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Prioritizing seagrass meadows for biodiversity conservation based on landscape connectivity

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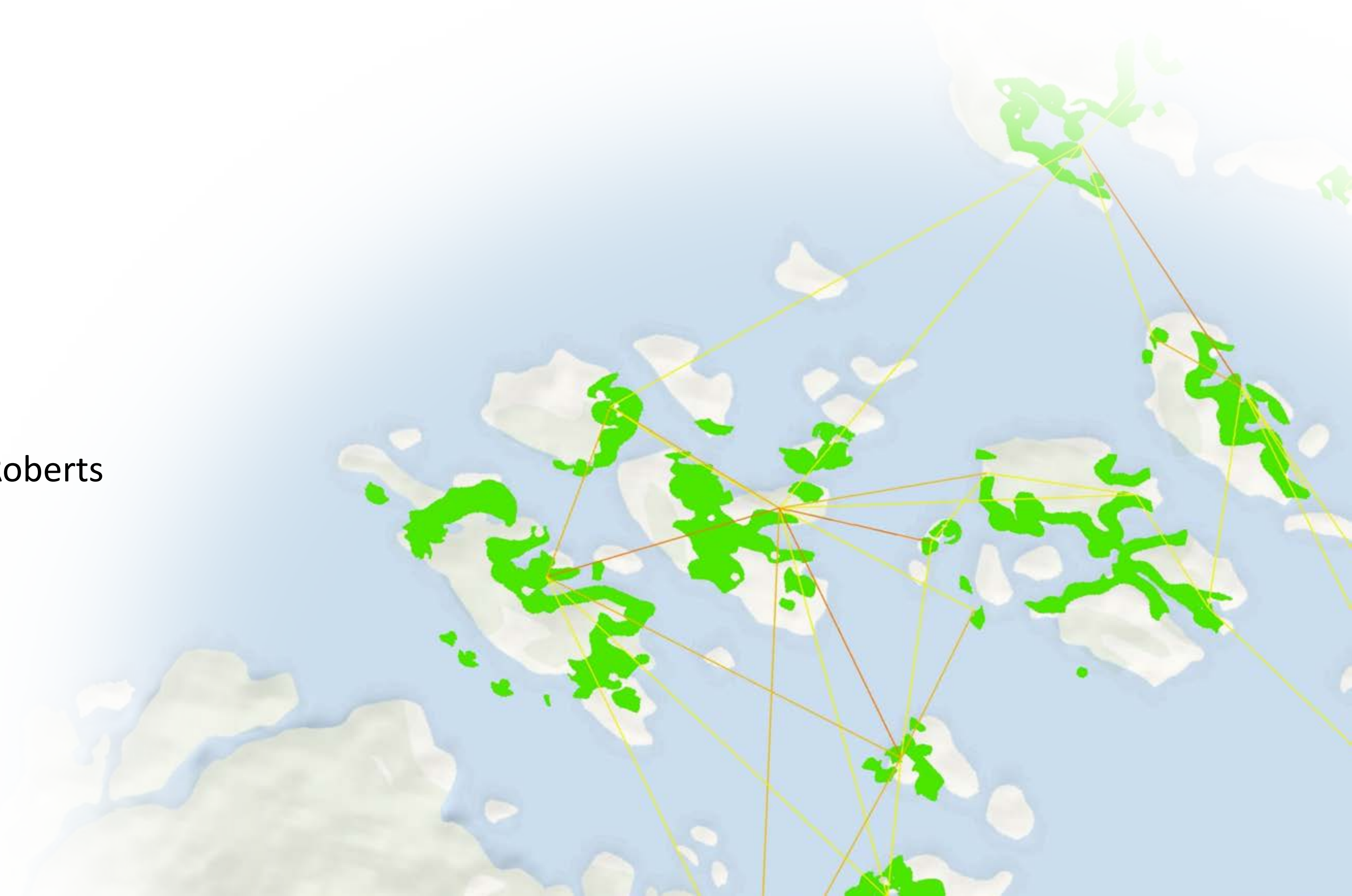

Marine Geospatial Ecology Tools – Jason Roberts
UBC Salish Sea Project – Susan Allen

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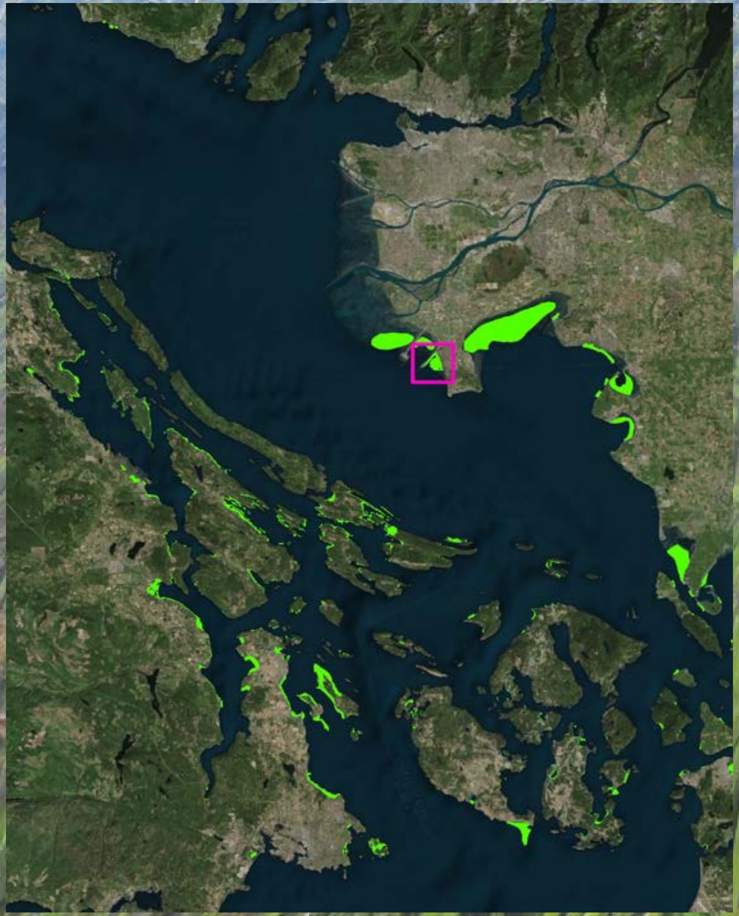
Conserving seagrass epifaunal biodiversity requires thinking at local and regional scales

What’s currently missing at the regional level is an understanding of connectivity and a knowledge of at which scale communities are actually connected.



Photos: Emily Adamczyk

Understanding the scale at which communities are connected is important for management

Decisions are made at regional levels

Threats to habitat may have regional consequences

What happens if we remove *one meadow? How does this affect the neighboring meadows and the biodiversity of the region?*

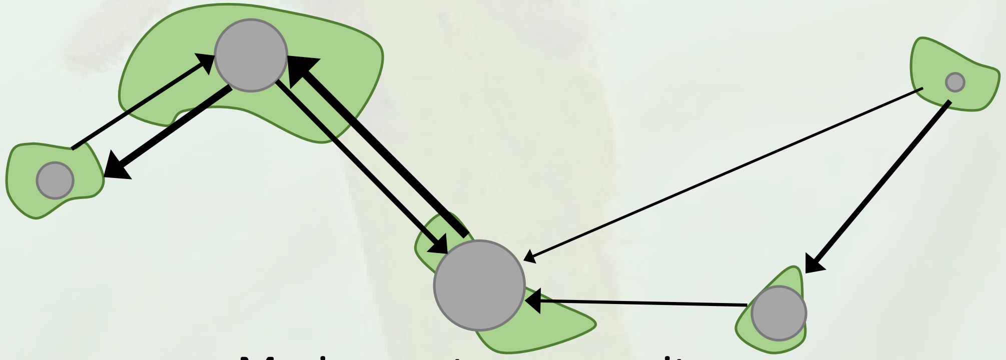
Need to think at a metacommunity level

Regional diversity requires dispersal between local patches

Dispersal determined by:
ocean currents and life history traits

Photo: Gwen Griffiths

Photo: Emily Adamczyk



Marine metacommunity:
Nodes of distinct habitat connected by dispersal

Connections vary, and therefore some groups of meadows may be more "central" and important than others

Local patch level

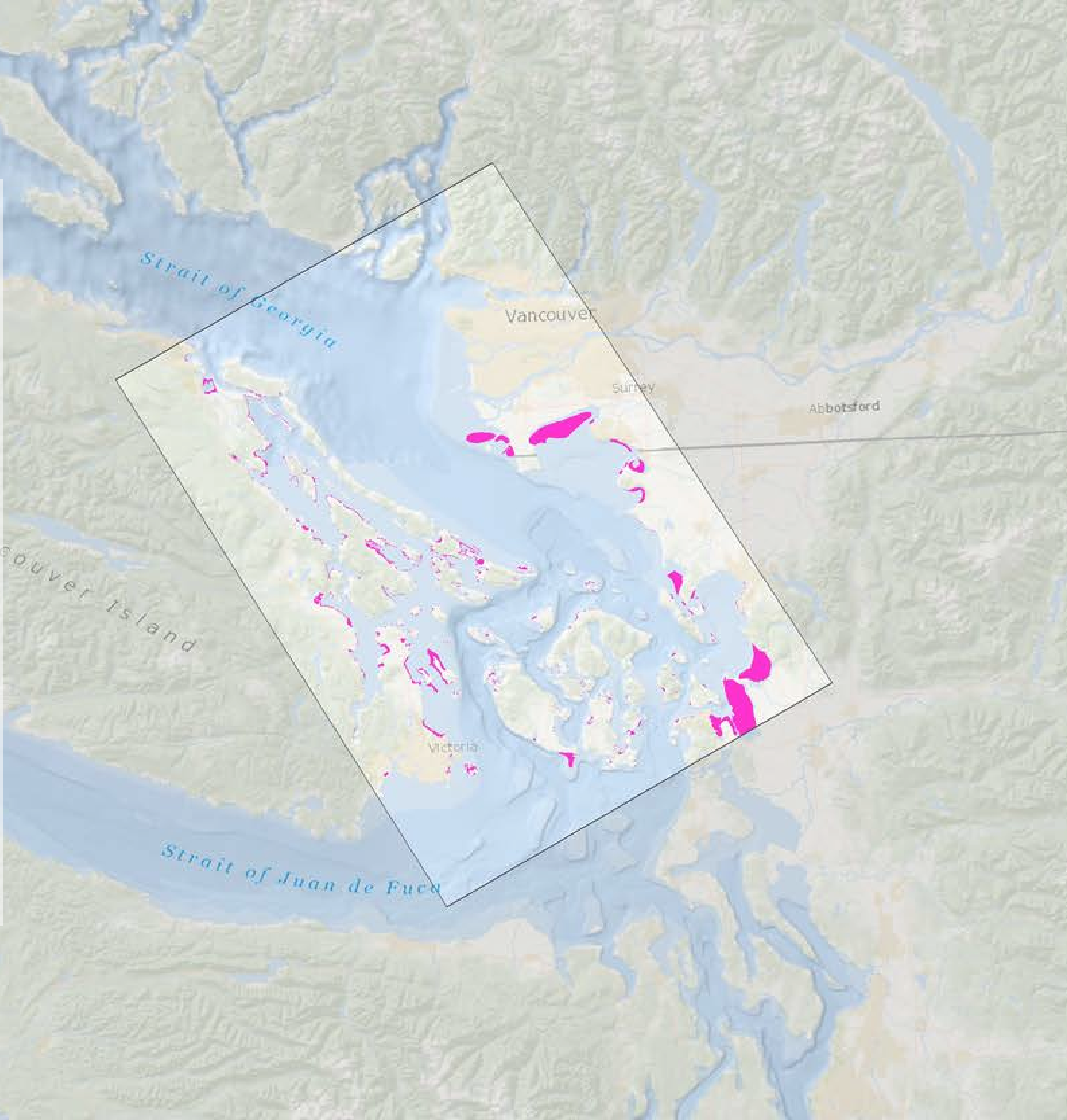
↓

Regional level

Are seagrass meadows connected by passive dispersal?

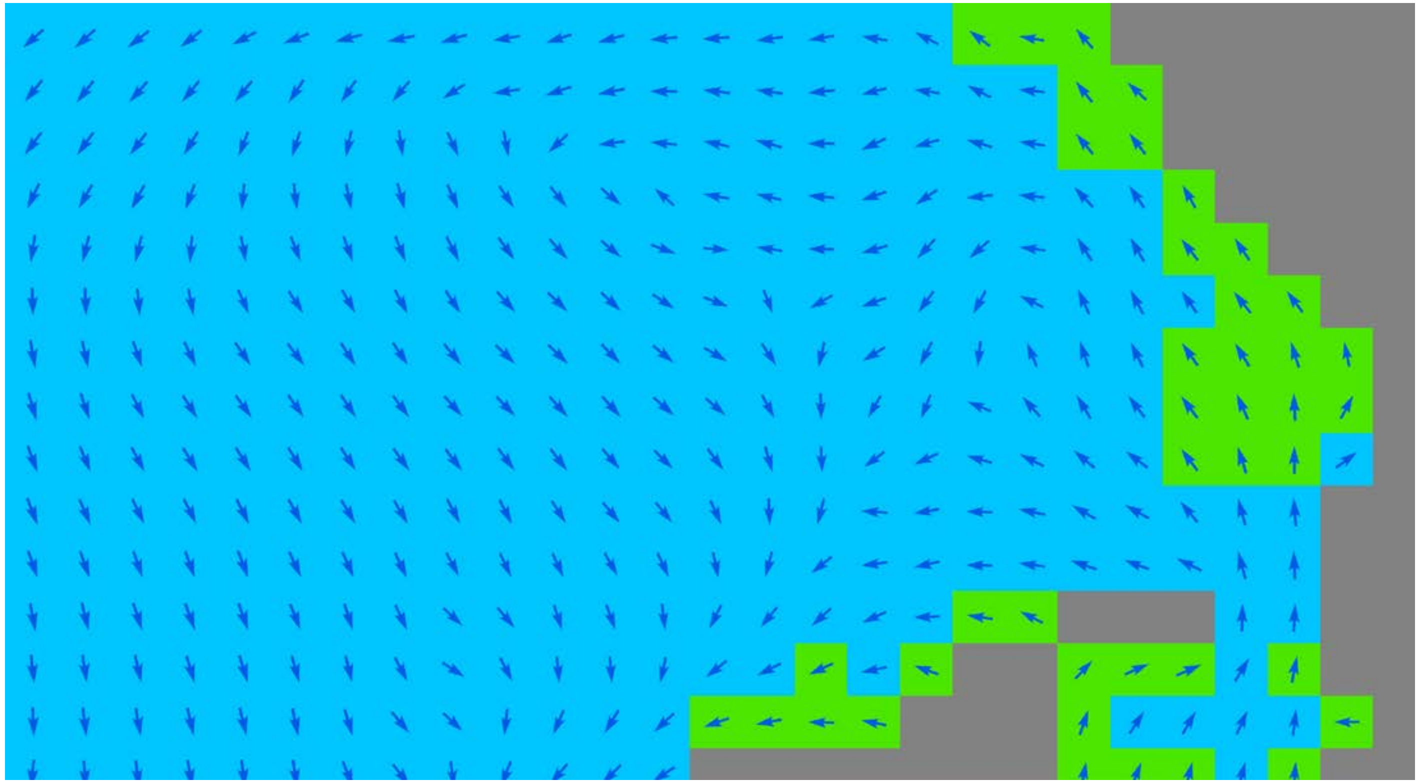
Are certain meadows more important than others for maintaining connectivity?

Can we use network theory as a tool to identify and protect important groups of meadows?



Simulate dispersal with particle tracking

Follow invertebrates as they move in ocean currents across the seascape
See if they settle on other seagrass patches



Spatial resolution: 436 meters
Temporal resolution: 1 hour

Movement affected by:

ocean currents
mortality

Passive surface dispersal

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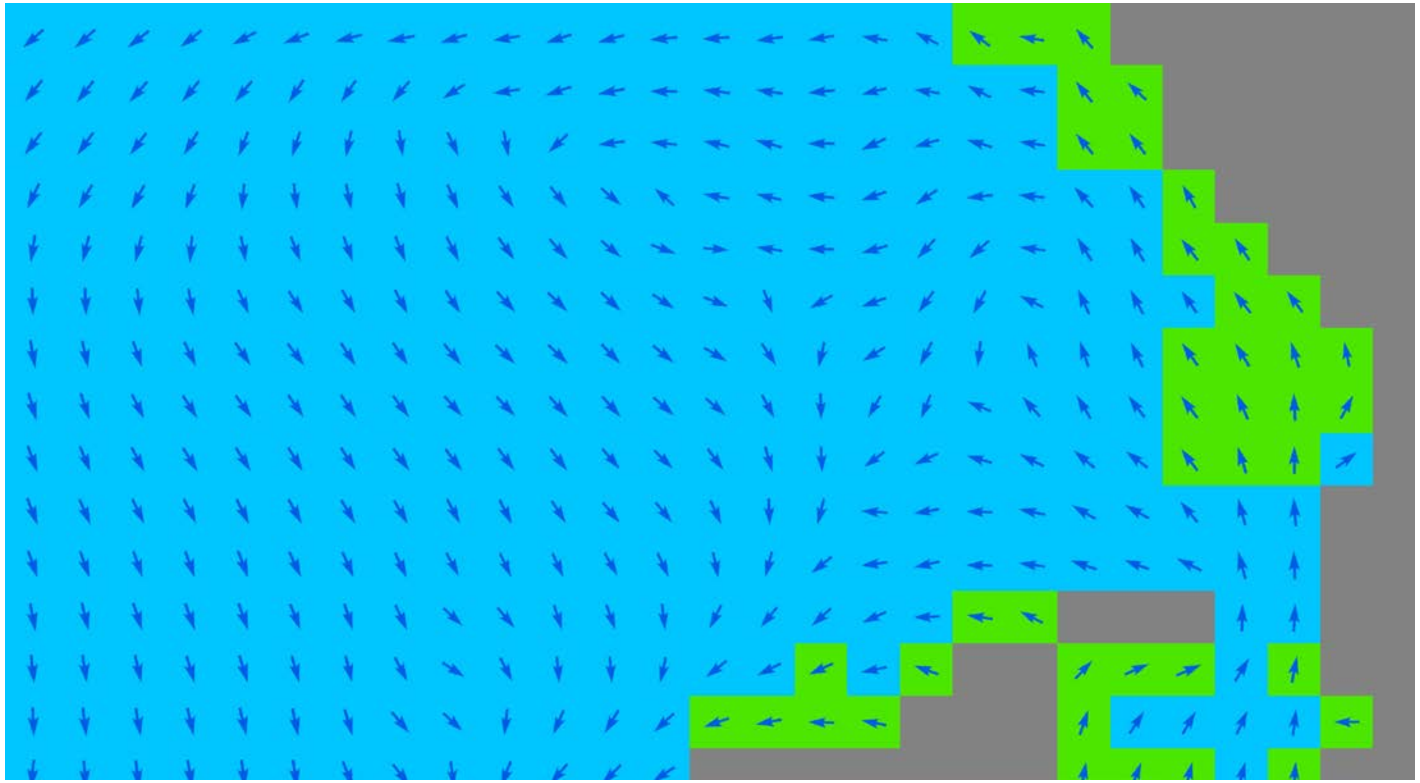
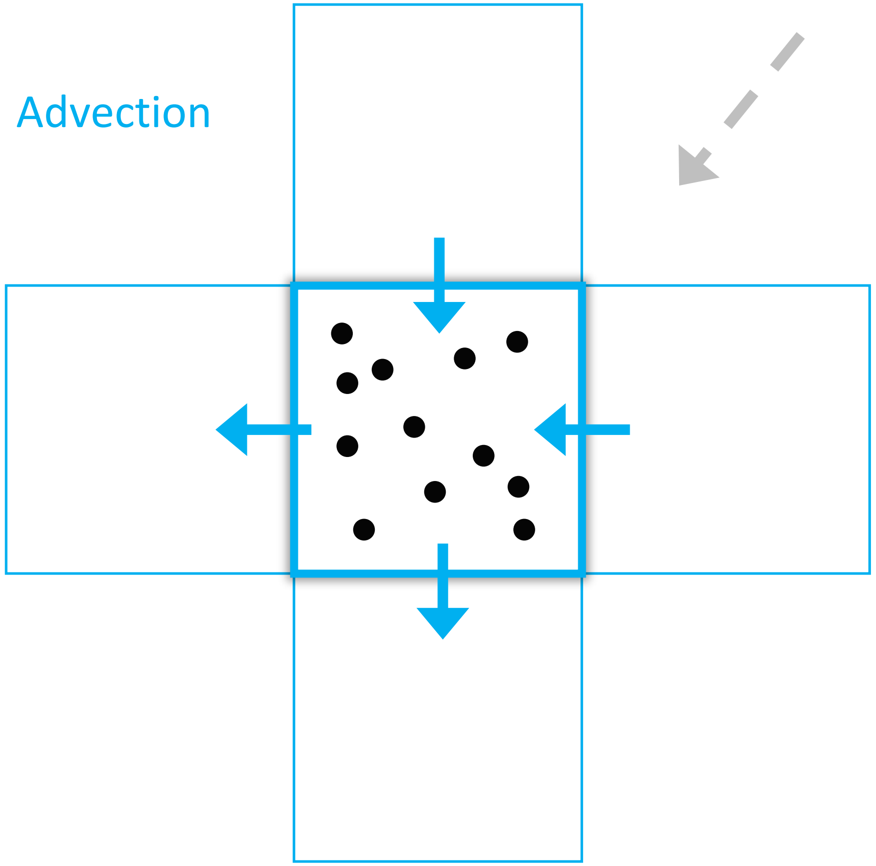
Simulate dispersal with particle tracking

$$\frac{\partial N}{\partial t} = -u\frac{\partial N}{\partial x} - v\frac{\partial N}{\partial y} + K\left(\frac{\partial^2 N}{\partial x^2} + \frac{\partial^2 N}{\partial y^2}\right) - \mu N$$

Concentration = Advection + Diffusion - Mortality

Treml et al 2008





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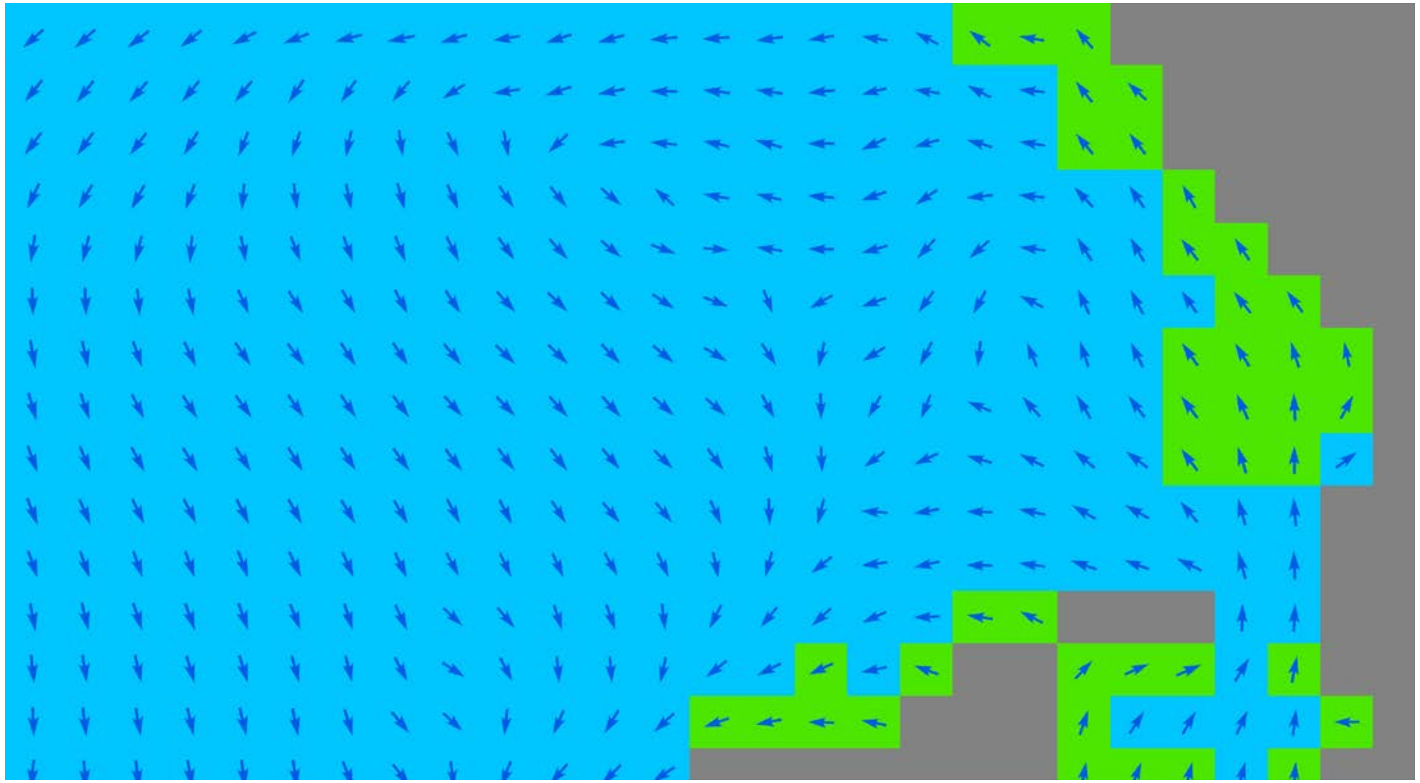

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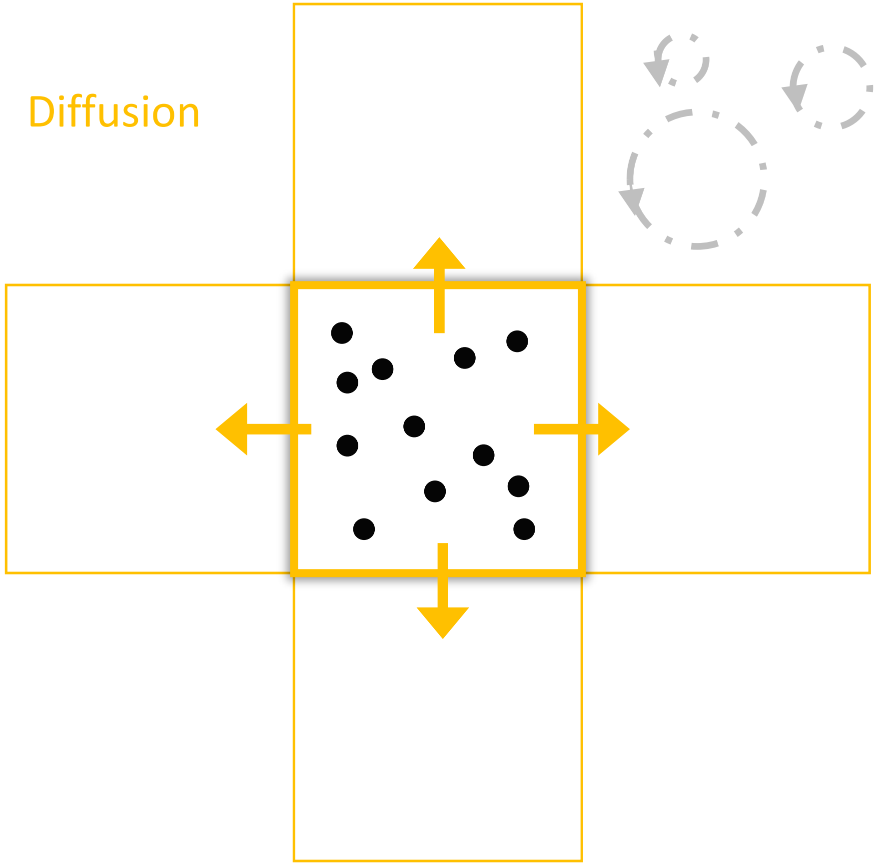

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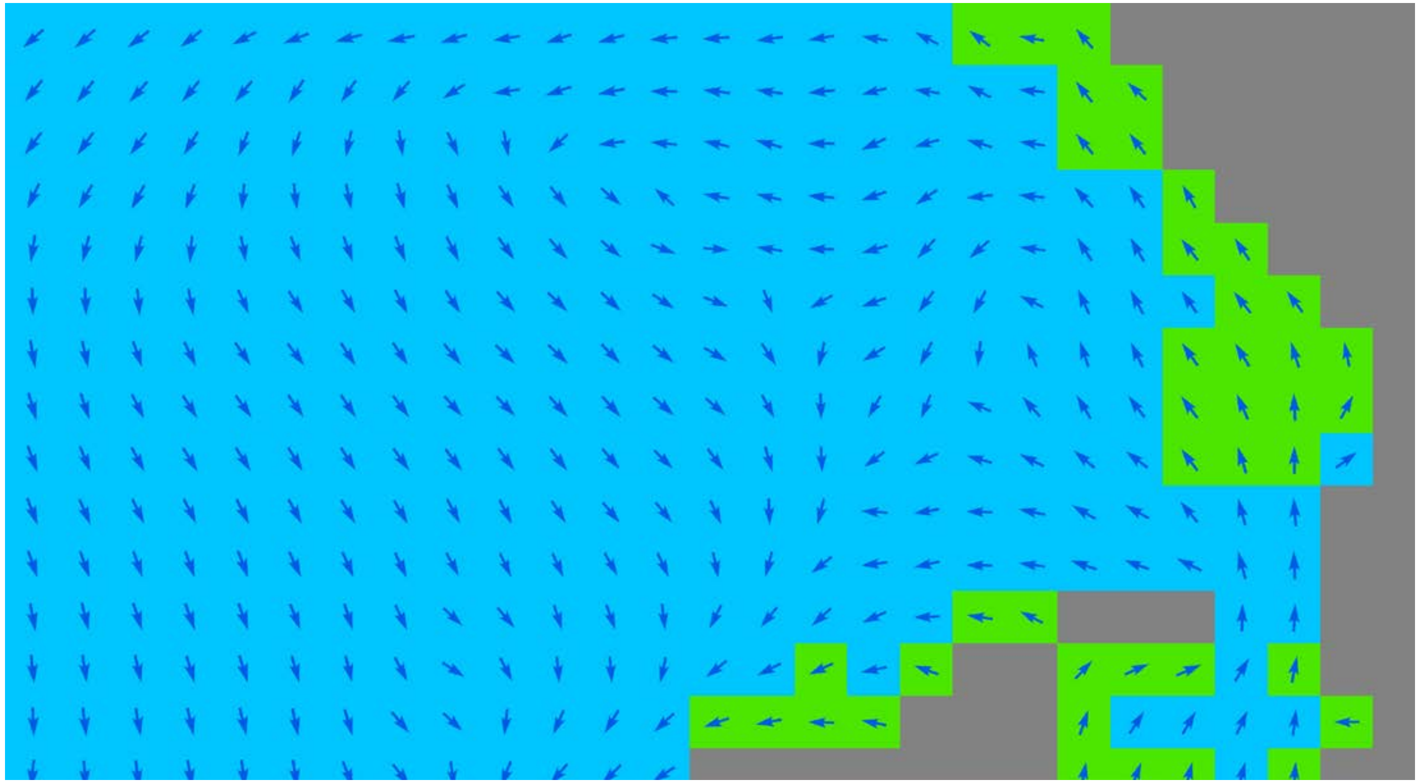


Spatial resolution: 436 meters
Temporal resolution: 1 hour

Baseline Parameters:

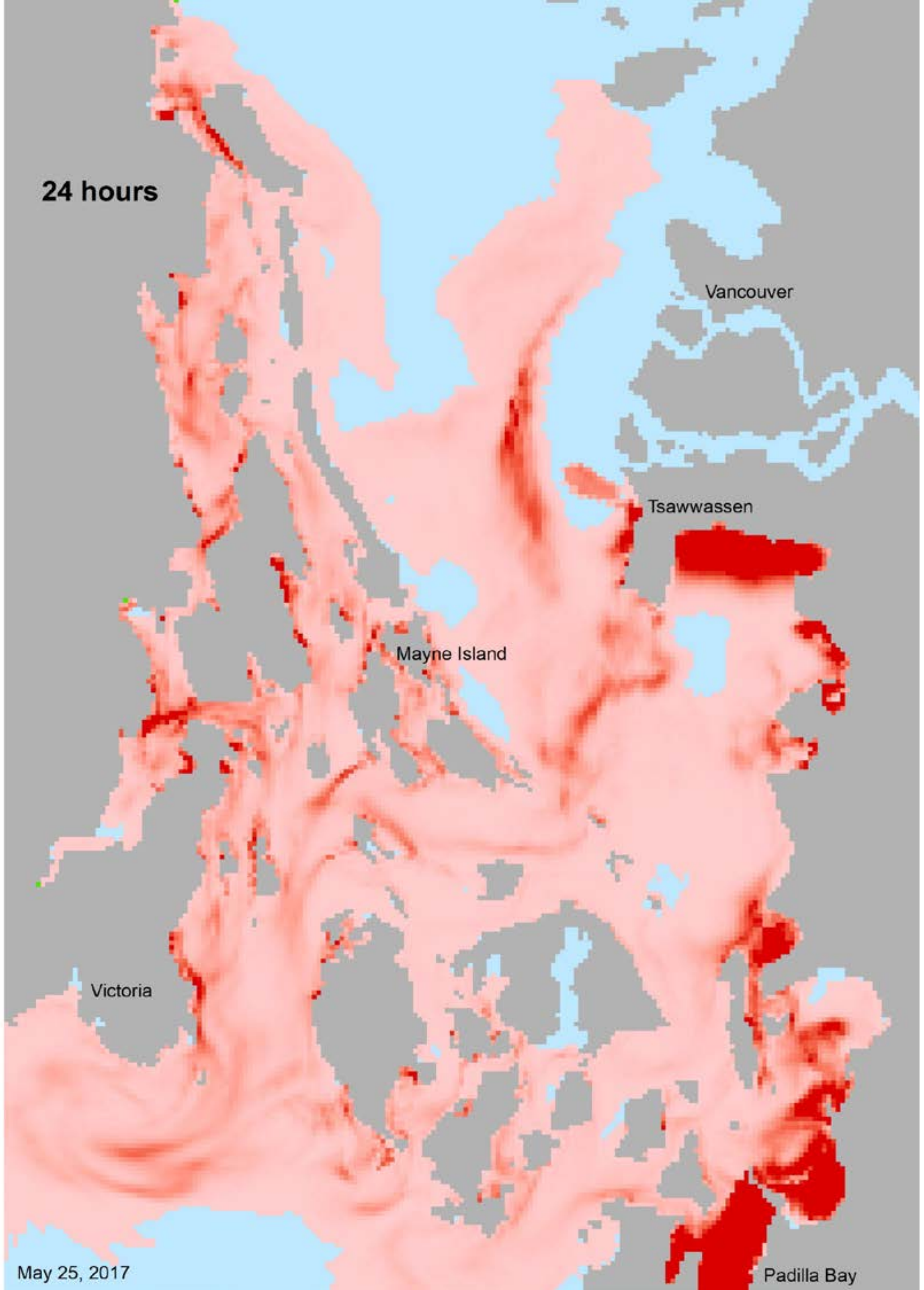
15% daily mortality rate
Simulation runs for 7 days

Timing of scenarios to capture variation by:

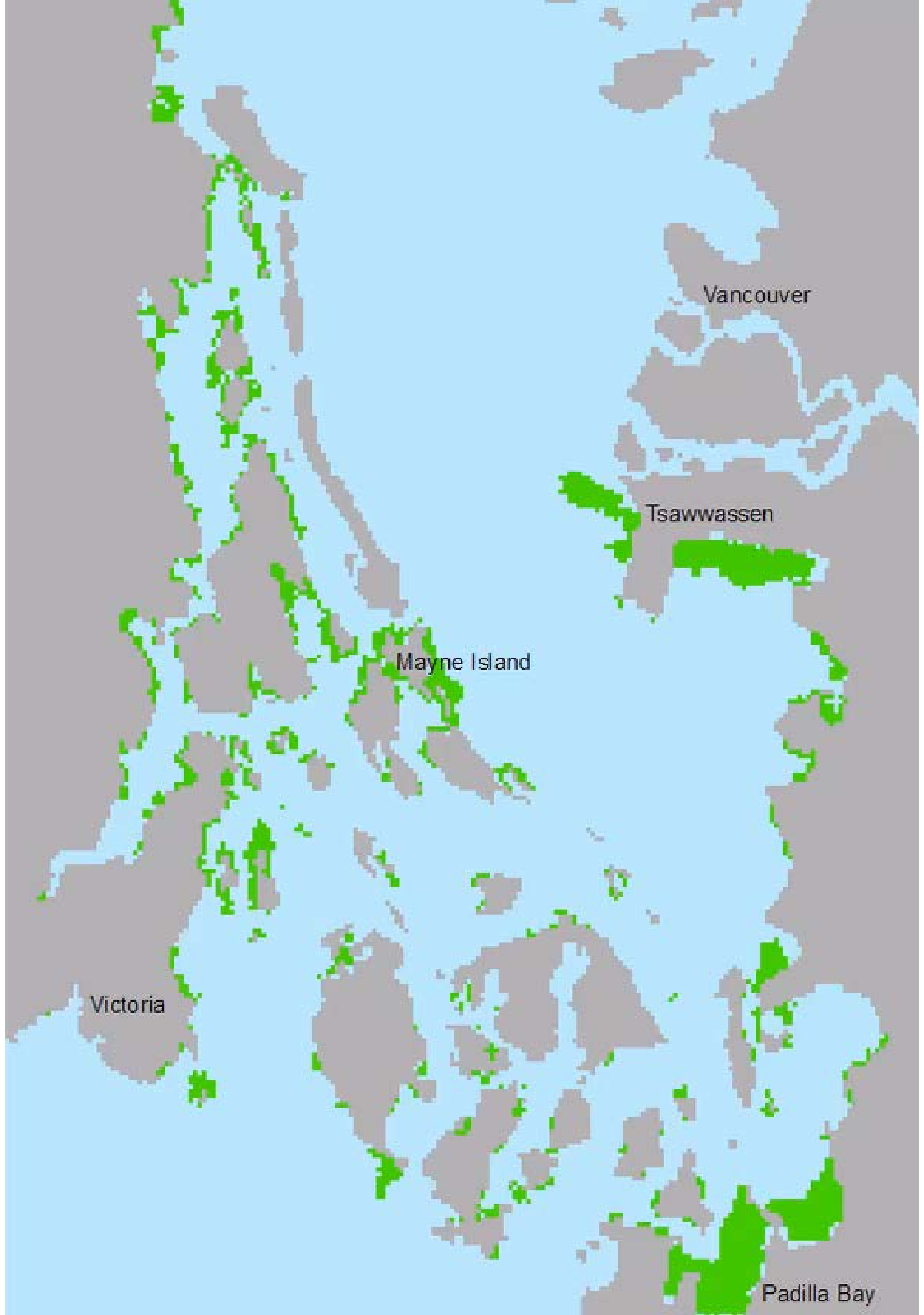
Season
Two week tidal cycle
Daily tidal cycle

UBC Salish Sea Project
Marine Geospatial Ecology Tools

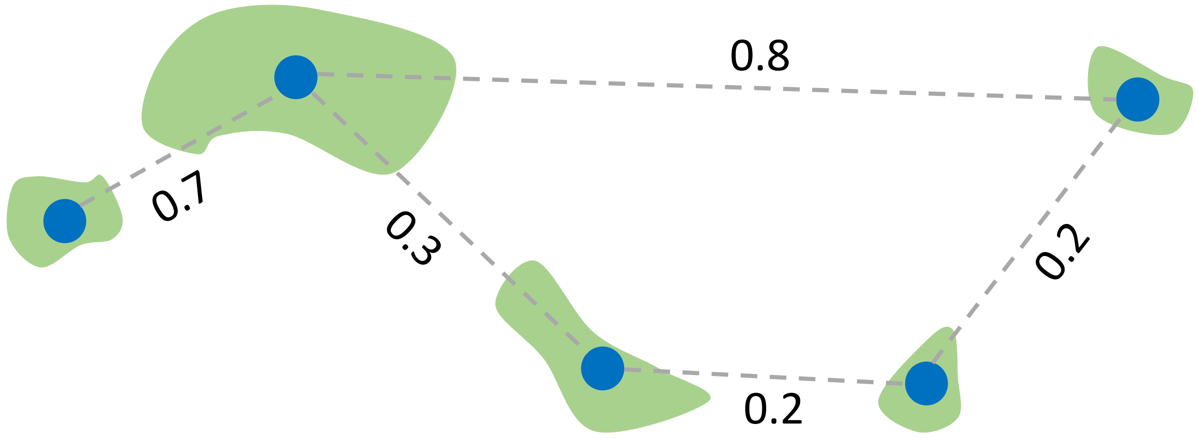
Track densities of particles to determine where inverts are likely to disperse



Establish connections based on a minimum threshold of particles settling at a distant patch



Using network analysis and connectivity metrics to identify important meadows



Node removal to measure importance

Change in overall graph connectivity (*d*PC):
The change in the sum of the product probability of all paths between all nodes

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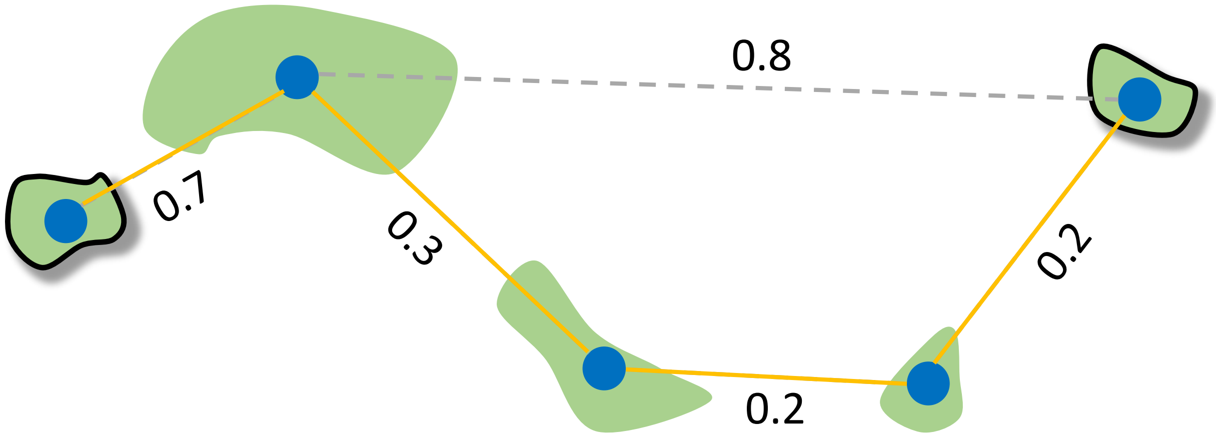

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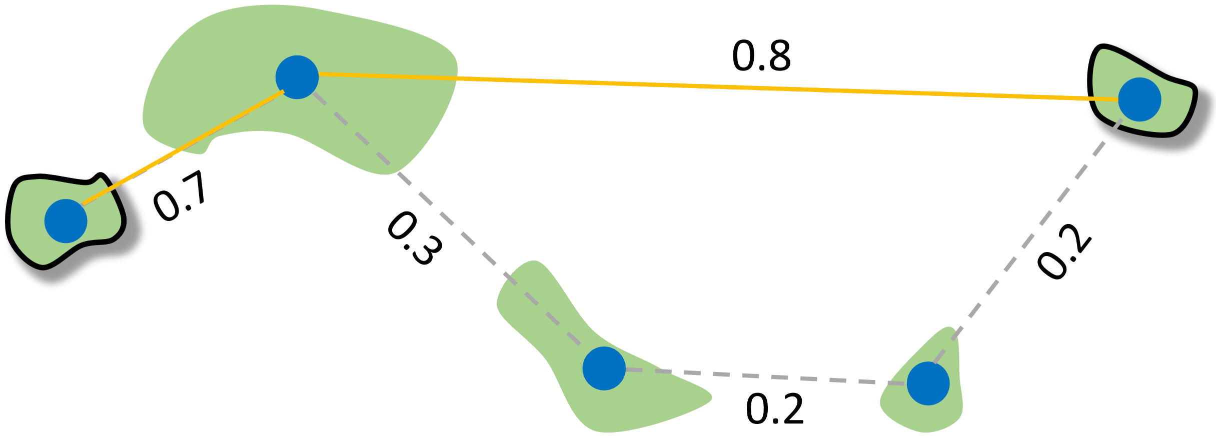

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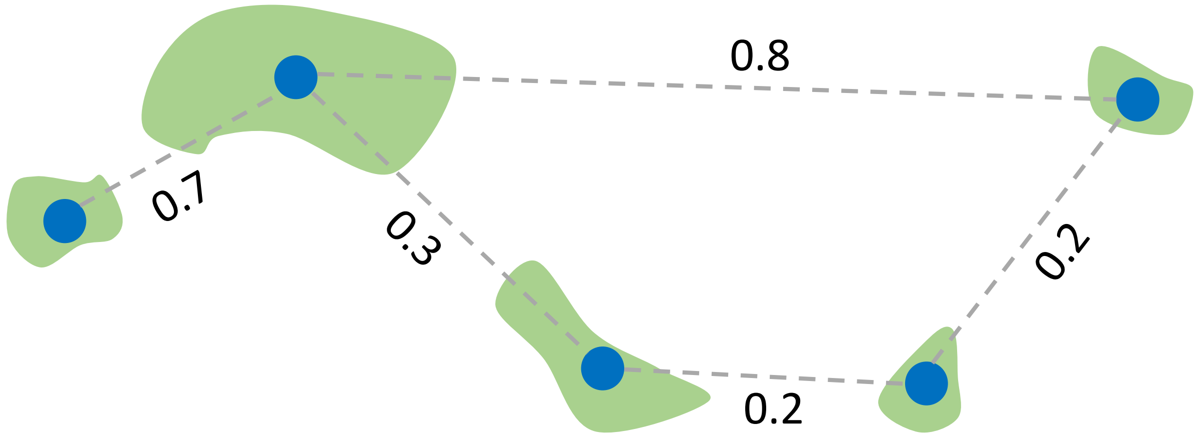

PC = 6.53

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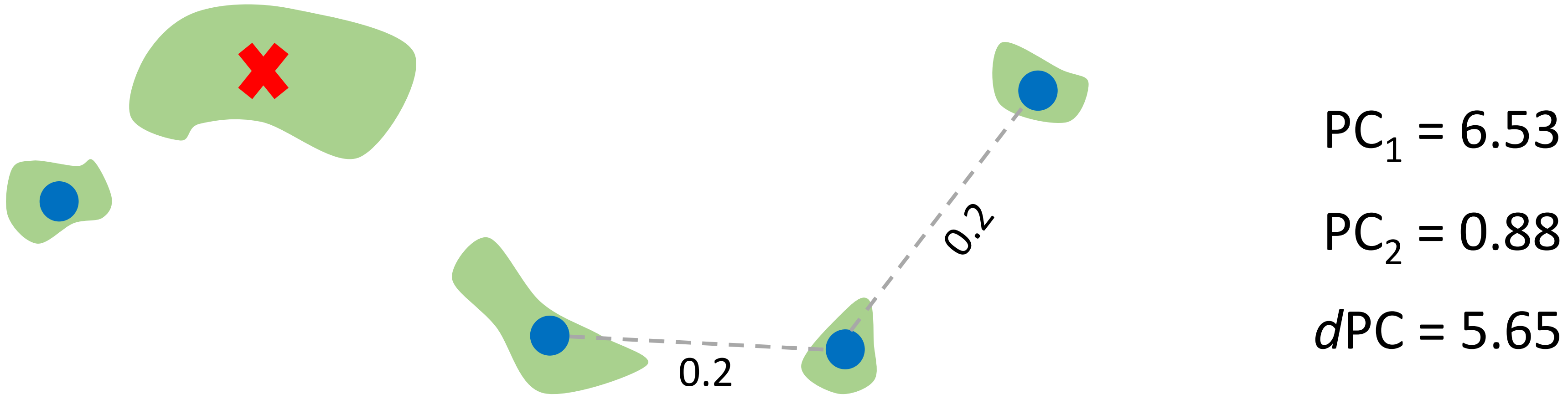

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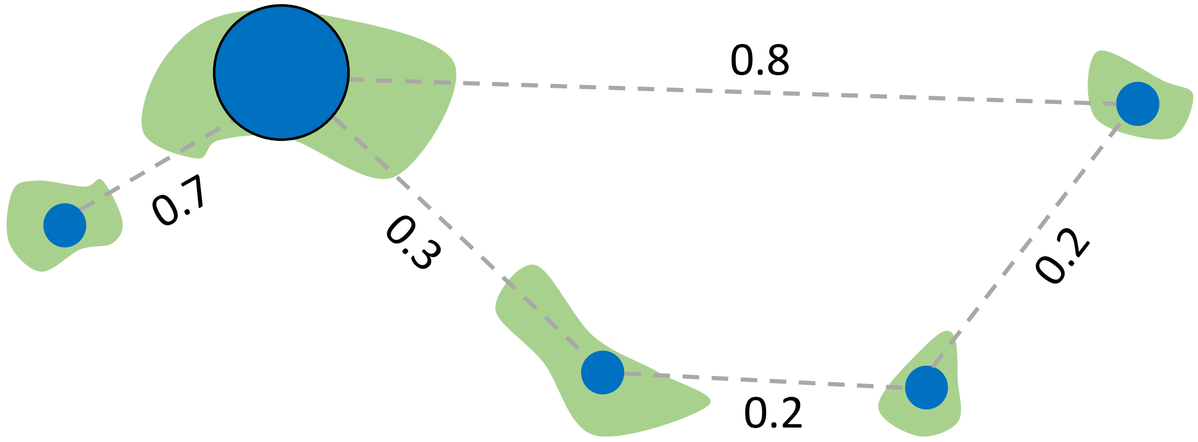

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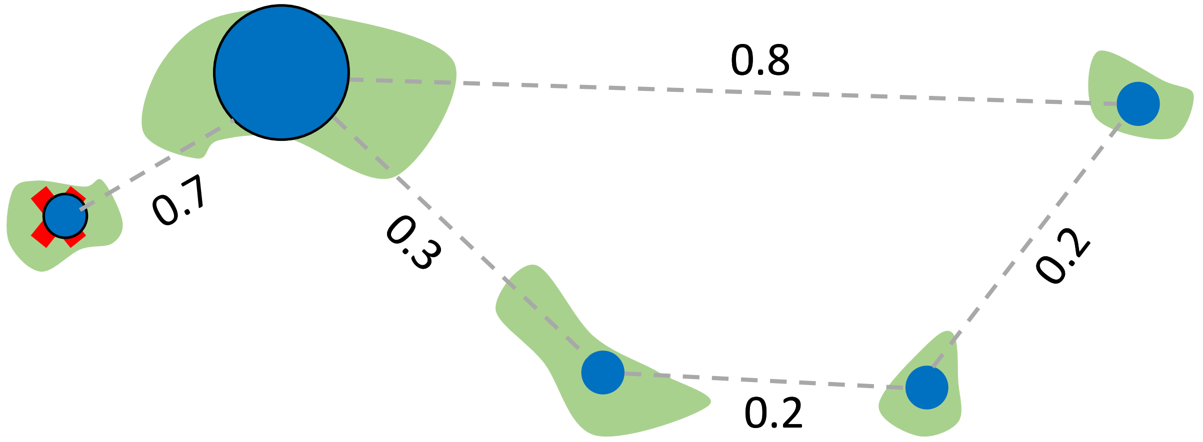

$PC_1 = 6.53$

$PC_2 = 4.28$

$dPC = 2.25$

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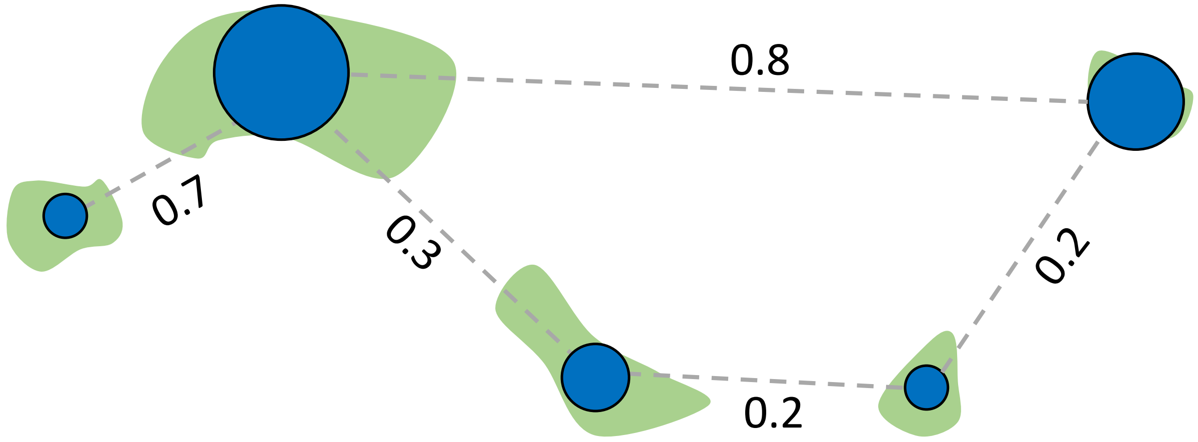

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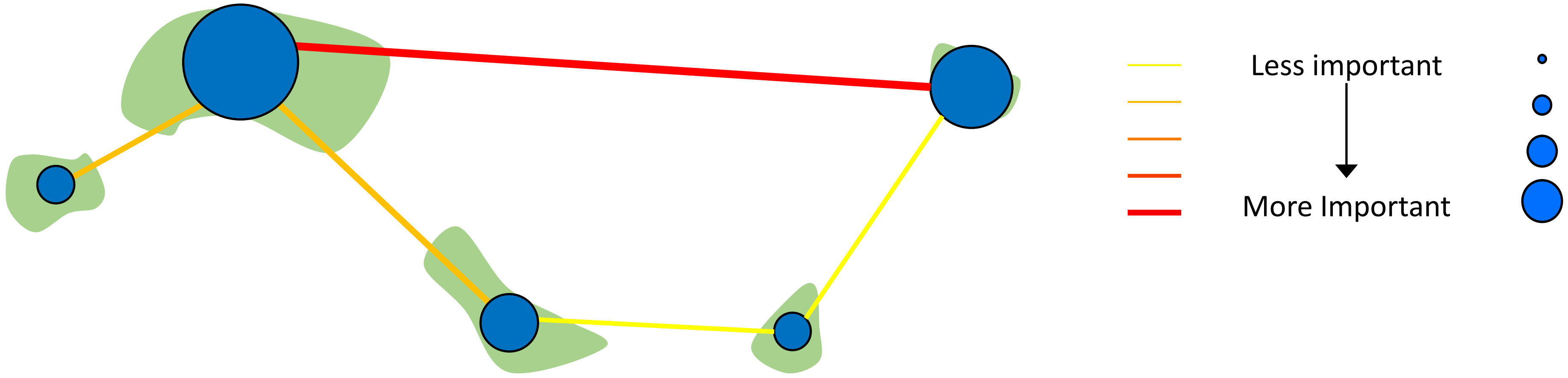

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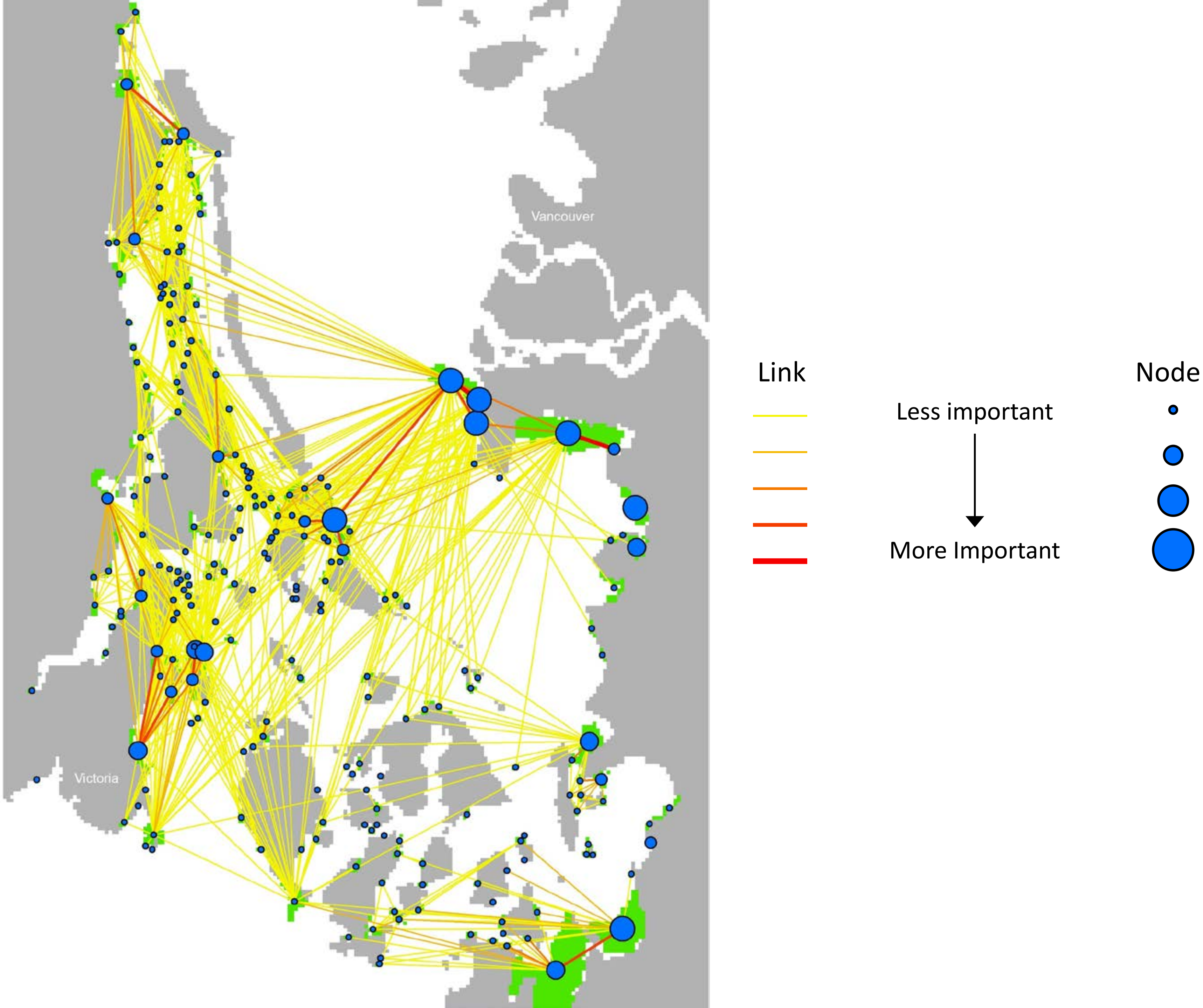
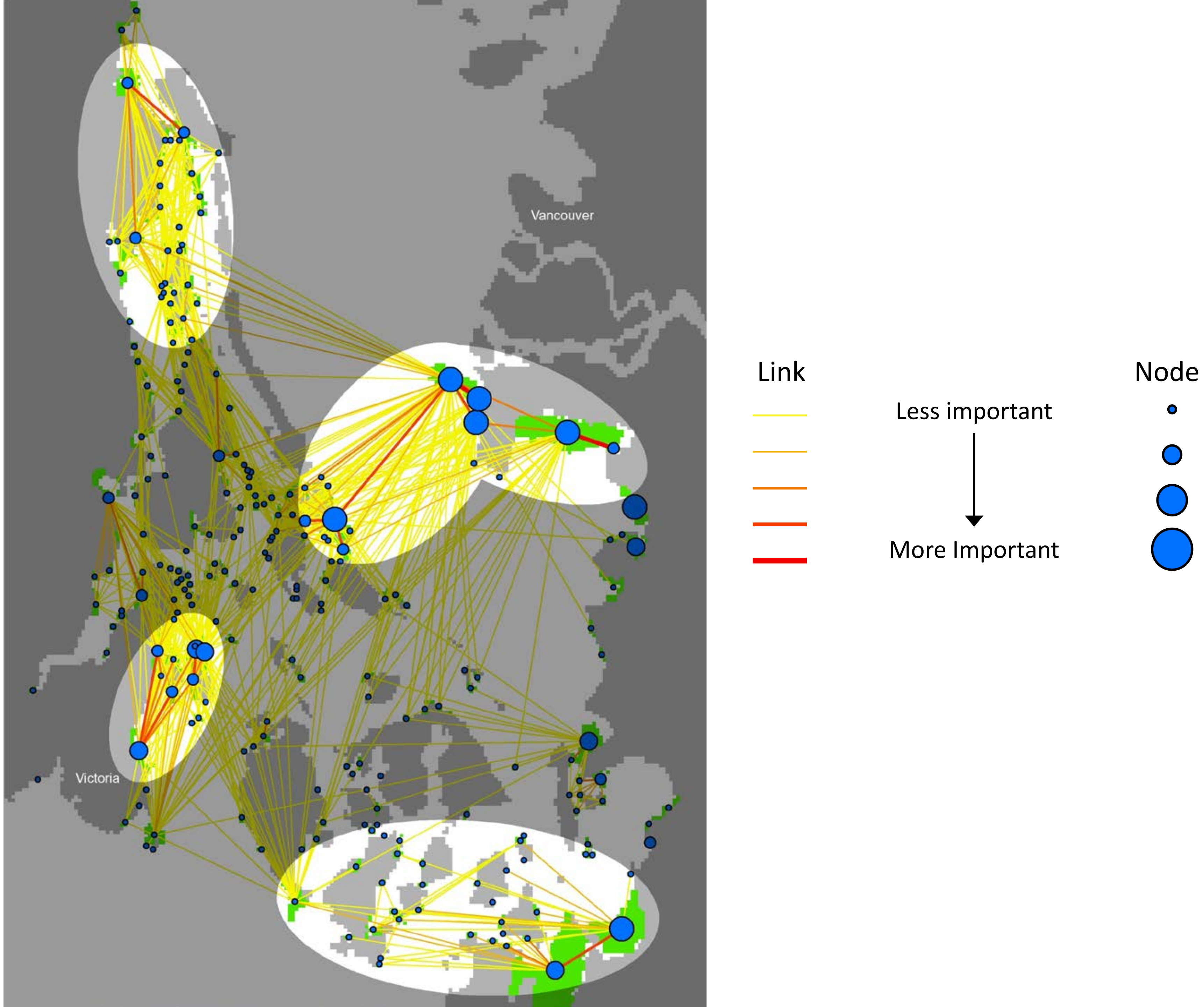
Meadow and link importance to connectivity (*d*PC)



Defining biologically meaningful regions



Local patch level

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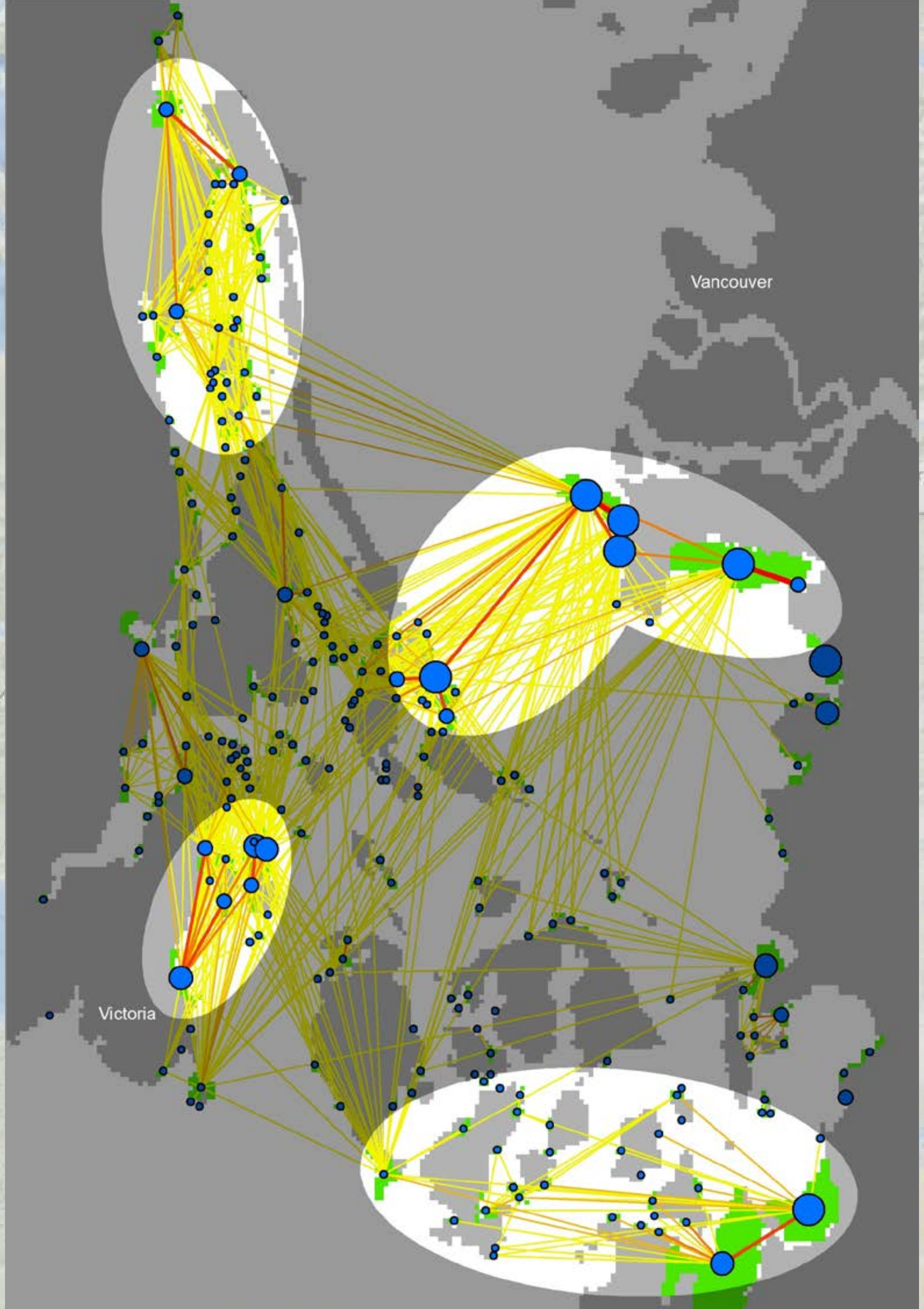
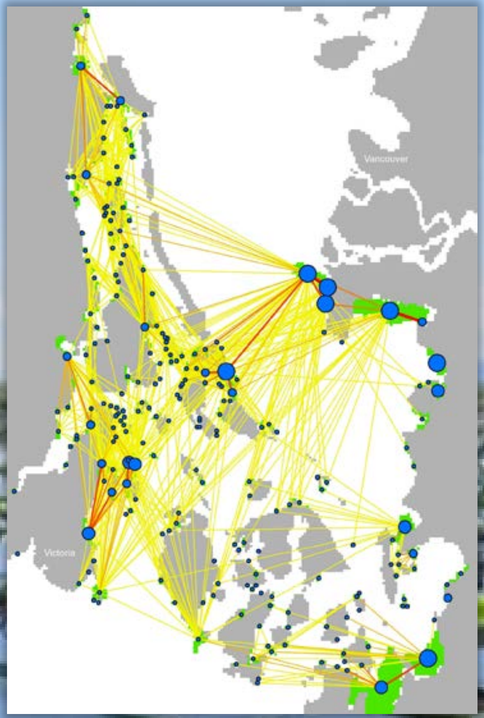
Can we use network theory as a tool to identify and protect important groups of meadows?

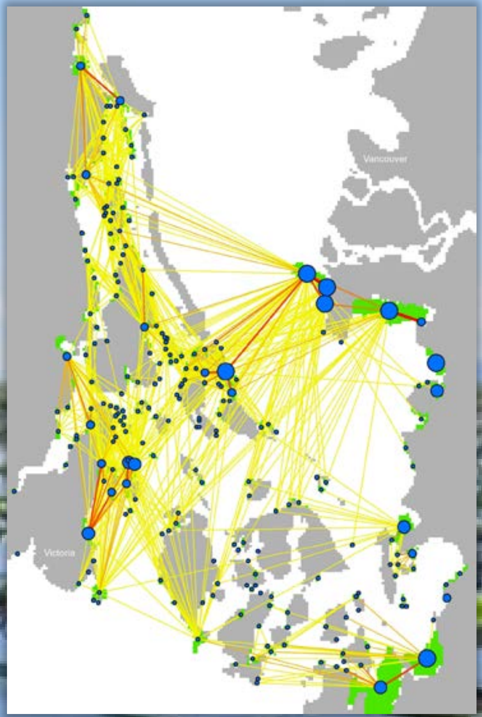
Regional level





Research

Management



Research

Additional trait based scenarios and dynamic community modeling

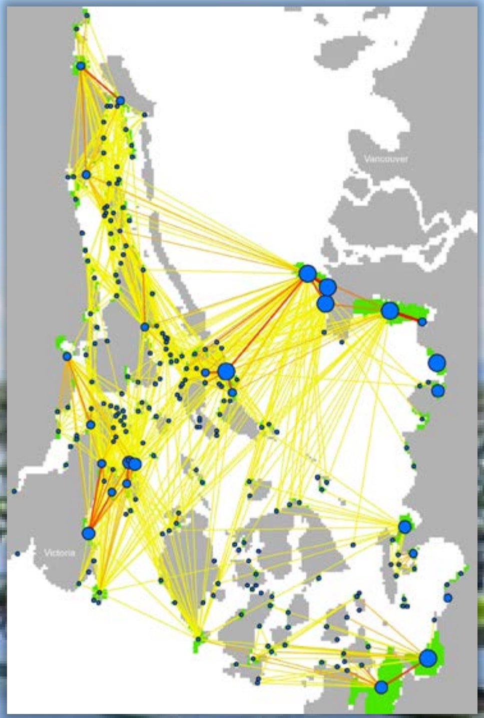
Field sampling data
- centrality vs. diversity
- connection strength vs. diversity similarity

Genetic testing

Management

Focus sampling efforts
- sample from meadows that represent a range of connectivity importance

Incorporate into planning tools
- 10% of oceans by 2020
- prioritize and give higher weighting in MPA design



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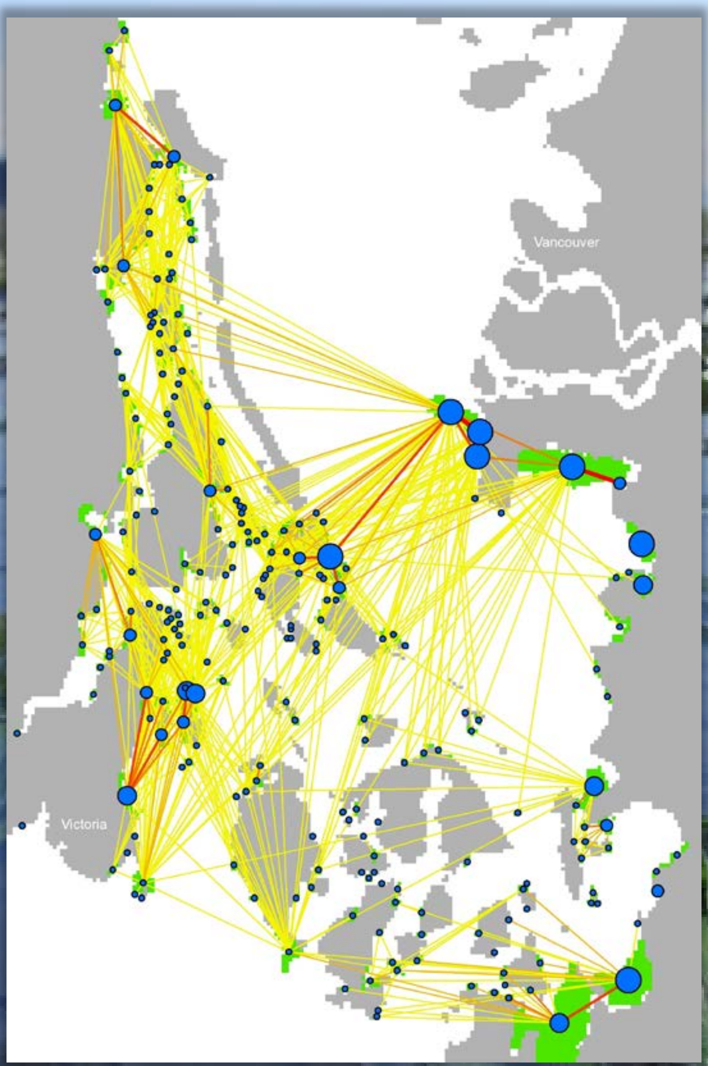

In summary…

Modeling connectivity can define biologically relevant management units that can maximize the conservation of biodiversity

John Cristiani – MSc candidate
Mary O’Connor – Principal Investigator

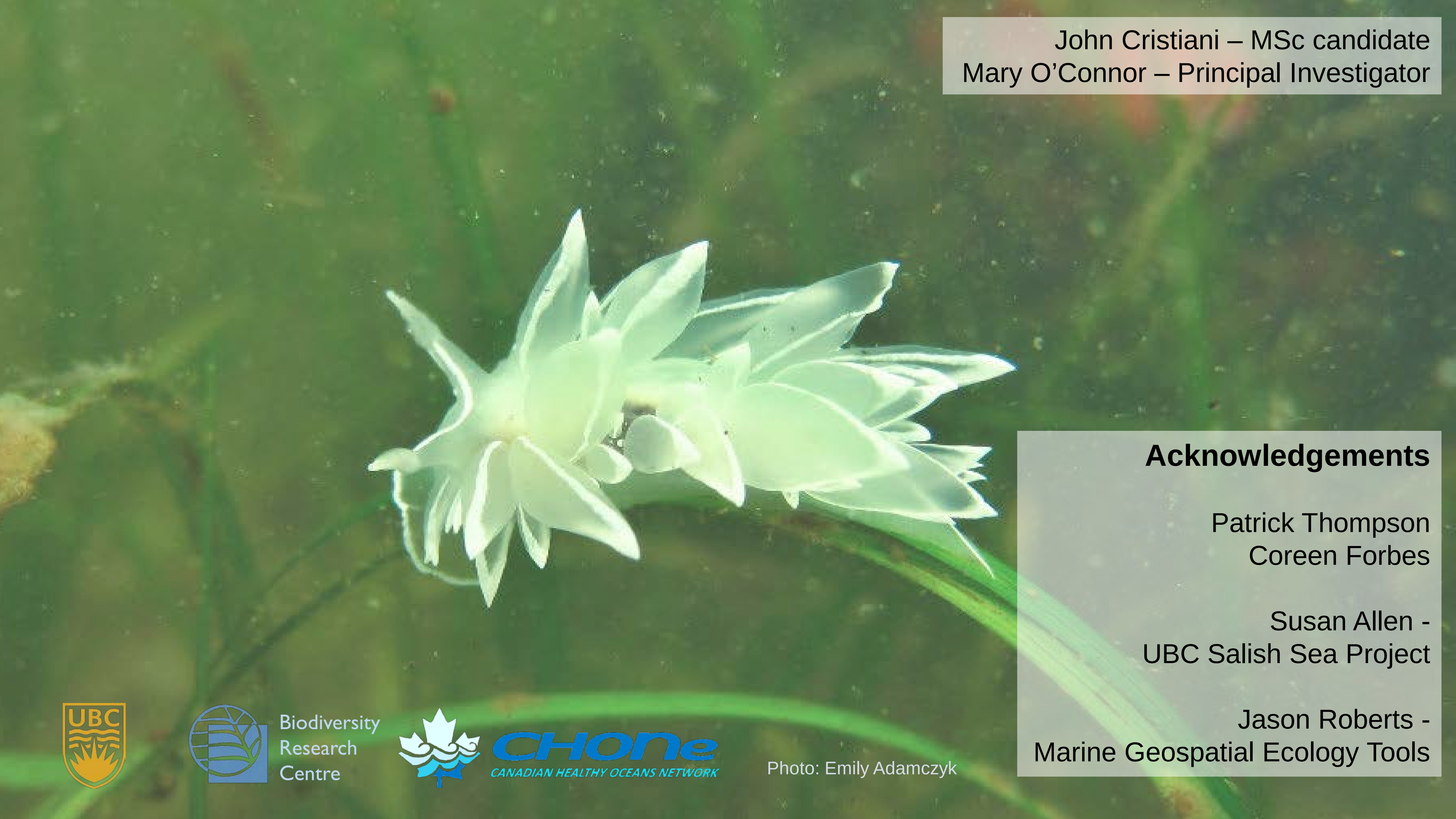

Photo: Emily Adamczyk

Acknowledgements

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Jason Roberts -
Marine Geospatial Ecology Tools

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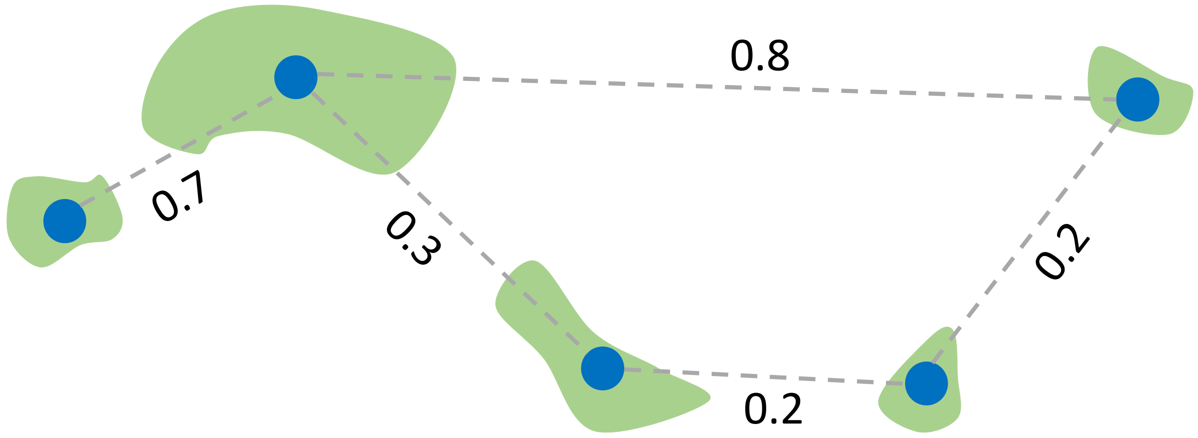
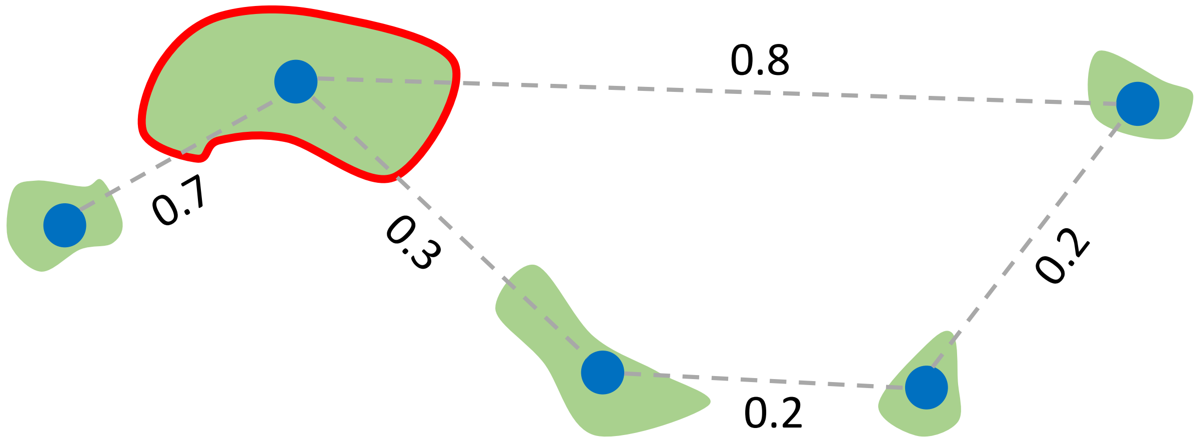


Identify "stepping stones"

Betweenness Centrality of a node: the number of shortest paths from all nodes to all other nodes that pass through that node

Using network analysis and connectivity metrics to identify important meadows



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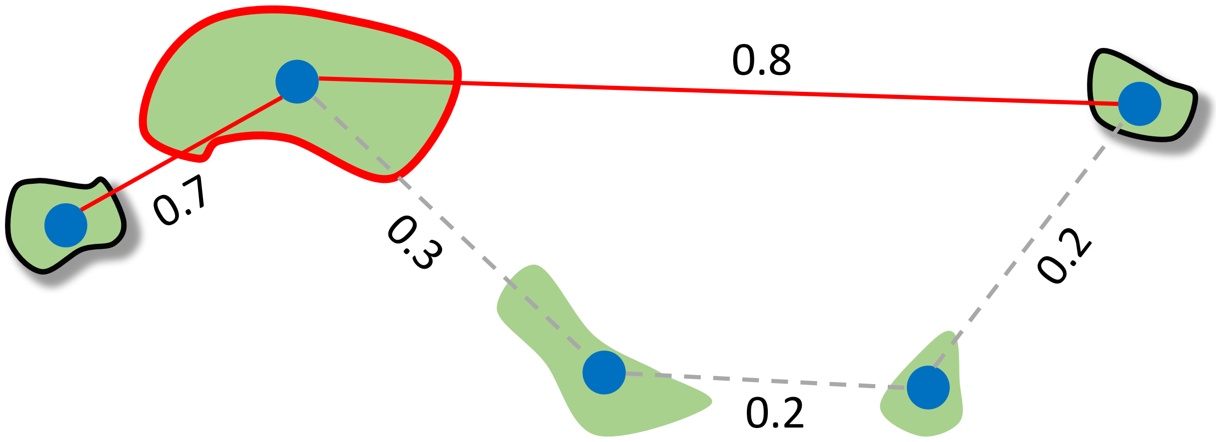

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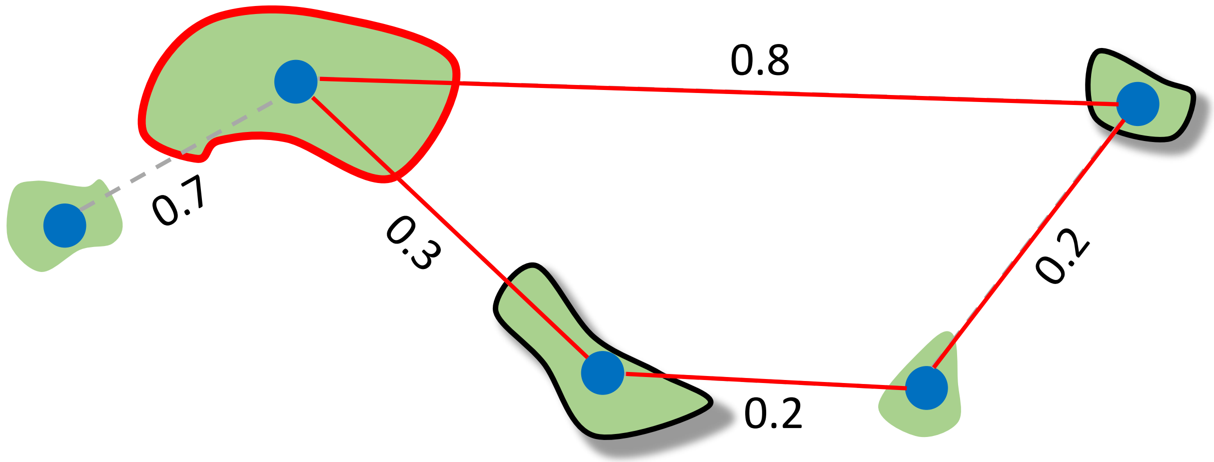

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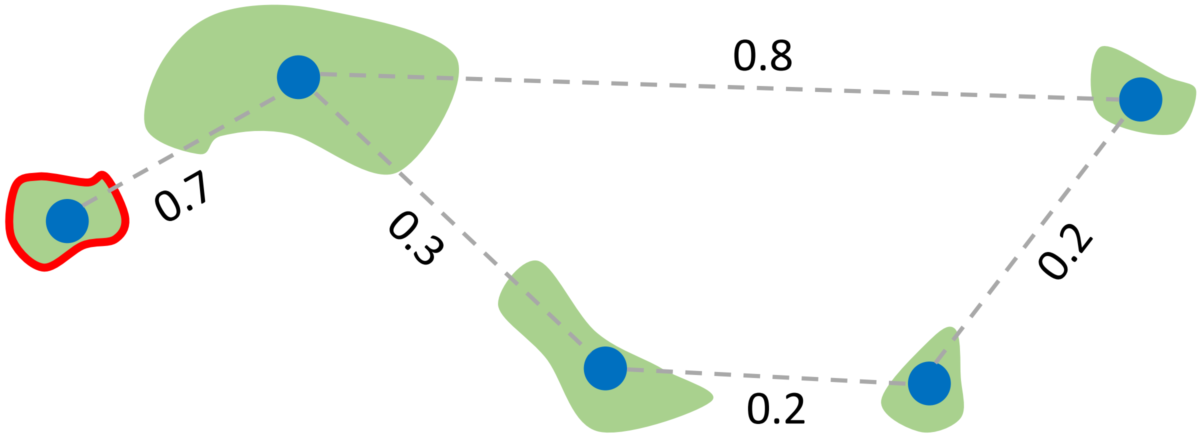

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