MiCO:
Migratory Connectivity in the Ocean

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Nicholas School of the Environment
Duke University

THANK YOU!

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International Climate Change Initiative (IKI)

GOBI Global Ocean Biodiversity Initiative

seascape consultants ltd

Partners/Collaborators:

University of Exeter

CSIRO

MarViva

OBIS Ocean Biogeographic Information System

OBIS-SEAMAP

cnrs

BirdLife International

IUCN

Convention on Biological Diversity

UNESCO

SWOT The State of the World's Sea Turtles

30 TETHYS 1986 2016

University of California Santa Cruz

University of Maryland Center for Environmental Science

Sargasso Sea Commission

Monterey Bay Aquarium

Old Dominion University IDEA Fusion

Marine Mammal Protected Areas Task Force

Sargasso Sea Commission

The Nature Conservancy

Conservation Science Partners

Smithsonian Conservation Biology Institute Migratory Bird Center

CMS

Deakin University

The Ocean Foundation

NOAA Fisheries

Oregon State University

Stanford University

IOOS Integrated Ocean Observing System

YOUR LOGO HERE

AND YOU!

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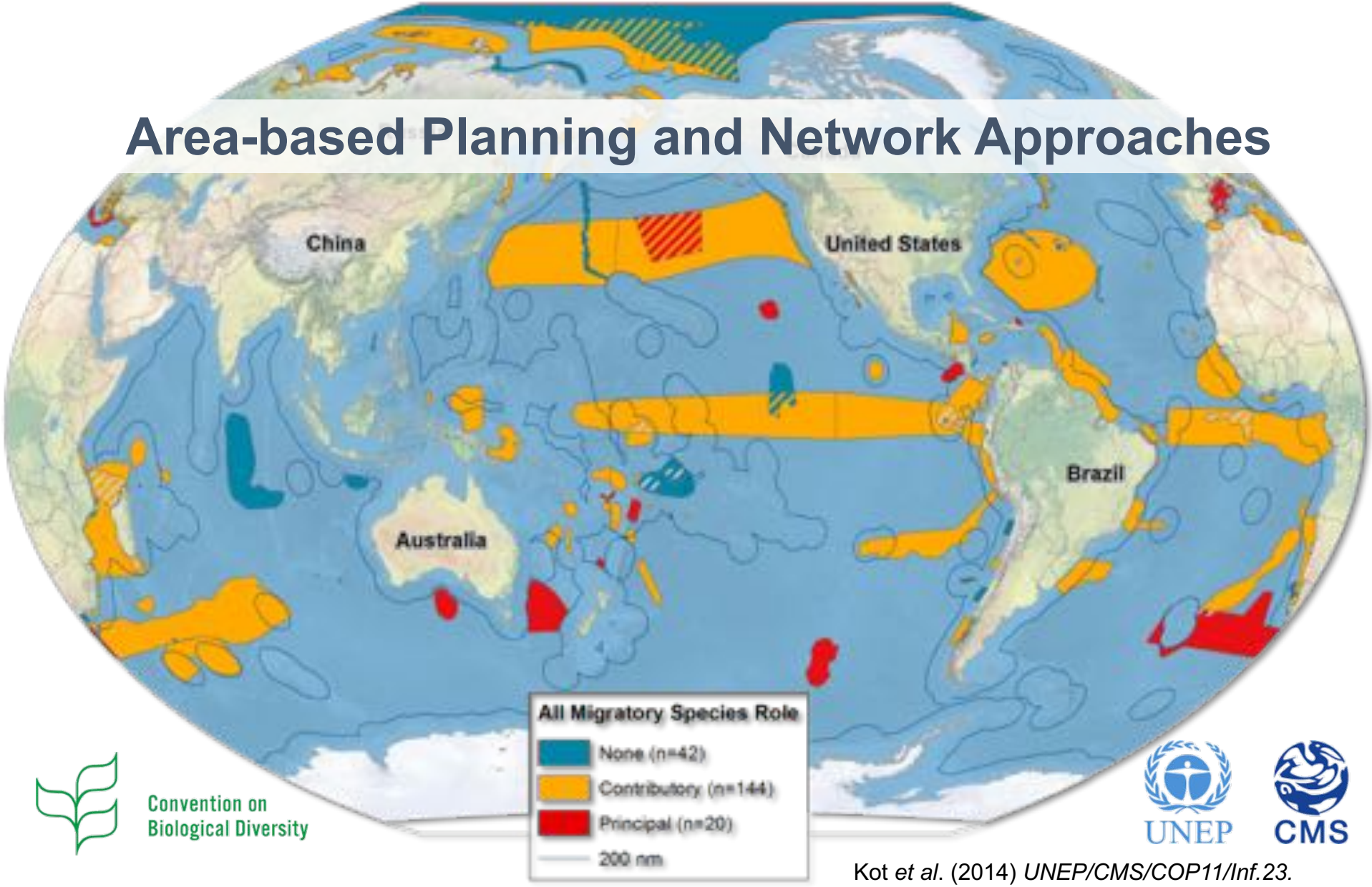
Area-based Planning and Network Approaches



Convention on Biological Diversity

UNEP CMS

Kot *et al*. (2014) *UNEP/CMS/COP11/Inf.23.*

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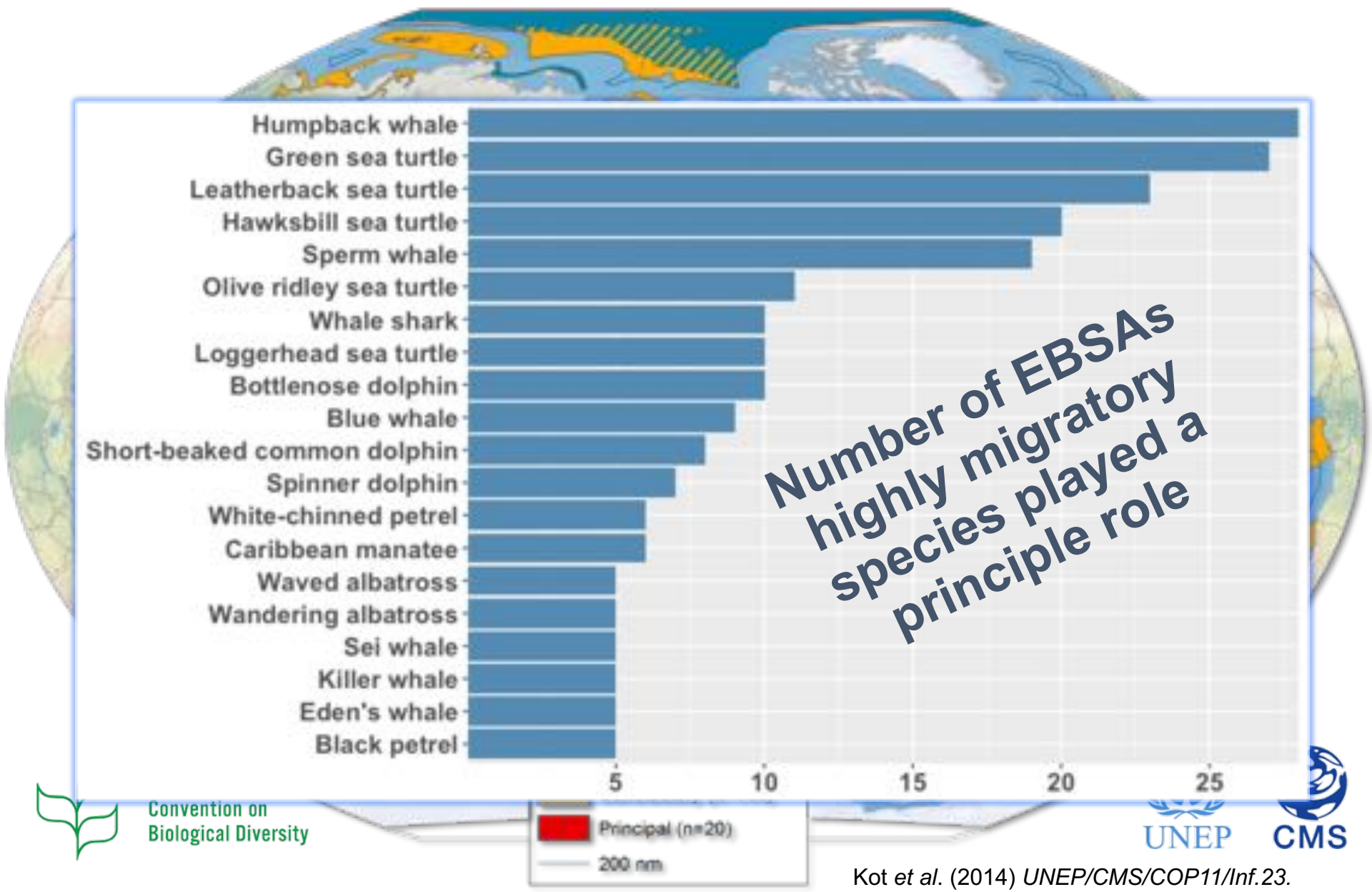

Convention on Biological Diversity

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Kot *et al*. (2014) *UNEP/CMS/COP11/Inf.23.*

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Literature Review and Data Compilation

Data Type		Connection	
	Telemetry	Sites Routes	Points with dates (individuals identified), high spatial resolution
	Mark-Recapture	Sites	Points with dates (individual identified), high spatial resolution
	Passive Acoustic	Sites	Points with dates (populations or individuals identified), often coarse spatial resolution
	Genetics	Sites	Points with variable temporal information (populations or individuals identified), variable spatial resolution
	Stable Isotopes	Sites	Points with variable temporal information (populations or individuals identified), often coarse spatial resolution

Scaling up Data to Knowledge

DATA

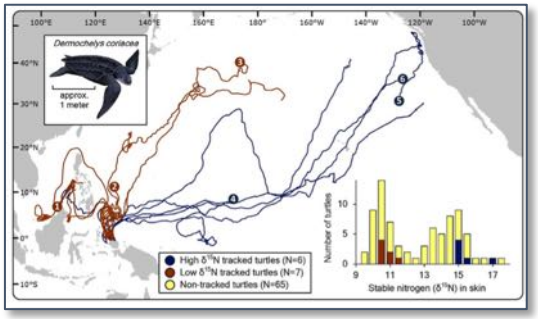
- Sites
- Routes

ANALYSIS

KNOWLEDGE

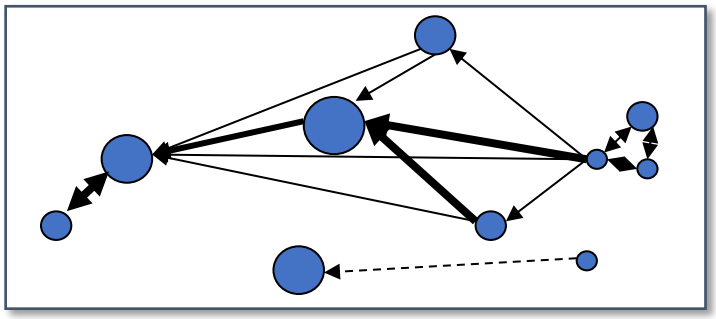
- Nodes
- Corridors

"Raw" observations,
Geographic representation



Seminoff *et al*. (2012) *PLoS ONE.*

Interpreted patterns,
Functional representation



Using Knowledge for a Framework

KNOWLEDGE

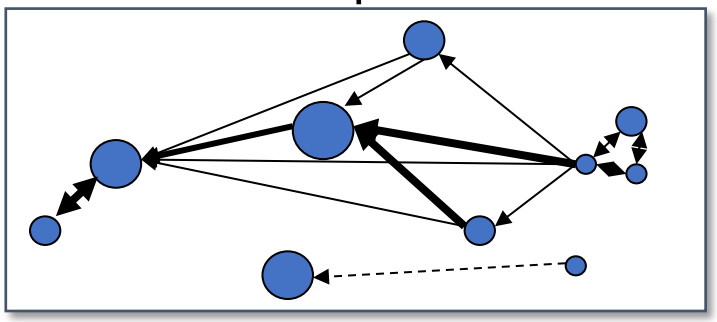
- Nodes
- Corridors

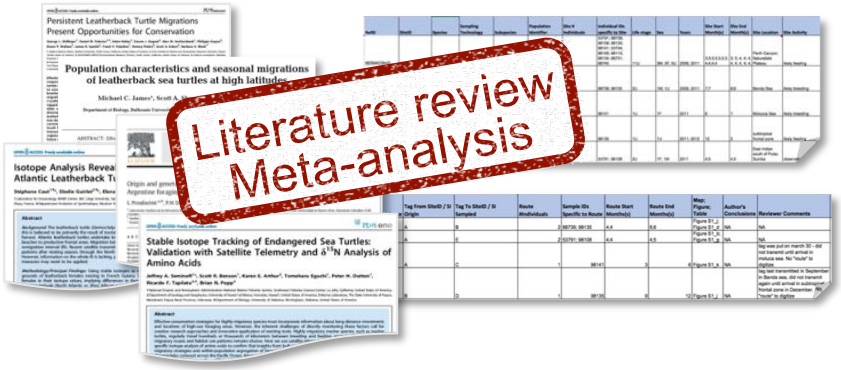
RESULTS

FRAMEWORK to assess:

- Function
- Relative importance
- Interconnections
- Alternative pathways

Interpreted patterns,
Functional representation





Communicating Knowledge with New Tools

KNOWLEDGE

- Nodes
- Corridors

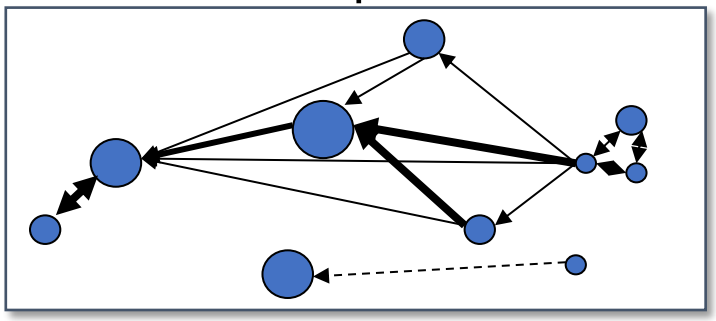
RESULTS

COMMUNICATION TOOLS

to explain:

- Function
- Relative importance
- Interconnections
- Alternative pathways

Interpreted patterns,
Functional representation



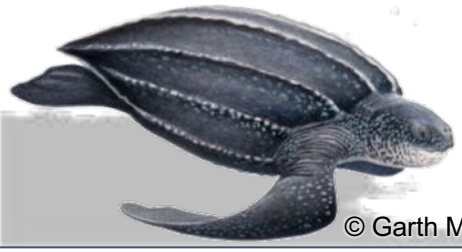
Telemetry & stable isotope data from Seminoff *et al*. (2012) *PLoS ONE.*

Mark-recapture data from James *et al*. (2007) *MEPS.*

Stable isotope data from Caut *et al*. (2008) *PLoS ONE.*

Utilization distribution data from Shillinger *et al*. (2004) *PLoS Biol.*

Genetic data from Prosdocimi *et al*. (2014) *JEMBE.*



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Telemetry & stable isotope data from Seminoff *et al*. (2012) *PLoS ONE.*

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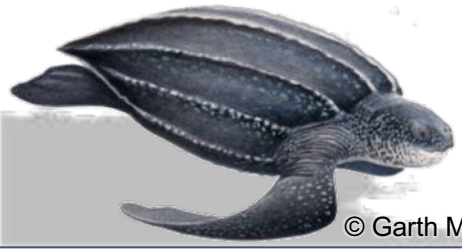

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Kilometers
0 750 1,500 3,000 4,500 6,000

Sea Turtle Case Study: Data

- Telemetry and mark-recapture data for 7 species
- How to contribute:
  - Direct transfer to MiCO initiative
  - Established network connections
    - ❑ Seaturtle.org/STAT
    - ❑ OBIS-SEAMAP
    - ❑ SWOT
- High level of interest/engagement

seaturtle.org

OBIS-SEAMAP

SWOT
The State of the World's Sea Turtles

Seabird Case Study: Data

- Telemetry and mark-recapture data for 7 species
- How to contribute:
  - Direct transfer to MiCO initiative
  - Requested through network connections
    - ❑ BirdLife Seabird Tracking Database
    - ❑ USGS North American Bird Banding Program
    - ❑ Smithsonian Institute Migratory Bird Center
- High level of interest/engagement

BirdLife INTERNATIONAL

USGS science for a changing world

Smithsonian Institution

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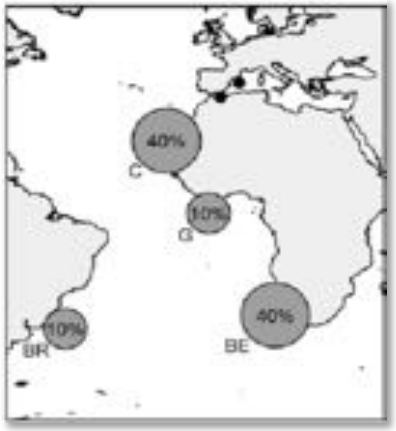
Examples for Visualizing Connectivity: Nodes

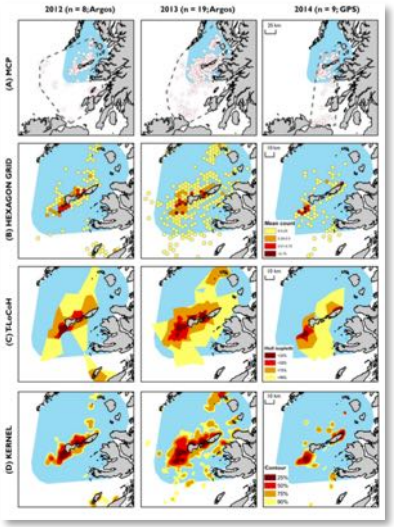
Increasing complexity

- General location and utilization
  - Center of node placed in general geographic location
  - Size is scaled by quantity (e.g., % birds tracked in wintering zones)



Pérez *et al*. (2014) *Behav Ecol*.

- Utilization distribution
  - Minimum convex polygon/hull (MCH)
  - Grid density
  - Local convex hull (LoCoH)
  - Kernel density

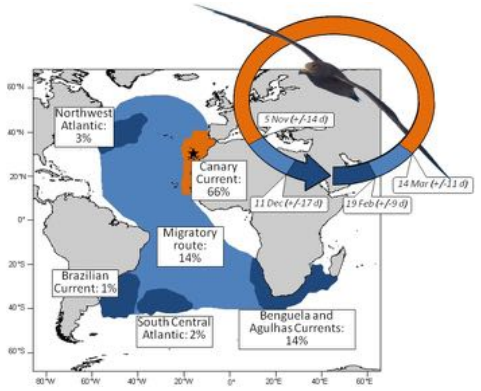


Doherty *et al*. (2017) *Biol Conserv*.

Examples for Visualizing Connectivity: Corridors

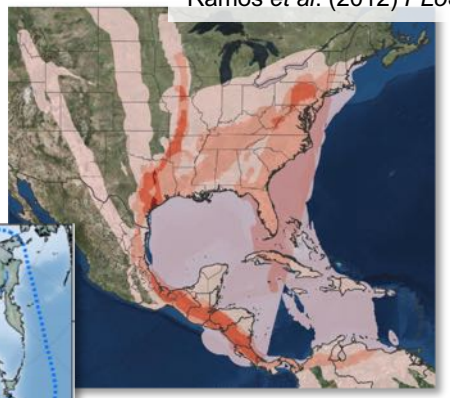
Increasing complexity

- Schematic
  - general extents delineating activities; simplified paths

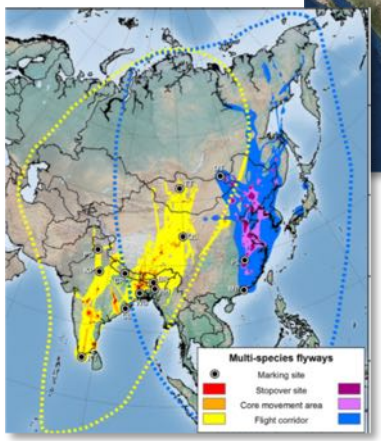


Ramos *et al*. (2012) *PLoS ONE*.

- Utilization distribution
  - Gridded line density
  - Line-based kernel density estimate
  - Brownian bridge



Brenner *et al*. (2016) *TNC*.

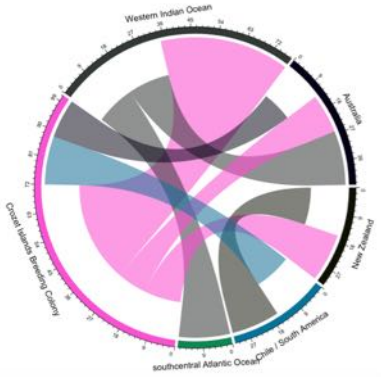


Palm *et al*. (2015) *Movement Ecol.*

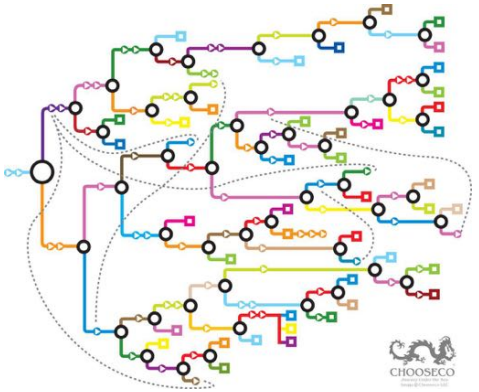
Examples for Visualizing Connectivity: Networks

Increasing complexity

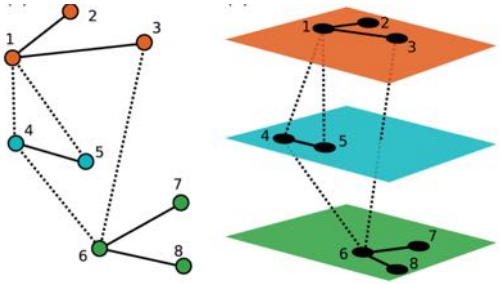
- 2D adjacency matrix
- Chord diagrams
- Hierarchical graph-networks



Adapted from Weimerskirch *et al*. (2015) Sci Rep.

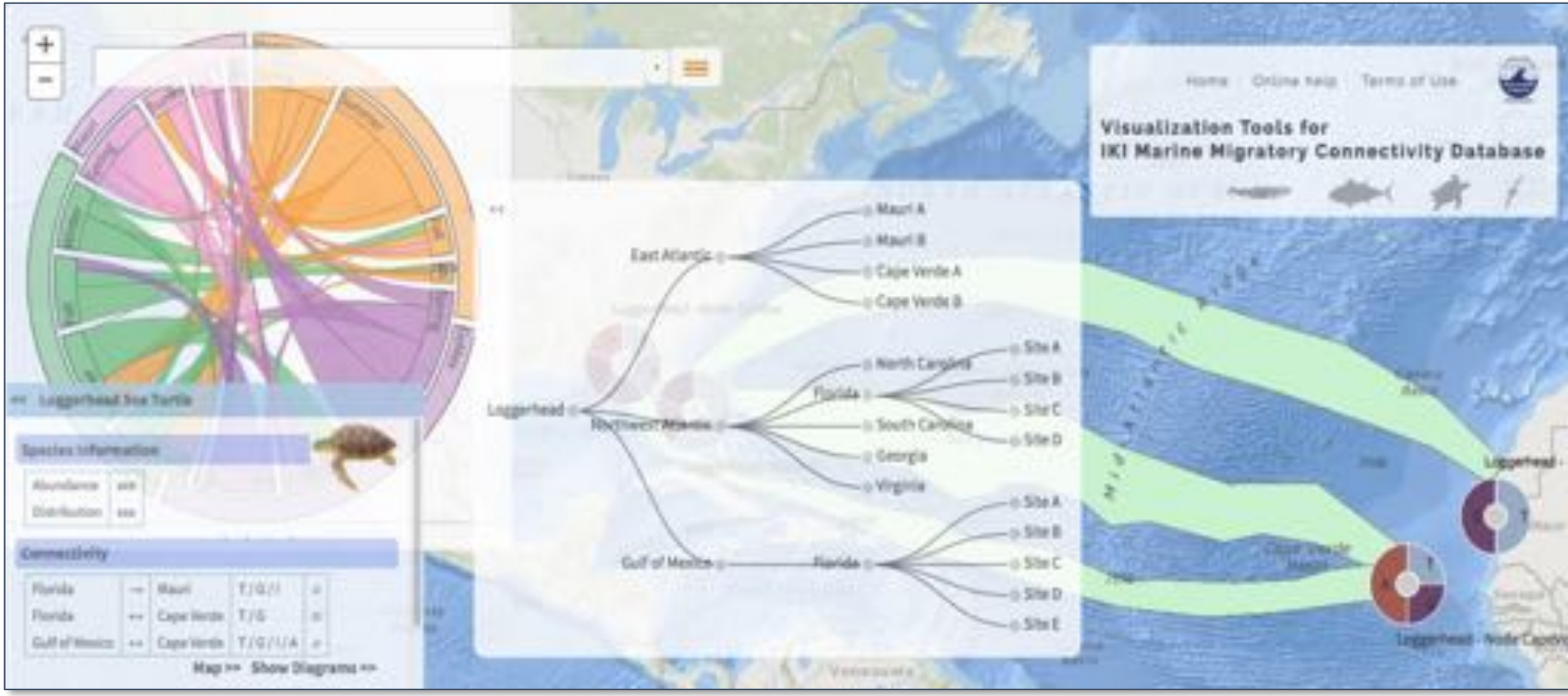


https://flowingdata.com/2017/06/15/mappings-for-choose-your-own-adventure-books



Kivelä *et al*. (2014) J Complex Networks.

Sandbox Fun!


Visualization Tools for
IKI Marine Migratory Connectivity Database
Loggerhead
East Atlantic
Mauri A
Mauri B
Cape Verde A
Cape Verde B
Florida
Site A
Site B
Site C
Site D
Georgia
Virginia
Gulf of Mexico
Site E
Species Information
Connectivity
Map >> Show Diagrams >>

Questions?

Migratory Connectivity in the Ocean
http://www.micosystem.org

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