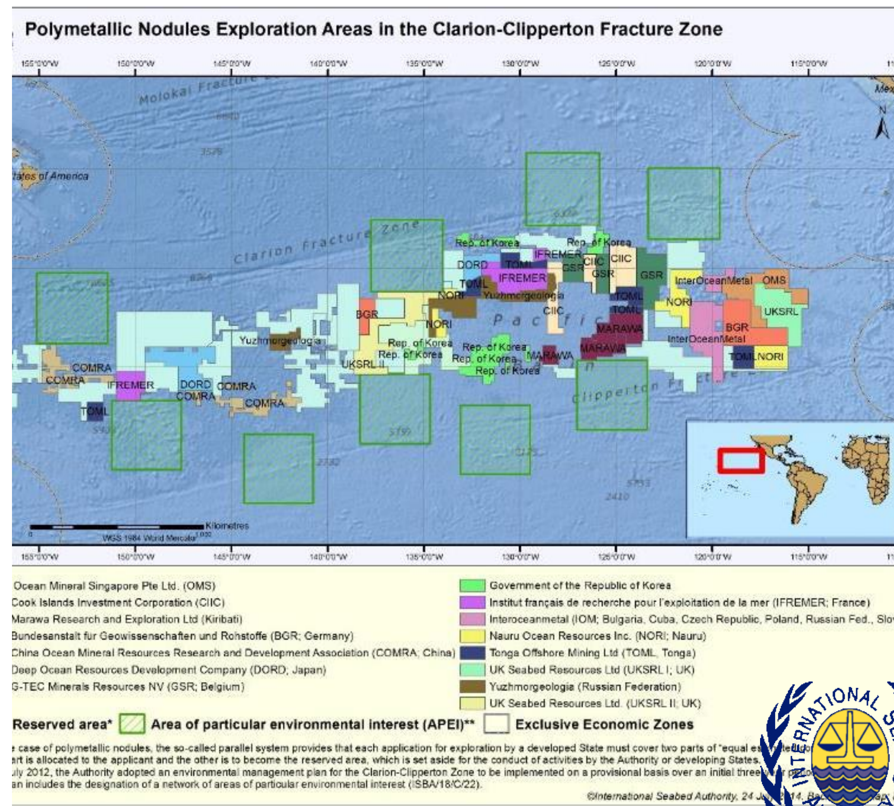
Dunn, D.C., C.L. Van Dover, R.J. Etter, C.R. Smith, L.A. Levin, T. Morato, A. Colaço, A.C. Dale, A.V. Gebruk, K.M. Gjerde, P.N. Halpin, K.L. Howell, D. Johnson, J.A.A. Perez, M.C. Ribeiro, H. Stuckas, P. Weaver and the SEMPIA Workshop Participants

Environmental Management Plan
(Jones & Weaver, *in review*)

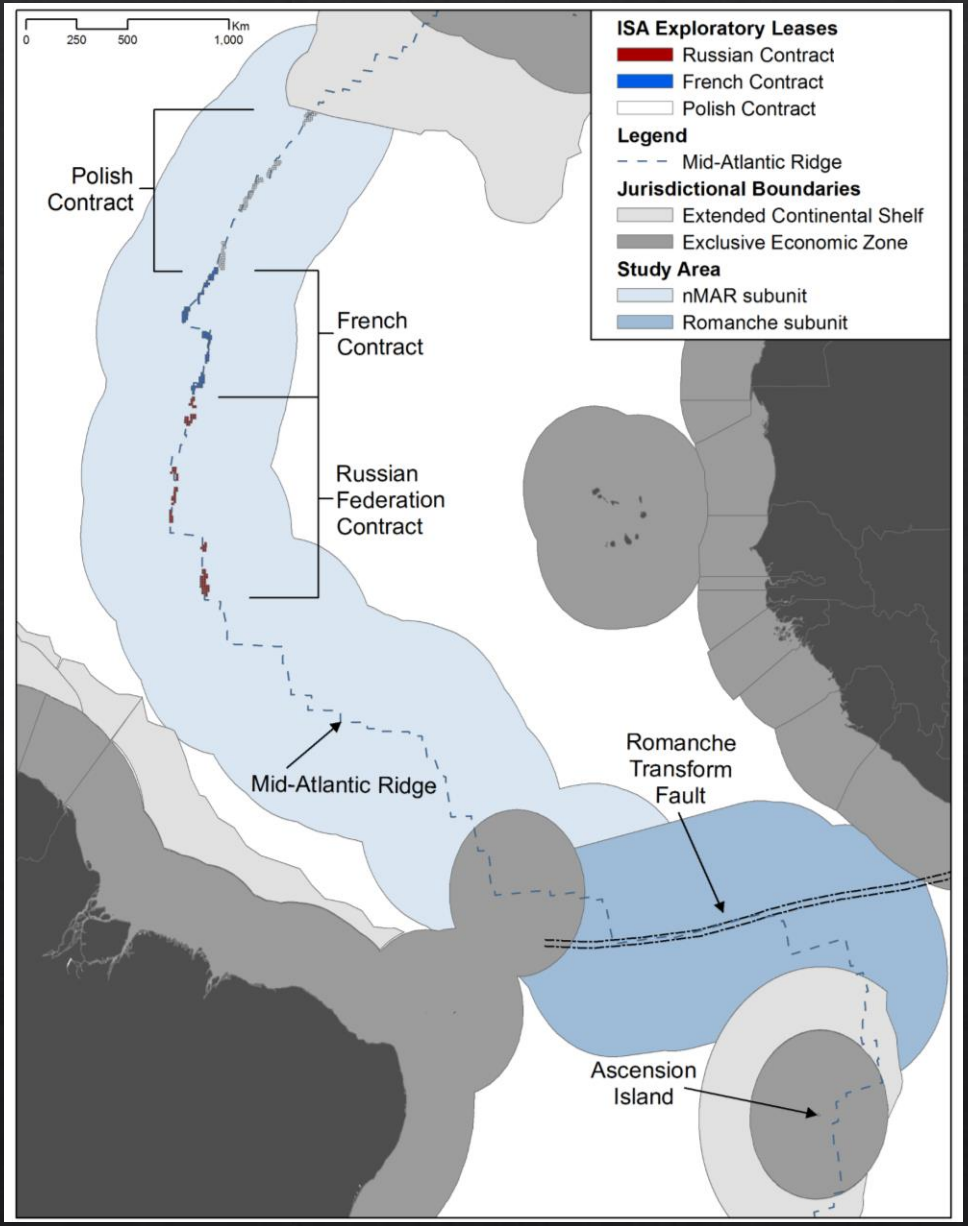
- set clear objectives for the environmental management of the region, guided by the SEMP;
- produce a plan for conservation measures across the area of the REMP based on sound science and best practice. This should include spatial management approaches including, but not limited to, **APEIs**, PRZ, VMEs, and consideration of other significant and sensitive habitats;
- produce a plan to assess and address cumulative impacts from mining and other activities in the region (for example fishing, climate change, ocean acidification, hypoxia, and any new and emerging activities);
- accommodate exploitation as far as possible, bearing in mind the constraints listed here;
- describe the requirements to monitor the effectiveness of the plan (including at sea) and to review it if necessary;
- specify any standard environmental management requirements, such as monitoring or mitigation measures, for contractors operating in the region;
- specify region-specific baseline information that must be collected by all contractors for effective environmental management;
- define areas with key knowledge gaps and uncertainties to direct additional research effort, by contractors or outside parties;

Existing Frameworks

The Environmental Management Plan for the Clarion-Clipperton Fracture Zone



Study Region: The northern Mid-Atlantic Ridge



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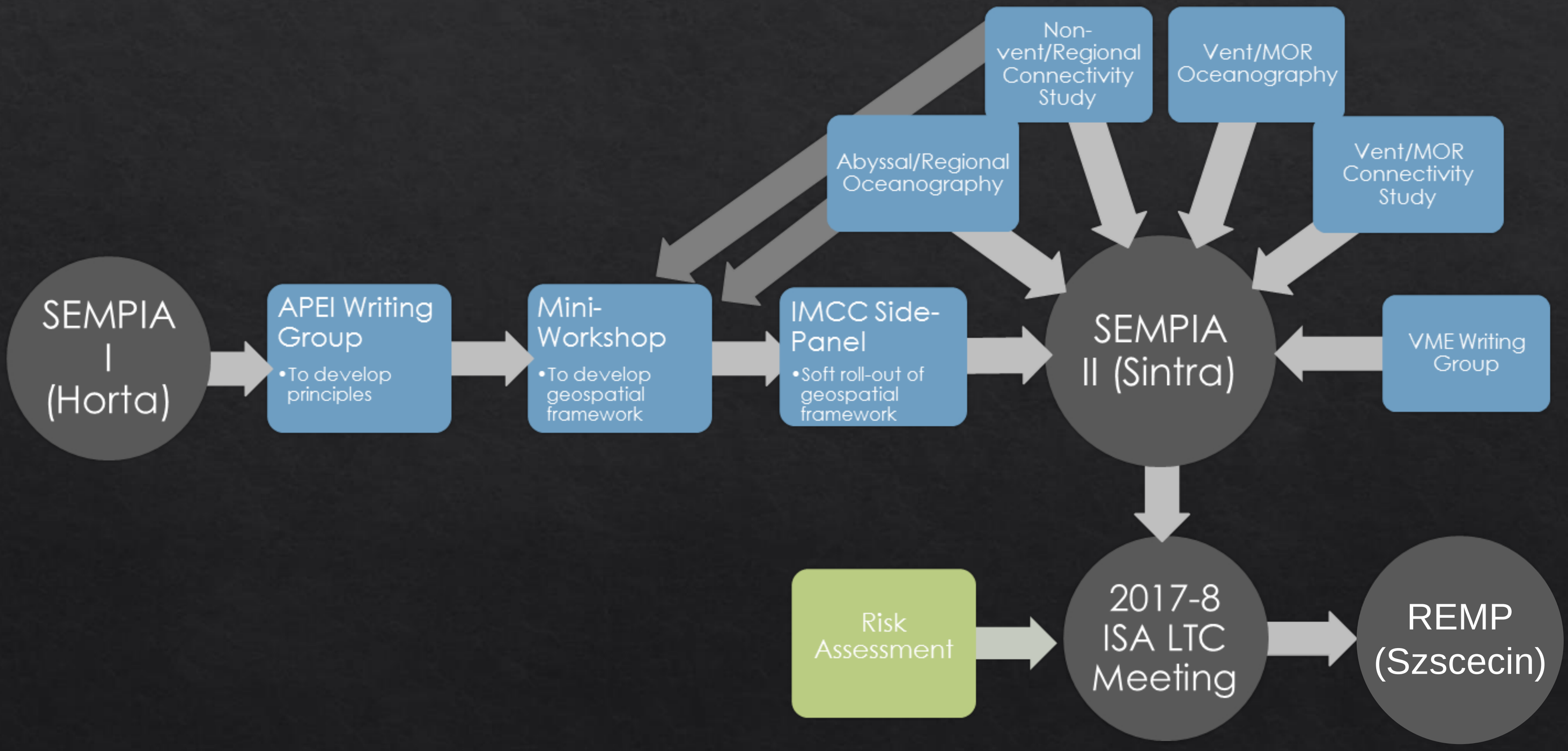
SEMPIA Roadmap



Conservation Goal

Building on the conservation goal reported in Wedding et al. (2013) for the CCZ, the conservation goal for the design of an APEI network on the Mid-Atlantic Ridge is to contribute to "*the protection of the natural diversity, ecosystem structure, function, connectivity, and resilience of deep-sea communities in the context of seabed mining in the region.*"

Framework

Representative approach based on drivers/proxies of deep sea biodiversity

- Bathymetry (Depth)
- Seamount Distribution
- Biogeographic Region
- Latitude
- POC Flux
- Seabed Slope
- Transform Faults
- Hydrothermal Vents
- Water mass properties

Conservation Objectives

Network criteria based on CBD Decision IX/20 Annex II:

Scientific guidance for selecting areas to establish a representative network of marine protected areas, including in open ocean waters and deep-sea habitats

1) Important Areas
2) Representativity
3) Connectivity
4) Replication
5) Adequacy & Viability

Convention on Biological Diversity

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Box 1. Network criteria and conservation objectives for APEIs on a mid-ocean ridge.

1. Important Areas
   a) Placement of APEIs within the network should capture areas considered to be ecologically and/or evolutionarily important based on best available science. APEI core areas should conserve 100% of identified Important Areas.
2. Representativity
   a) APEI core areas should conserve 30% - 50% of each habitat type (e.g., the spreading ridge, seamounts, active and inactive hydrothermal vents, transform faults) within each management unit.
   b) APEIs should be representative of the regional biophysical seascape (i.e., depth, slope, POC flux to the seafloor).
3. Connectivity
   a) The APEI network should minimize the average and maximum distance between core areas to the greatest extent possible to conserve all dispersal scales and to ensure exchange across the entire network.
4. Replication
   a) APEIs should be replicated within biogeographic provinces (where the area represented by a management unit permits) to capture along-axis variation in faunal composition and protect against localized catastrophes
5. Adequacy/Viability
   a) The APEI network should protect 30 to 50% of the total management unit.
   b) Each APEI unit within the network must include a core area of sufficient length and width to maintain viable populations and ecosystem function.
   c) Each APEI unit within the network should include an appropriately sized buffer zone to protect core areas from indirect mining effects.

   d) Viability under climate change
      i) Projected biophysical conditions (i.e., T, pH, O_2, POC flux to the seafloor) in APEIs should be within the range of current conditions across the study area.
      ii) APEIs should include at least 30% of the area projected to be least impacted by reasonable climate change scenarios (based on predicted changes in T, pH, O_2, POC flux to the seafloor).

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Why 30-50%?

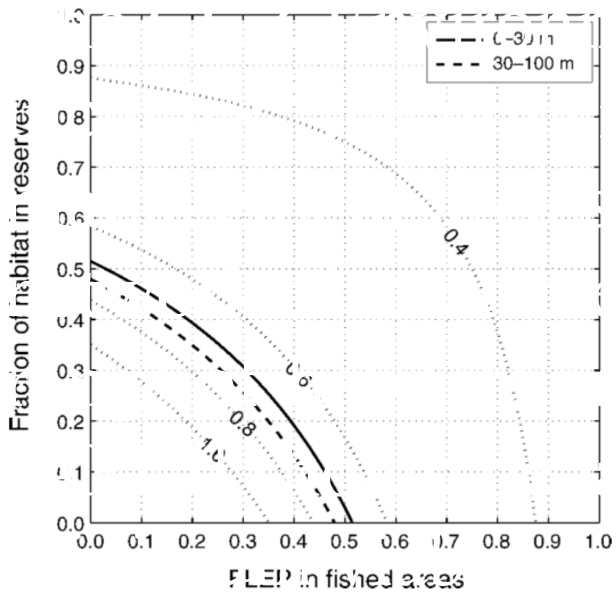


FIG. 9. Fraction of habitat in reserves above which persistence is guaranteed for larval pool dispersal on an infinite coastline as a function of fraction of lifetime egg production (FLEP) in fished habitat areas for several different fractions of the total area that is habitat. The fraction of total area in habitat is indicated on the dotted curves for several reference fractions, while the solid and dashed curves are the results for the fractions in habitat shown in Table 1 (without buffers) for 0–30 m depth and 30–100 m depth hard-bottom habitat, respectively.

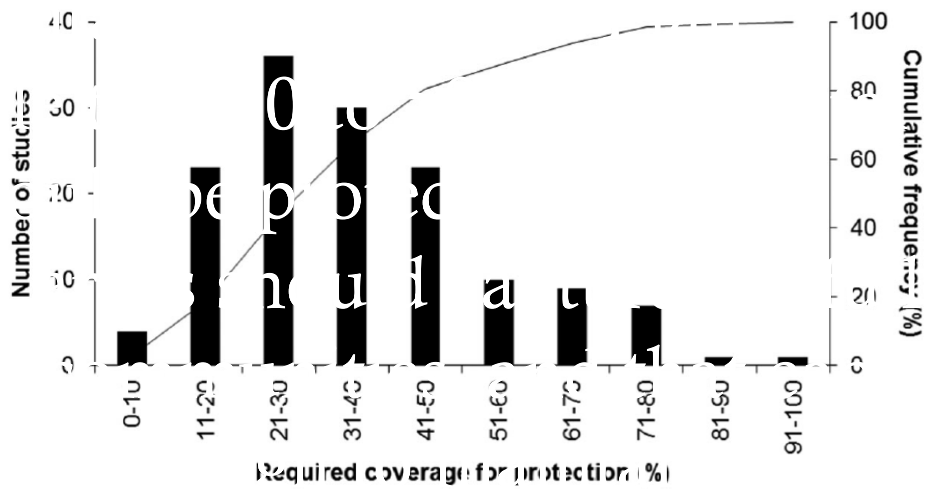


Figure 2 Frequency distribution of the required coverage for protection to meet MPA objectives based on 144 studies. Cumulative frequency (solid line) showing the percentage of studies that consider MPA goals will be met at each coverage level.

Kaplan et al., 2009

O'Leary et al. 2016

Framework

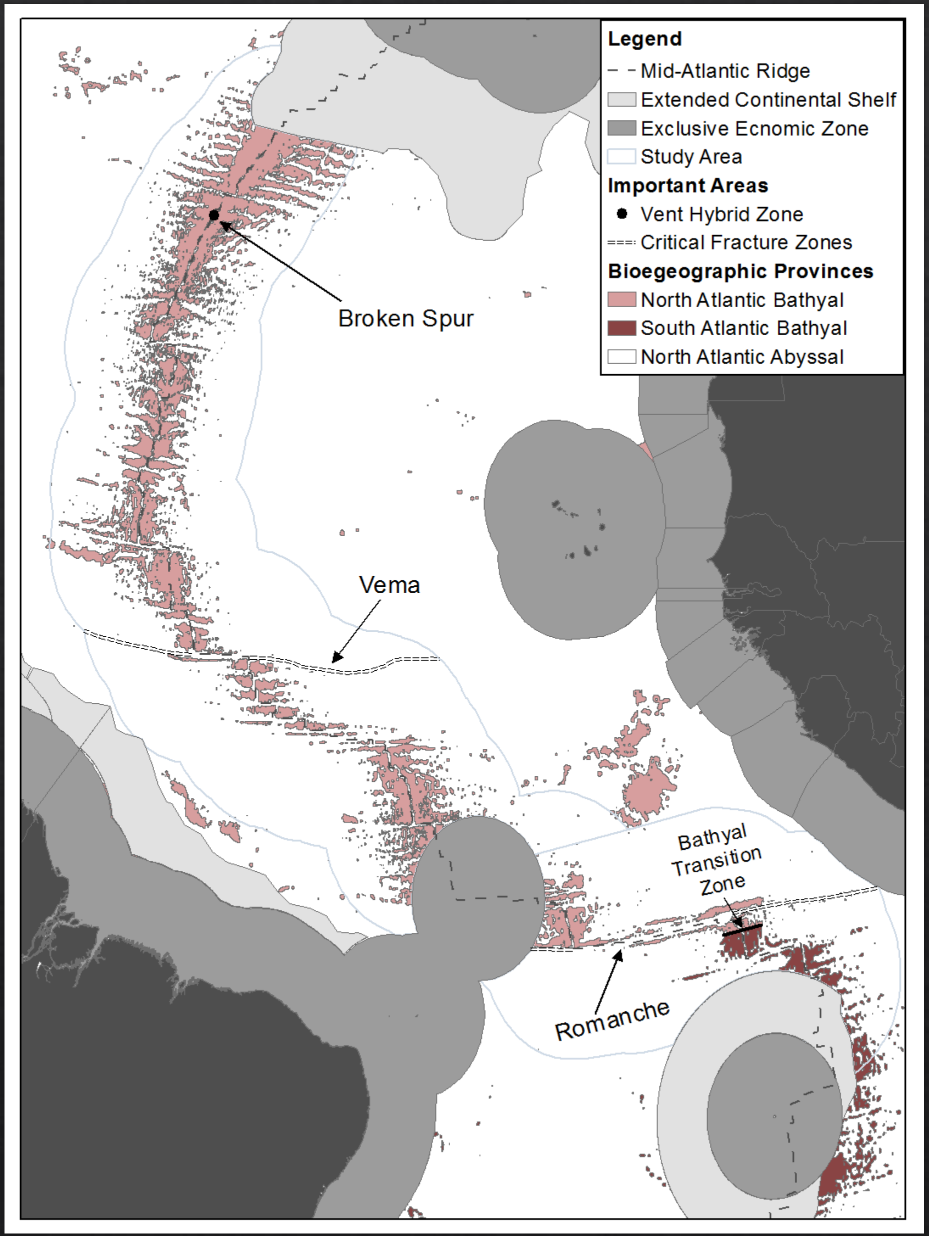
Based on CBD Decision IX/20 Annex III:

Four initial steps to be considered in the development of representative networks of marine protected areas

1) selection of a biogeographical approach;
2) identification of known ecologically or biologically significant areas;
3) iterative site selection; and
4) consideration of ecological coherence (e.g., ecological connectivity and viability)

Convention on Biological Diversity

Biogeographic Context & Important Areas



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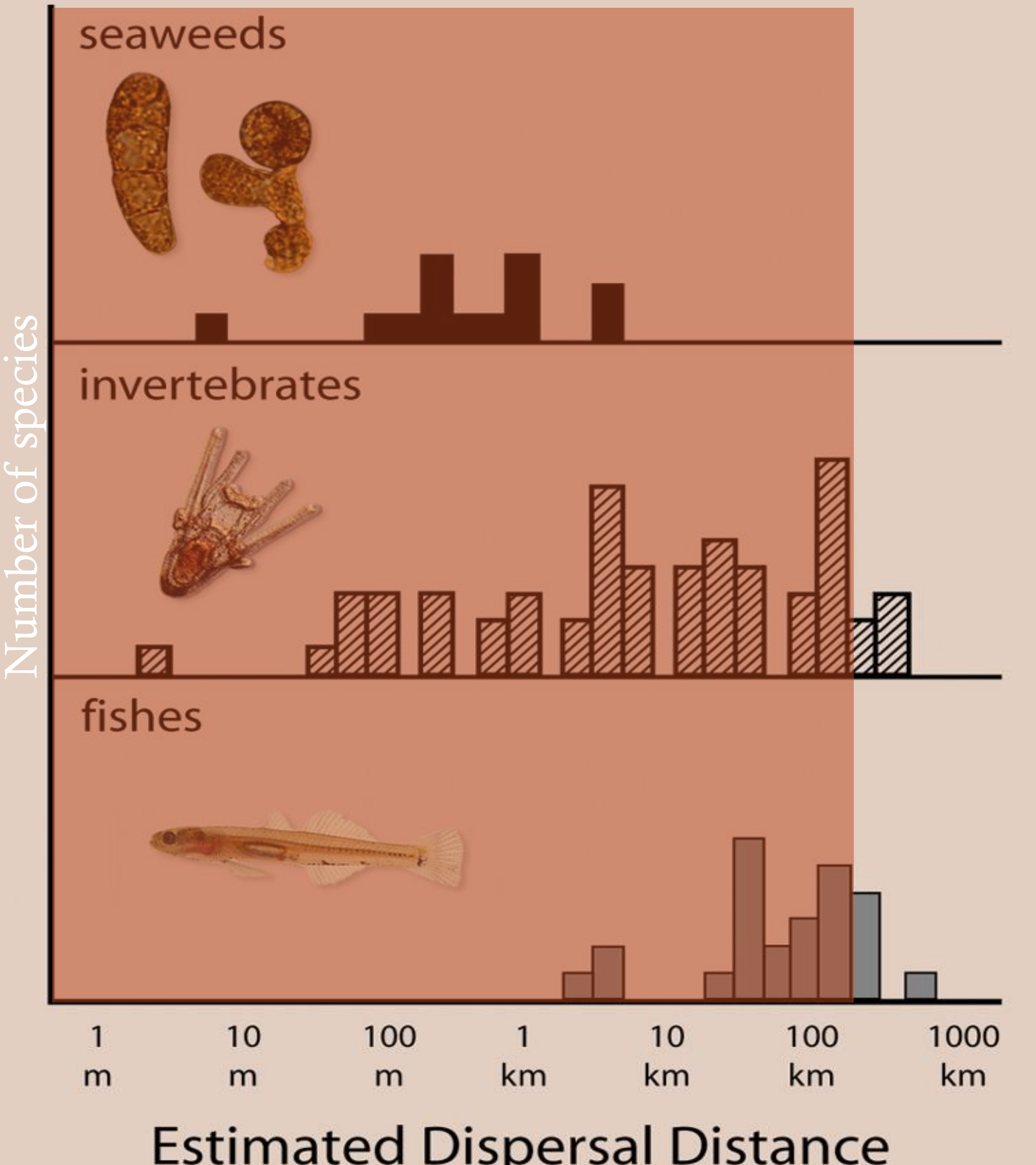
Iterative site selection: orientation, size & spacing

- Core length along the ridge axis
  - Each core of an APEI should be large enough to maintain a minimum viable population size for a large percentage of deep-sea invertebrates through self-replenishment (2 * 75% median dispersal distance = 200km)
- Core width across the ridge axis
  - Capture representative habitats across depths
  - Capture cross-axial hydrographic flows and flows toward the ridge crest
  - Accommodate future exploitation of buried minerals on ridge flanks
- Buffer zones
  - details of SMS mining plume structure and dispersion are not well constrained at present
  - we assume that plume dispersal may be on the order of tens of kilometers
- Spacing
  - minimize the difference between length of the core protected area versus distance between core areas



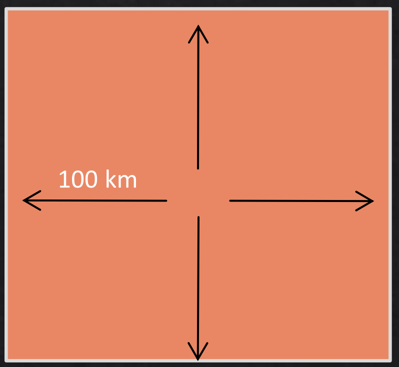
Kinlan and Gaines, 2001

For sustainable populations, APEI size should be 2X mean dispersal distance of larvae

In 2007, most known marine benthos had mean larval dispersal distances < ~100 km

Recommended size of APEI core region –

200 x 200 km



Slide c/o Craig Smith

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Dataset	Taxon Group	N	Geometric Mean (Lower95%CI, Upper95%CI)	Median (25%ile, 75%ile)	90th %ile	Max
SigMantel Dataset	All taxa	56	33.2 (19.4, 57)	33.9 (8.8, 133)	377	2028
	Fishes	*17*	*134.8 (59.6, 305)*	*131.8 (31.1, 462)*	*1512*	*2028*
	CE Inverts	*18*	*34.6 (19.0, 63)*	*25.9 (11.5, 103)*	*225*	*352*
	NCE Inverts	*21*	*10.3 (3.8, 28)*	*8.5 (1.6, 74)*	*249*	*367*

Baco et al. 2016

Reassessed in 2016 by Baco et al.

75% Percentile median dispersal distance for invertebrates associated with chemosynthetic systems

Recommended length of APEI core region – 200km

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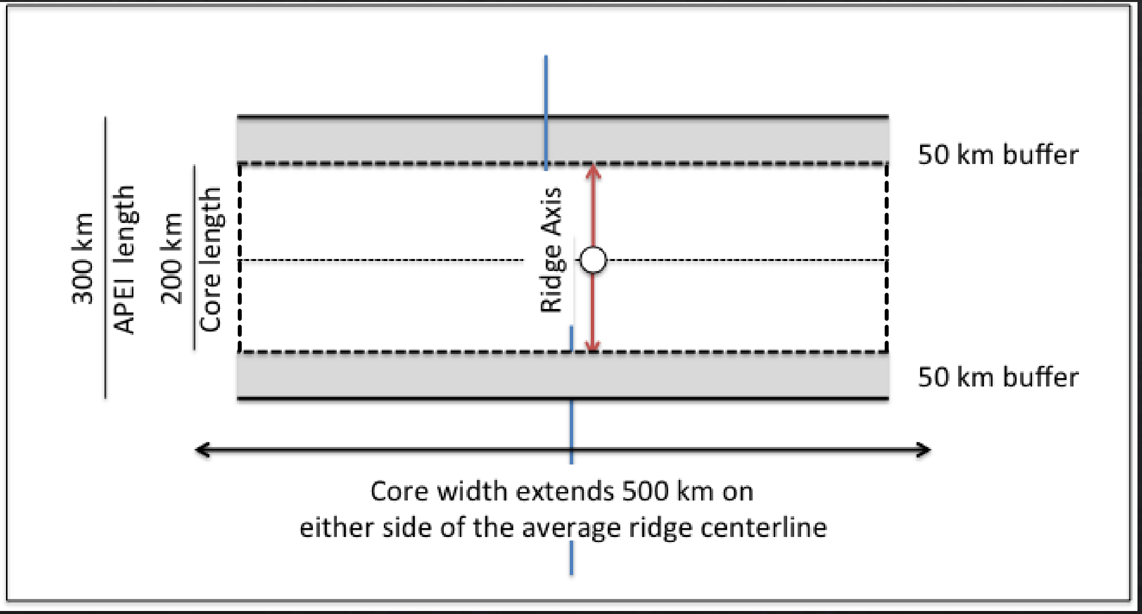
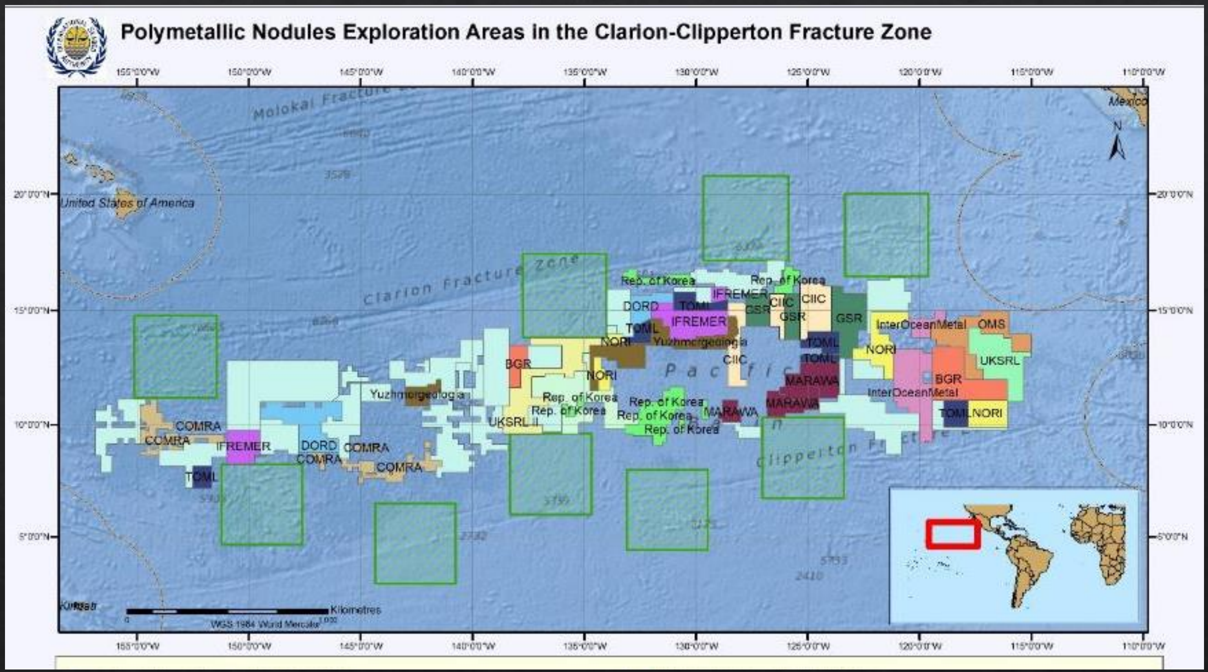


Efficiency

- Because of the need for buffers around APEIs, larger APEIs will more efficiently meet any area target than smaller APEIs.



- Imagine how many APEIs would be needed in the CCZ if the core area was 50km x 50km instead of 200km x 200km?
- You would need 16x as many APEIs and 4x MORE SPACE IN BUFFERs (720000km^2 vs 180000km^2)

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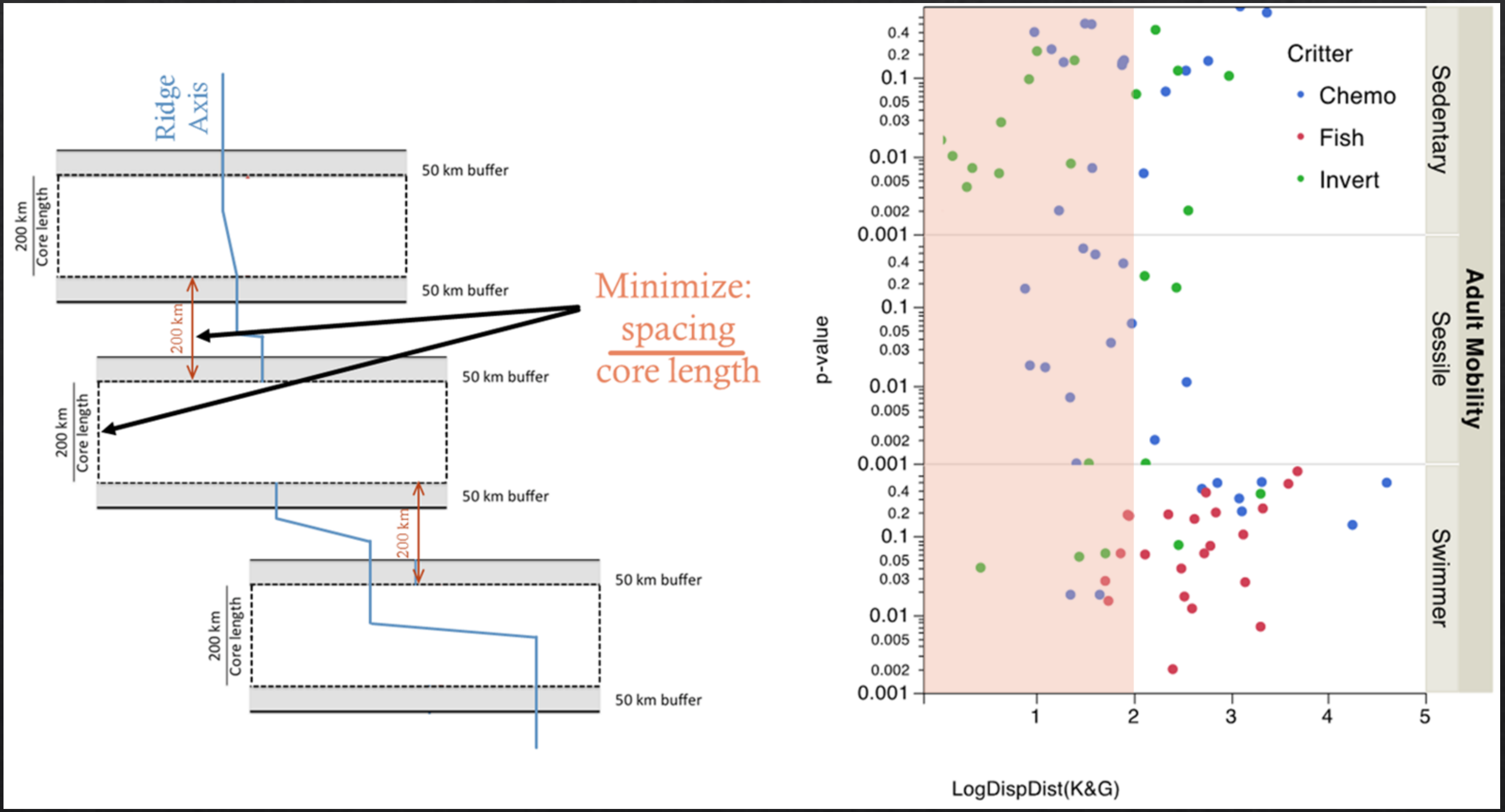
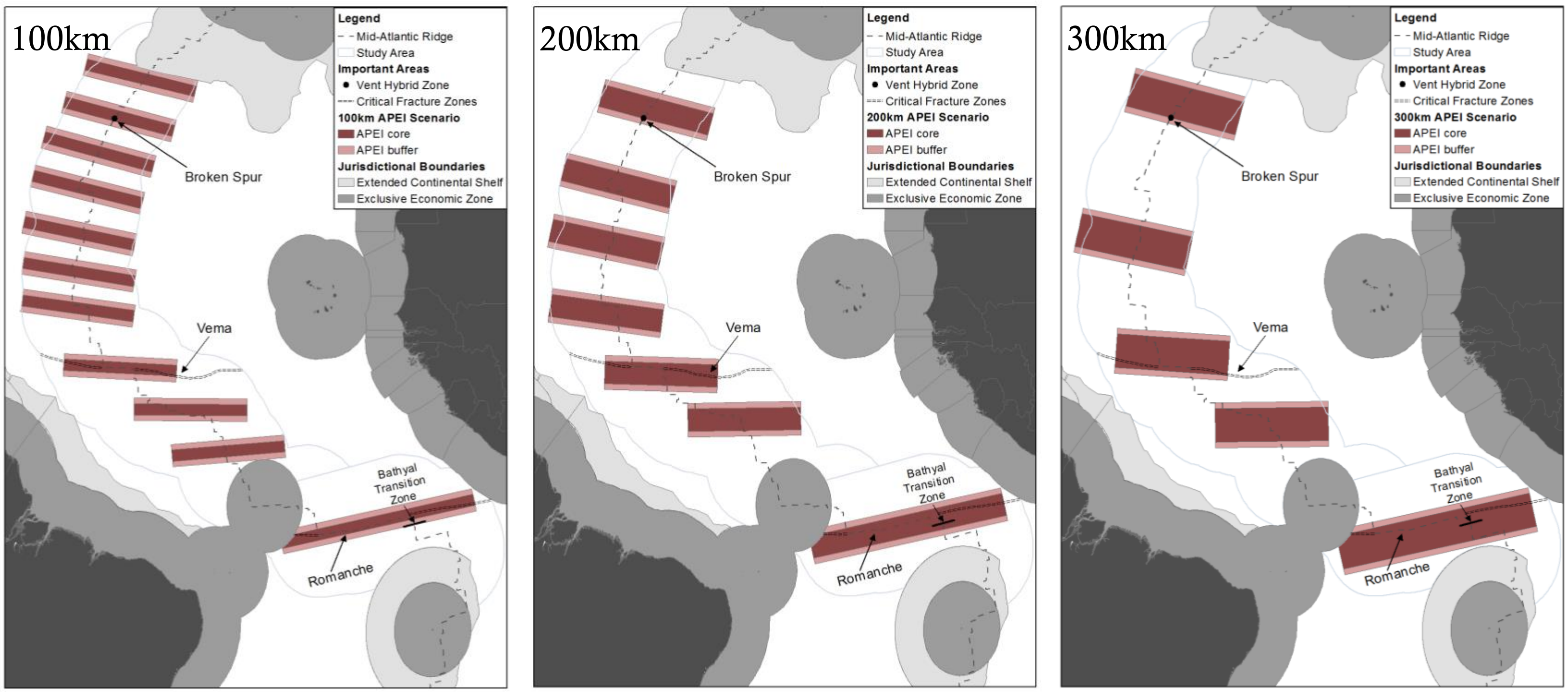


Baco et al. 2016

Scenarios



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Ecological Coherence

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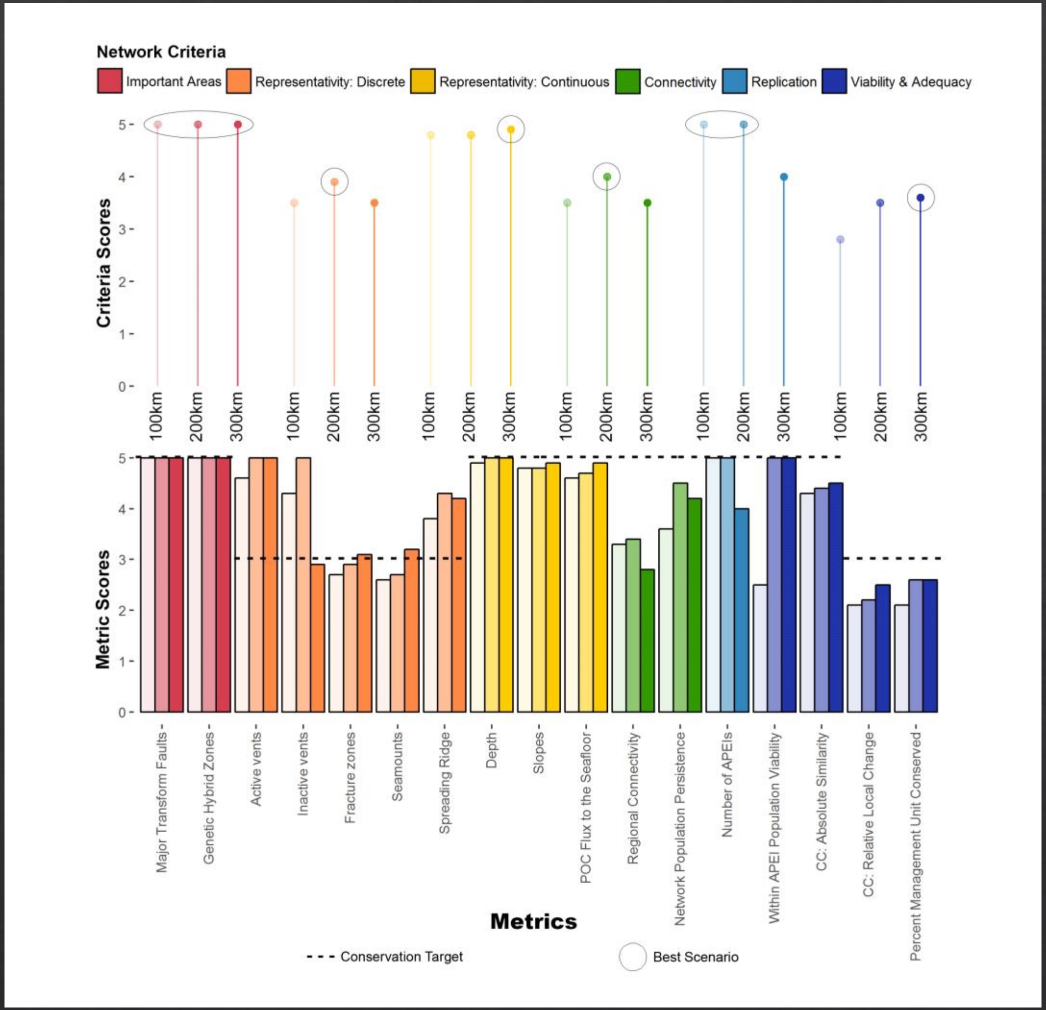
1) Important Areas
   1) Genetic Hybrid Zones
   2) Major Transform Faults
2) Representativity: Discrete
   1) Spreading Ridge
   2) Active vents
   3) Inactive vents
   4) Fracture zones
   5) Seamounts
3) Representativity: Continuous
   1) Slopes
   2) Depth
   3) POC Flux to the Seafloor
4) Connectivity
   1) Regional Connectivity
   2) Network Population Persistence
5) Replication
   1) Number of APEIs
6) Viability & Adequacy
   1) Percent Management Unit Conserved
   2) Within APEI Population Viability
   3) CC: Absolute Similarity
   4) CC: Relative Local Change

Performance Evaluation Framework

5 Criteria, 17 Metrics:

- Important Areas
- Representativity
  - Discrete
  - Continuous
- Connectivity
- Replication
- Viability & Adequacy
  - Incl Climate Change

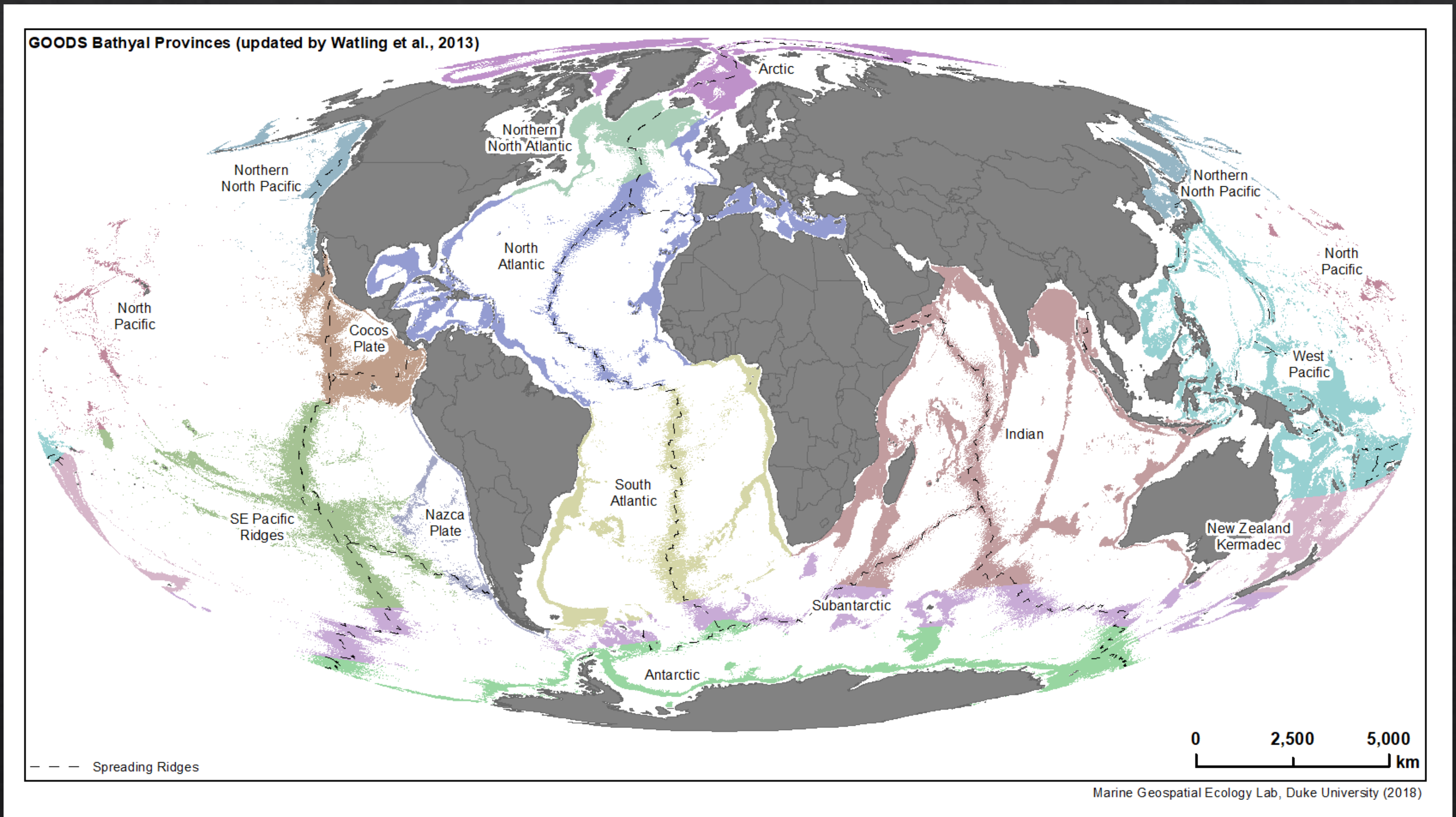


Dunn, Van Dover et al., (2018) Science Advances

Take Home Messages

- APEIs (no mining areas) are only one part of a larger Environmental Management Plan
- **Regional conservation targets will be met by multiple management measures**
- We are NOT proposing a specific set of APEIs
- We ARE providing a robust framework based on inter-governmentally agreed criteria
- We developed quantitative metrics to evaluate performance toward our conservation goals
- A network of buffered, 200km long APEIs, distributed latitudinally along the northern Mid-Atlantic Ridge at distances ~200km apart performed best at meeting our conservation targets

A Regional Approach Requires Regions…



GOODS/Watling et al. Bathyal Provinces

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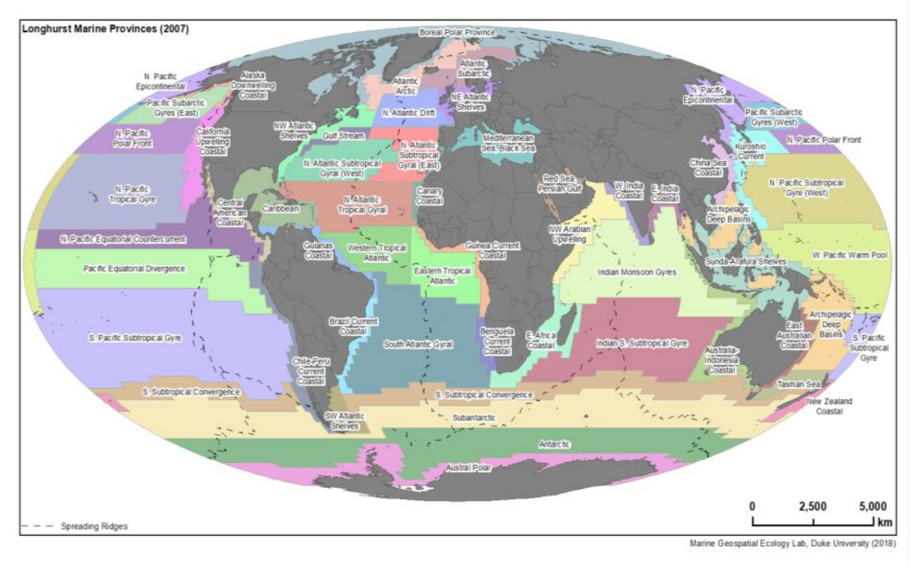

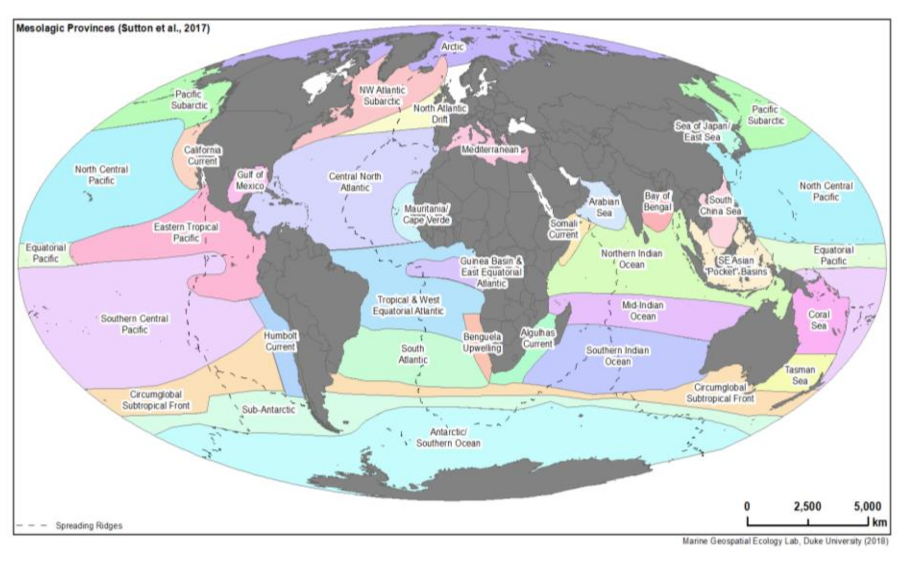

Longhurst Provinces (Epipelagic)

Glasgow Provinces (Mesopelagic)

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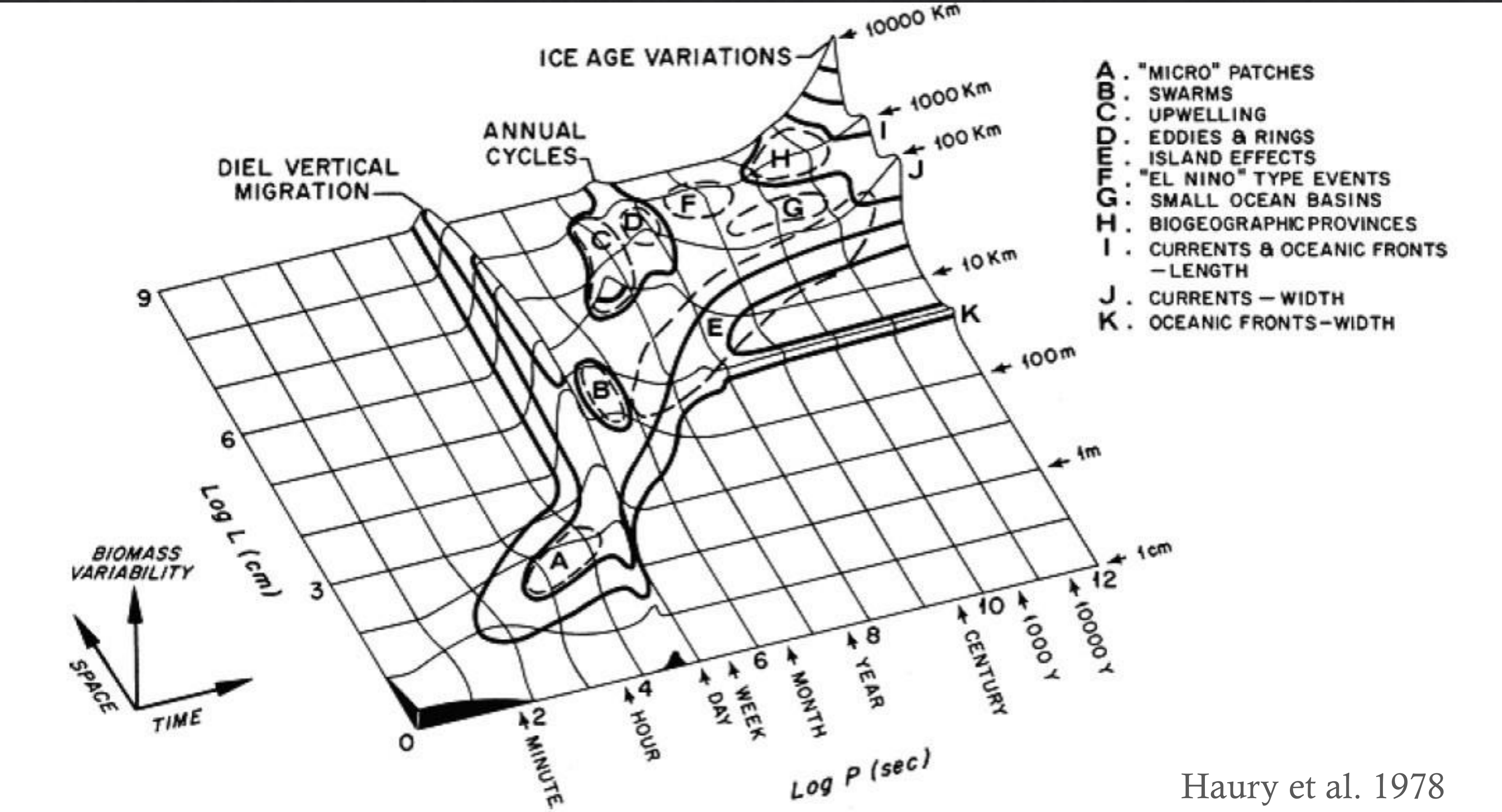
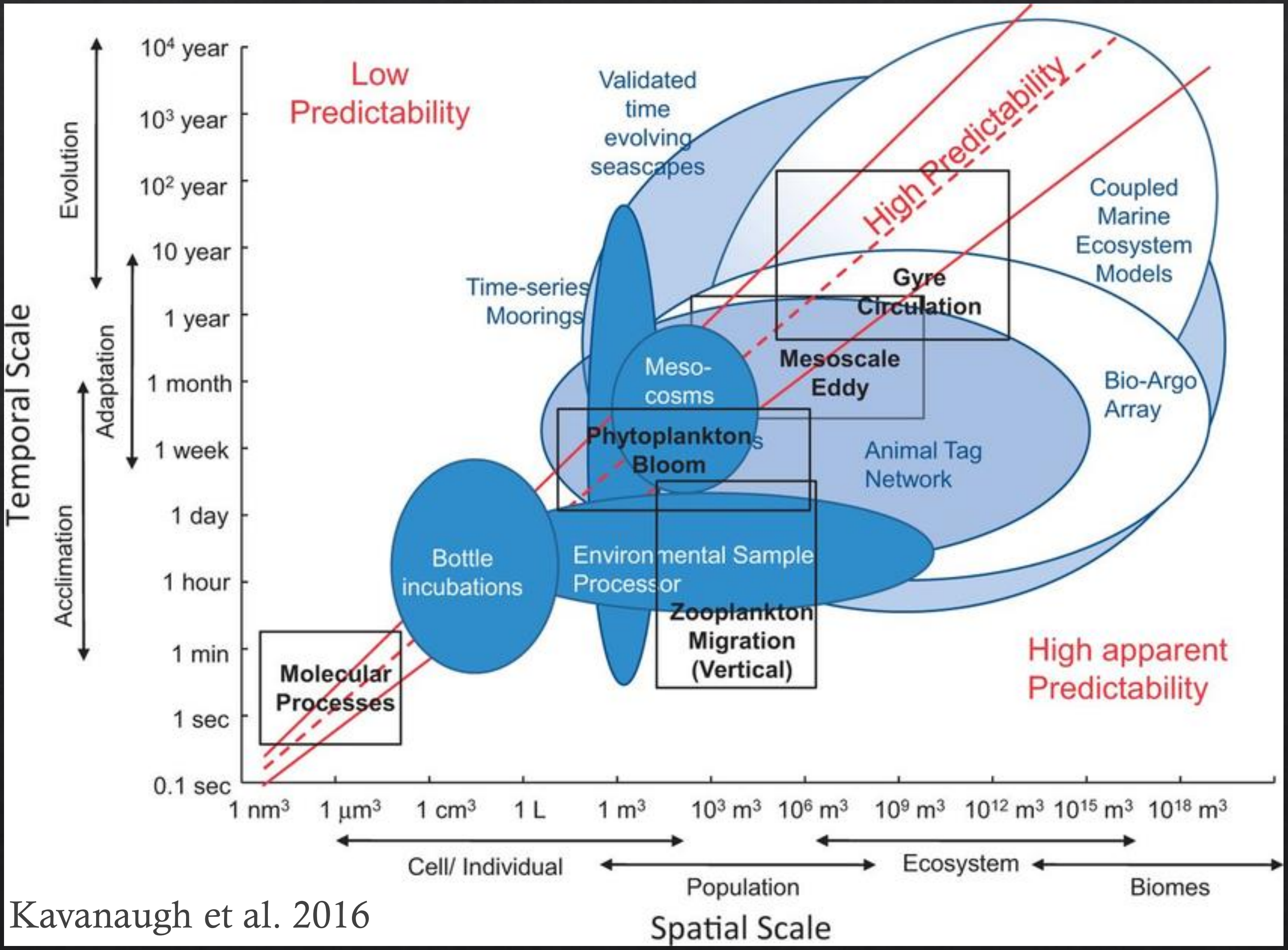
Space & Time



Haury et al. 1978

Space & Time



Kavanaugh et al. 2016