Resilient MPAs and MPA Networks

Trina Leberer

The Nature Conservancy

Guam - August 2009

Five Guiding Design Criteria

Five criteria to help guide the design and planning for individual MPAs and MPA networks:

1. Representation & Replication
2. Critical Areas
3. Connectivity
4. Size, Shape, & Spacing
5. Socioeconomic

Resilient MPAs and MPA Networks

Section 1:

Representation and Replication

The Nature Conservancy

Protecting nature. Preserving life.

Resilient MPAs:
Representation & Replication

Why Representation?

1. Different coral reef habitats support different groupings of coral species
2. Protecting a variety of coral reef habitats will help conserve biodiversity by:
   - preserving full range of coral communities
   - maintaining diverse larval supply

Resilient MPAs: Representation & Replication

Three factors to consider and account for in MPA planning for representation:

1. ***Biodiversity composition:*** each habitat supports a unique community, and most marine animals use more than one habitat during their lives
2. ***Biogeographic structure:*** the environmental/latitudinal gradients in habitats and species composition
3. ***Ecosystem integrity:*** maintenance of the ecological processes of the system

Resilient MPAs & Networks

Resilient MPAs & Networks

Resilient MPAs:
Representation & Replication

What can you do?

- Determine detailed reef classification (types, zones)
- Determine values and threats
- Select and protect different reef habitats/coral communities

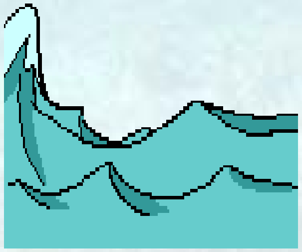
Resilient MPAs: Representation & Replication

Reef classification

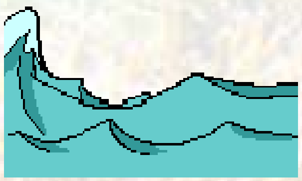
What information can you use?

- reef types, major reef zones
    - Barrier, mid-shelf patch, inshore fringing
    - Fore-reef, spur & groove, reef crest, back reef
- distance from shore (salinity, turbidity)
- neighboring and linked habitats
- condition: biodiversity, levels of use, threats, bleaching response
- waves, winds, currents, depth

Consider physical characteristics



Extremely high wave energy: coralline algal ridge replaces corals
High-energy (outer) reef crest: small, low profile, robust/encrusting



Moderate-energy (mid-shelf): large, branching, columns, tables

Low-energy inshore/deep: branching, plates, massive heads

Deeply sheltered bays/lagoons: delicate, branching, whorls, tables

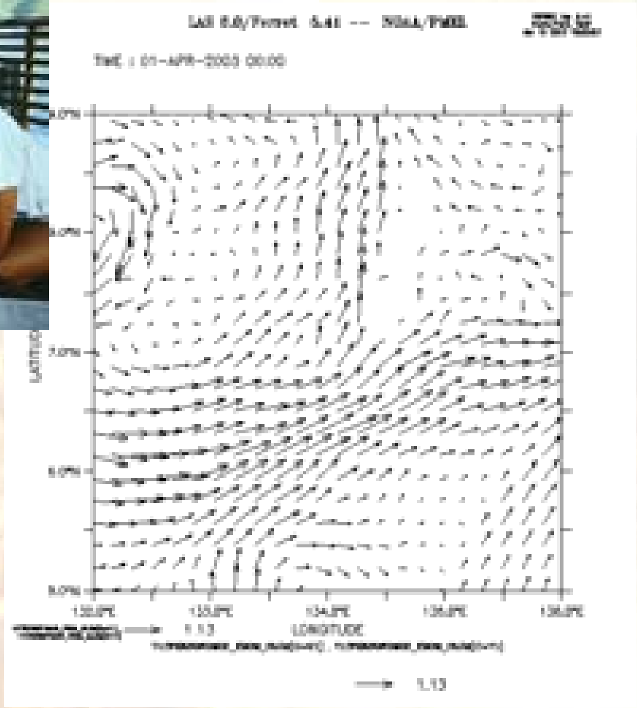
Resilient MPAs:

Representation & Replication

Reef classification

Where to find information?

- Images, maps, nautical and weather sources, experts

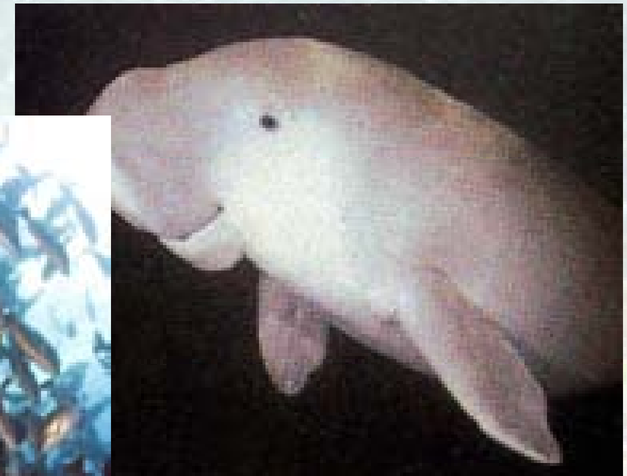


A good source to start:

- Millennium coral reef mapping
- Millenium Coral Reef Landsat Archive
- Oceanographic and current data

Resilient MPAs:
Representation & Replication

Determine values and threats



Values:
- recreation, tourism,
- fisheries, coastal
- protection, research,
- fish/coral biodiversity,
- threatened species

Threats:
- destructive uses,
- pollution, disease,
- development, predation,
- climate change

Resilient MPAs: Representation & Replication

Determine values and threats

Ask those who know

Rapid assessment

Resilient MPAs: Representation & Replication

Why Replication?

- To provide a stepping-stone for the dispersal of marine species
- To insure against catastrophic local disasters
- For use as reference sites during monitoring and to evaluate the effects of human influences on communities

Resilient MPAs:
Representation & Replication

Tips for Replication

- Aim for at least 3 replicates
  - The number of replicates of each habitat type must be a balance between ensuring representation and ensuring effective monitoring and enforcement
- Large areas (100s–1000s km): MPA should conserve a representative example of each bioregion
- Smaller areas (1 km–100s km): MPA should include reef types and major reef zones, which can serve as proxies (or substitutes) for community types

Resilient MPAs and MPA Networks

Section 2:

Critical Areas

The Nature Conservancy
Protecting nature. Preserving life.

NOAA

Resilient MPAs & Networks:
Critical Areas

Five criteria to help guide the design and planning for individual MPAs and MPA networks:

1. Representation & Replication
2. **Critical Areas**
3. Connectivity
4. Size, Shape, & Spacing
5. Socioeconomic

Resilient MPAs & Networks: Critical Areas

Identify ecologically significant areas

- Sources of larvae and spawning aggregations
- Nursery and breeding grounds of fish and other marine organisms
- Developmental and feeding habitats
- Migration corridors
- Sea turtle nesting areas

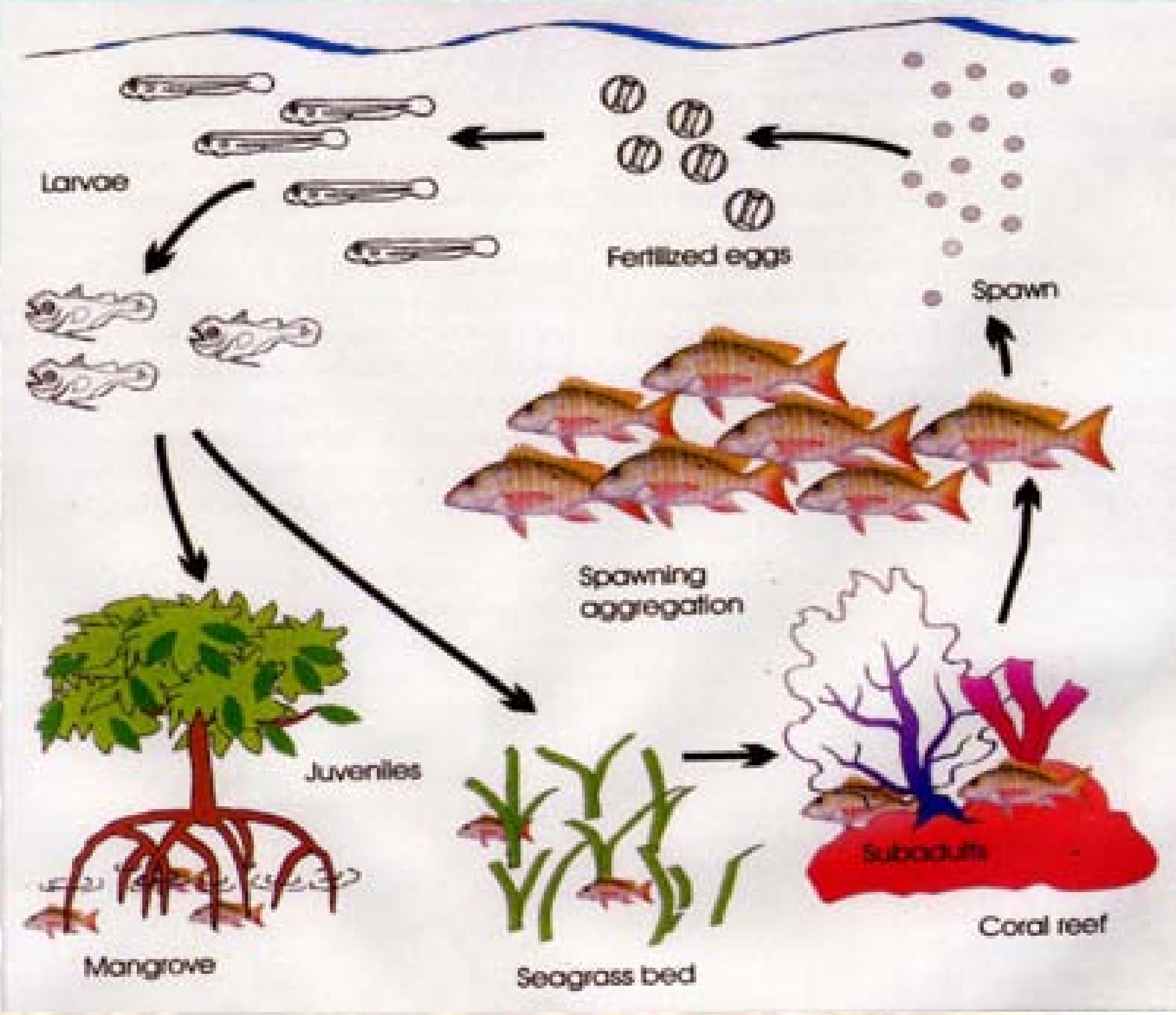
and unique or vulnerable habitats

- Coral reefs
- Deep-sea coral communities
- Oyster reefs
- Salt marshes
- Seagrass beds
- Mangroves

© D. Burdick, NOAA photo library

Resilient MPAs & Networks: Critical Areas

and <u>source areas</u>



Resilient MPAs & Networks: Critical Areas

Identify reef communities or coral types that display resistance to bleaching

Physical factors that :

- Reduce temperature stress
- Enhance water movement
- Decrease light and radiation stress
- Correlate with bleaching tolerance

and/or display resilience to bleaching

- Availability and abundance of local larvae recruits
- Evidence of recruitment success
- Diversity and abundance of different coral reef taxa
- Low abundance of bioeroders, corallivores, and diseases
- Effective management regime supported by legal framework, participation and enforcement
- Larval transport and connectivity by currents
- Concentration of larval supply (e.g., concentration and settlement)

Resilient MPAs and MPA Networks

Section 3:

Connectivity

Resilient MPAs & Networks: Connectivity

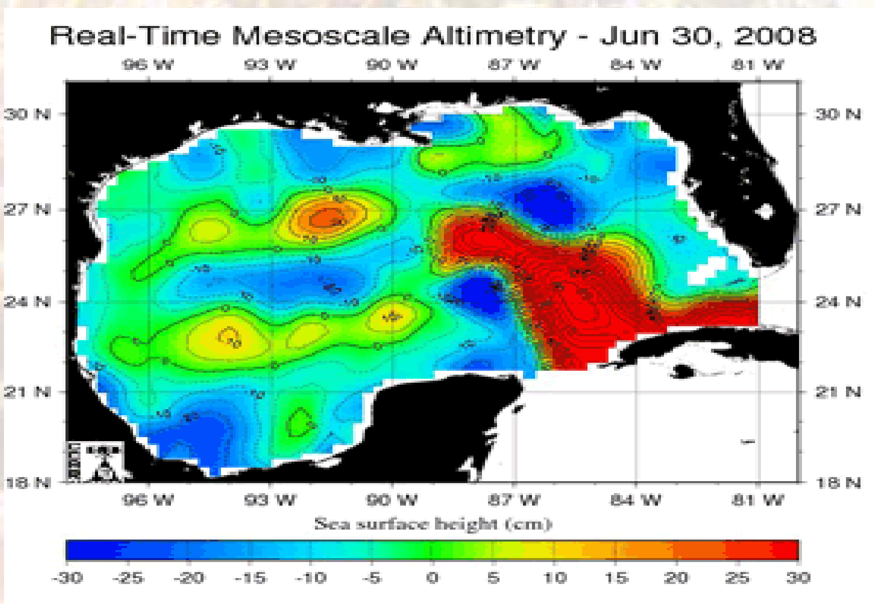
Five criteria to help guide the design and planning for individual MPAs and MPA networks:

1. Representation & Replication
2. Critical Areas
3. **Connectivity**
4. Size, Shape, & Spacing
5. Socioeconomic

Resilient MPAs & Networks: Connectivity

What is connectivity?

Connectivity describes the extent to which populations in different parts of a species range are linked by the exchange of eggs, larval recruits, or other propagules, juveniles, or adults, as well as the ecological linkages associated with adjacent and distant habitats.



Resilient MPAs & Networks: Connectivity

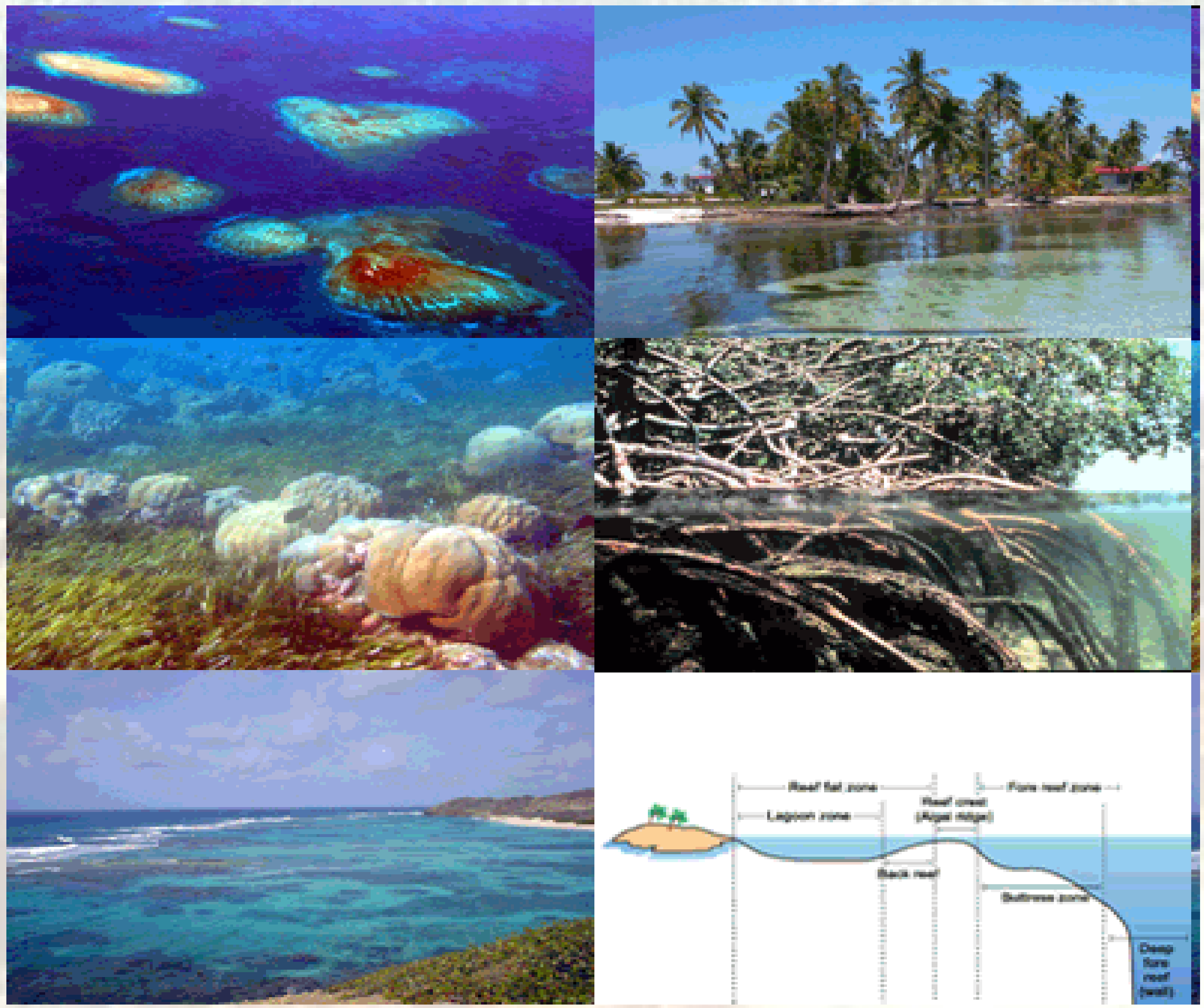
Connectivity includes:

- Connections between adjacent habitats
- Connections between distant habitats
- Connections through larval dispersal in the water column between and within sites
- Connections through adult movements in their home range, from one site to another, or because of spillover effects from MPAs

Resilient MPAs & Networks: Connectivity

Adjacent habitats are linked through the flow of matter, energy, and organisms.

- Reef flats
- Back-reef lagoons
- Seagrass beds
- Sand flats
- Mangroves
- Beaches and dunes



Resilient MPAs & Networks: Connectivity

Coral reefs are linked to distant areas by dynamic processes and may be influenced by activities occurring in remote areas

What can you do?

- Take a “ridge to reef” approach to resource management
- Use an integrated approach to coastal management addressing ecological linkages, fisheries, recreation, research, and ecosystem function

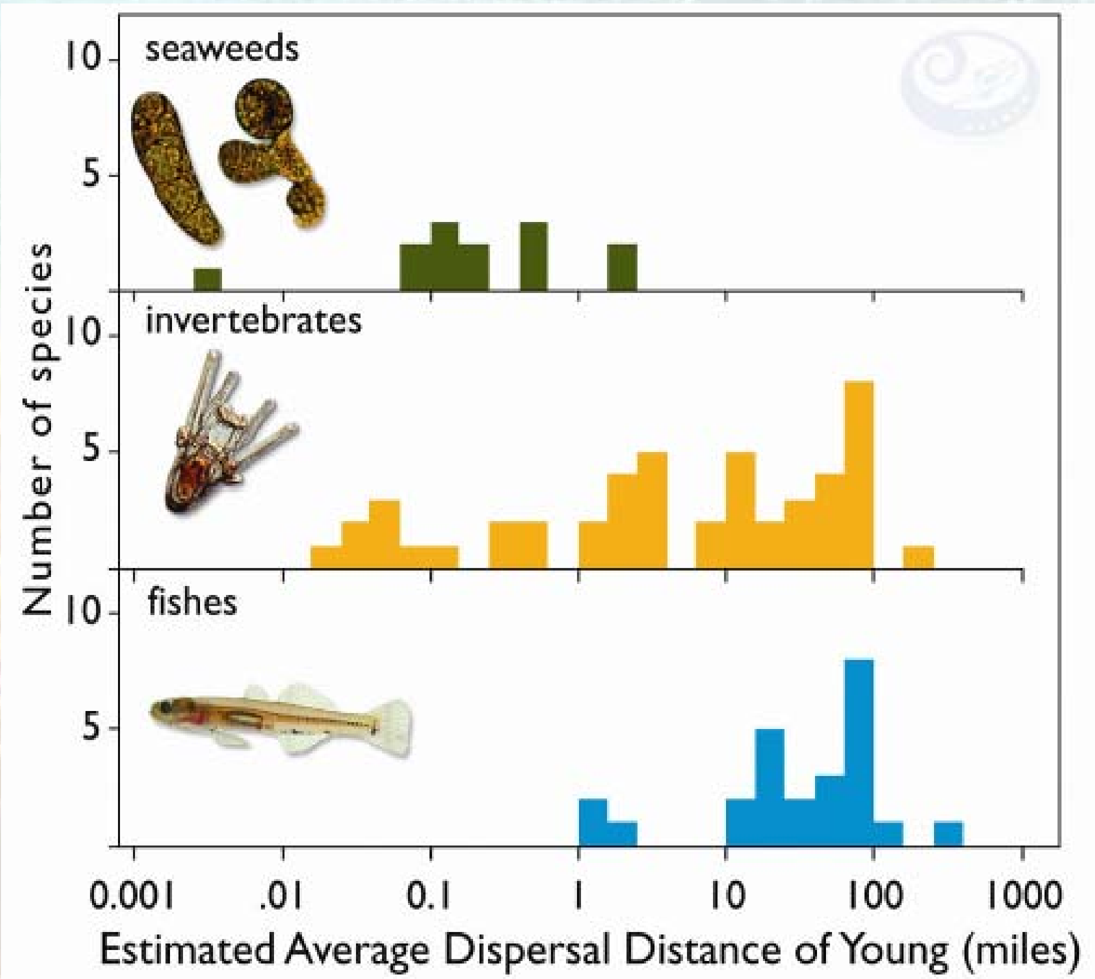
Resilient MPAs & Networks: Connectivity

Patterns of larval dispersal influenced by:

- Larval behavior
- Larval duration: species-specific; ranging from hours to months, and typical pelagic duration is 28-35 days
- Food resources
- Predators encountered
- Influences of currents or other oceanographic factors

Resilient MPAs & Networks: Connectivity

Estimated average larval dispersal distances



Focus on assemblage of species rather than larval dispersal patterns of a few.

Data: Kinlan & Gaines (2003); PISCO

Resilient MPAs & Networks: Connectivity

Consider adult movement patterns

Range of Movement (km)	Adult Life stage	Larval Life stage
> 1000s	Large migratory species (e.g., baleen whales, turtles)	Many species
100s – 1000s	Large pelagic fish (e.g., blue fin tuna)	Some fish
10s – 100s	Most benthic fish and small pelagic fish (e.g., mackerel, kingfish)	Most fish; most invertebrates
1 – 10s	Small benthic fish and benthic invertebrates	Algae, planktonic direct developers, few fish
<1	Sessile species and species with highly specialized habitat needs	Benthic species and direct developers
Adapted from Palumbi 2004		

Resilient MPAs & Networks: Connectivity

What can you do?

- Gather information on target species larval dispersal and adult movement distances and patterns
- Place MPAs in a wide variety of places in relation to the prevailing currents
- In areas where currents are complex (e.g., eddies or reverse flows), spread MPA sites evenly
- With strongly directional currents, place MPAs in upstream locations to support recruitment to other management areas
- Link MPAs by prevailing currents to facilitate the recovery of damaged areas and maintenance of biodiversity

Resilient MPAs and MPA Networks

Section 4:

Size, Shape, and Spacing

The Nature Conservancy
Protecting nature. Preserving life.™

Resilient MPAs & Networks: Size, Shape, and Spacing

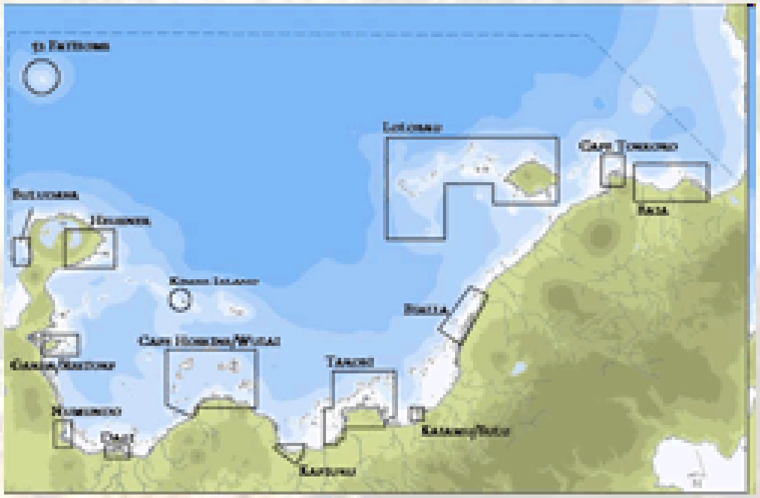
Five criteria to help guide the design and planning for individual MPAs and MPA networks:

1. Representation & Replication
2. Critical Areas
3. Connectivity
4. **Size, Shape, & Spacing**
5. Socioeconomic

Resilient MPAs & Networks:
Size, Shape, and Spacing

Why size, spacing, and shape?

- Facilitate and promote connectivity between and within the MPA/network
- Influence the degree to which conditions in the wider environment affect MPA
- Vary with the goals and objectives of the MPA, as well as the social and economic environment in which it is located



Resilient MPAs & Networks:
Size, Shape, and Spacing

Optimal Size

10-20 km in diameter - across minimum width

WHY:

- For biodiversity: few large MPAs are preferable to many smaller MPAs
- Consider feasibility of management (one large = easier)

Resilient MPAs & Networks: Size, Shape, and Spacing

Optimal Spacing

MPAs should be spaced within 10 - 20 km of one another (closer is better)

WHY? (Connectivity!)

- Capture the biogeographic range of variation in habitats and species
- More closely spaced MPAs are more likely to be ecologically connected and protect a greater number of species through movement of young and increased recruitment from other MPAs

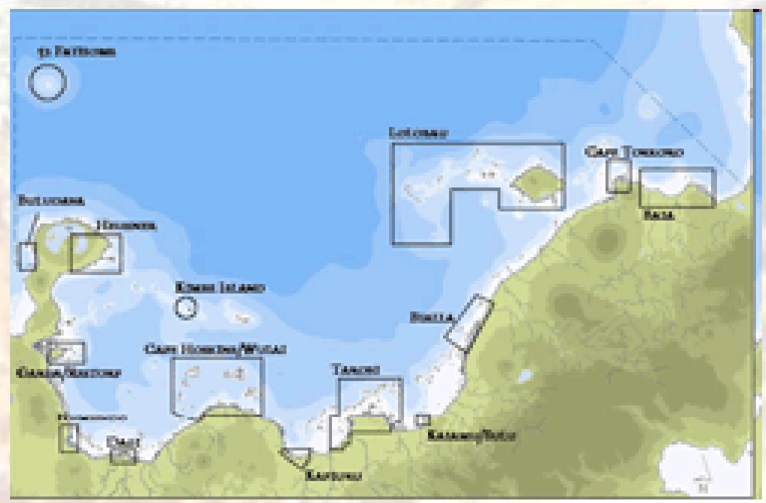
Resilient MPAs & Networks:
Size, Shape, and Spacing

<u>Shape</u>

Regular MPA shapes of squares or rectangles are preferable

Why?

- Can be delineated by lines of latitude and longitude, and therefore more easily identified by user groups
- Minimize edge effects



Resilient MPAs and MPA Networks

Section 5:

Socioeconomics

The Nature Conservancy
Protecting nature. Preserving life.™

Resilient MPAs & Networks: Socioeconomics

Five criteria to help guide the design and planning for individual MPAs and MPA networks:

1. Representation & Replication
2. Critical Areas
3. Connectivity
4. Size, Shape, & Spacing
5. **Socioeconomic**

Resilient MPAs & Networks: Socioeconomics

Why Socioeconomic Criteria?

- MPA creation can help move to a more holistic approach, including human and ecosystem interactions, and cumulative impacts
- Multi-objective approach can create a foundation that transforms the way people address conflicts between the environment and the economy

© S. Wear/TNC

Resilient MPAs & Networks: Socioeconomics

Which Socioeconomic Criteria?

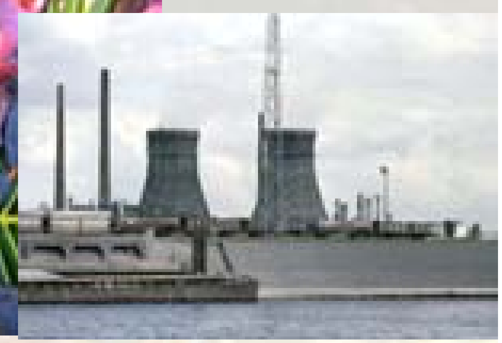
Tourism: Often a majority of income, especially in developing countries, comes from tourism

Fisheries: Commercial and some artisanal fishing can have the largest impacts, and be most impacted by MPA networks

Other (climate change, ports/marinas, coastal development)

© Wolcott Henry 2005/Marine Photobank

© S.Kilarski



Resilient MPAs & Networks: Socioeconomics

What can you do?

Measure ecosystem services thru:

- valuation papers
- practical guidelines (SOCMON)
- NOAA Coasts – I do not know what this is??????????

Include socioeconomic info in management:

- Prioritize areas to protect
- Balance between extractive and conservation uses

Summary

- Represent! (Do it 3x)
- Function & survival
- Stay connected
- Bigger is better
- Closer is better
- Square is better
- People people people

Kimbe Bay: A TNC Case Study

Kimbe Bay: A TNC Case Study
Conservation Targets

Habitats

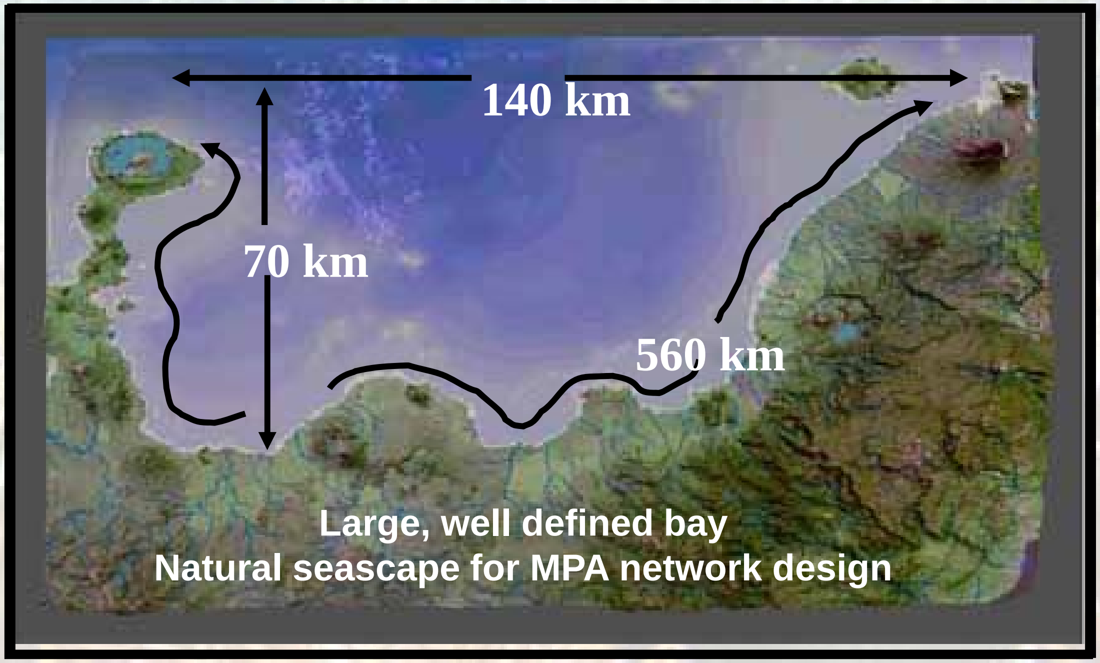
- Shallow: coral reefs, mangroves, seagrasses, estuaries
- Deep: oceanic waters, seamounts, canyons, upwellings and hydrothermal vents?
- Islands and associated flora and fauna

Species

- Rare & threatened
- Endemic (e.g. *Gobiodon*)
- Commercially important & exploited
- Large pelagic fish

Kimbe Bay: A TNC Case Study
Goals for the Kimbe MPA Network

- Scientifically Designed MPA network using marine reserve decision software – MARXAN
- Incorporate socioeconomic and cultural factors into design
- Incorporate resilience principles into design



Kimbe Bay: A TNC Case Study
Design Principles for the Kimbe MPA Network

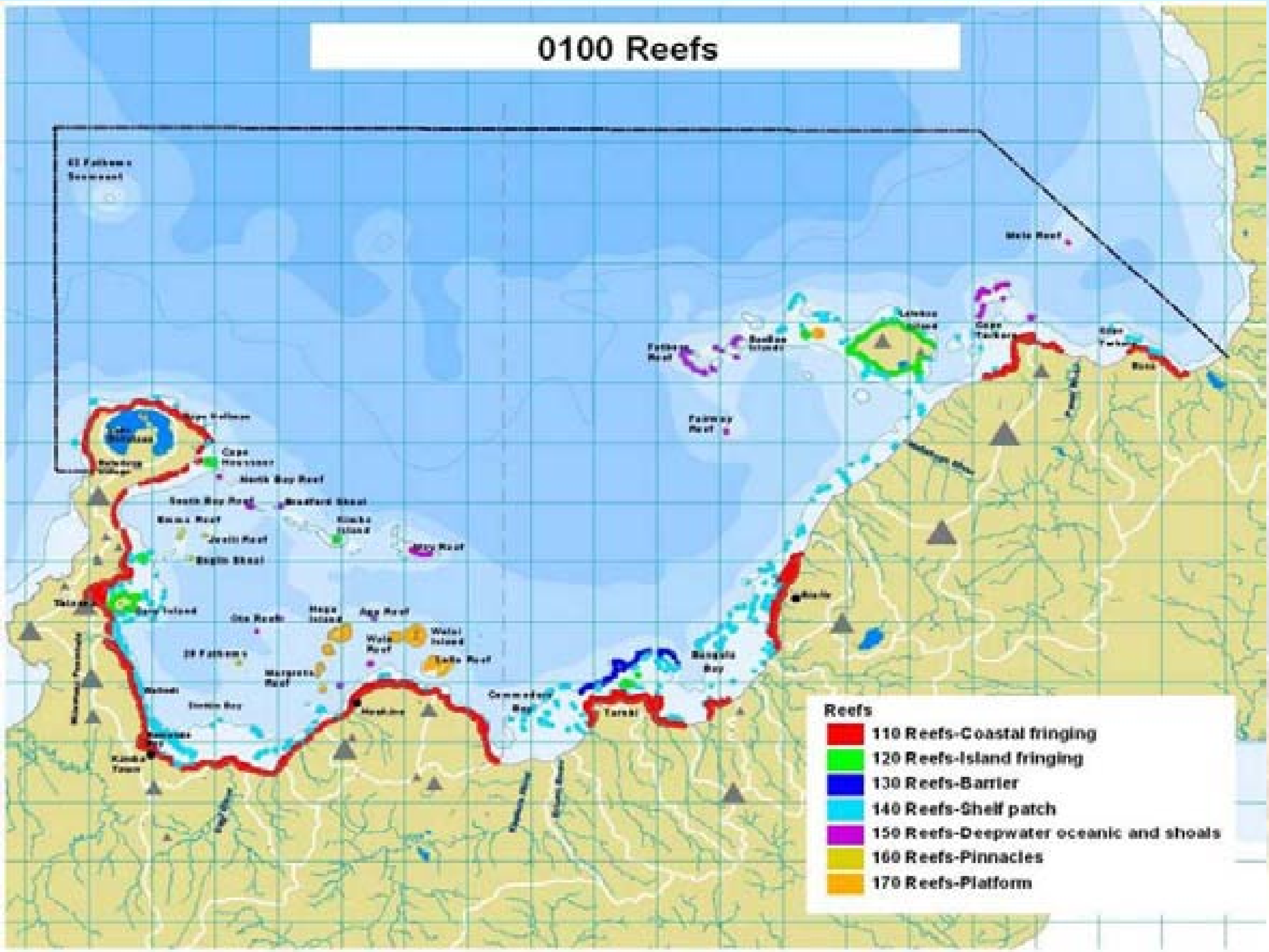
- Biophysical : To maximize biological objectives by taking into account key biological and physical processes.

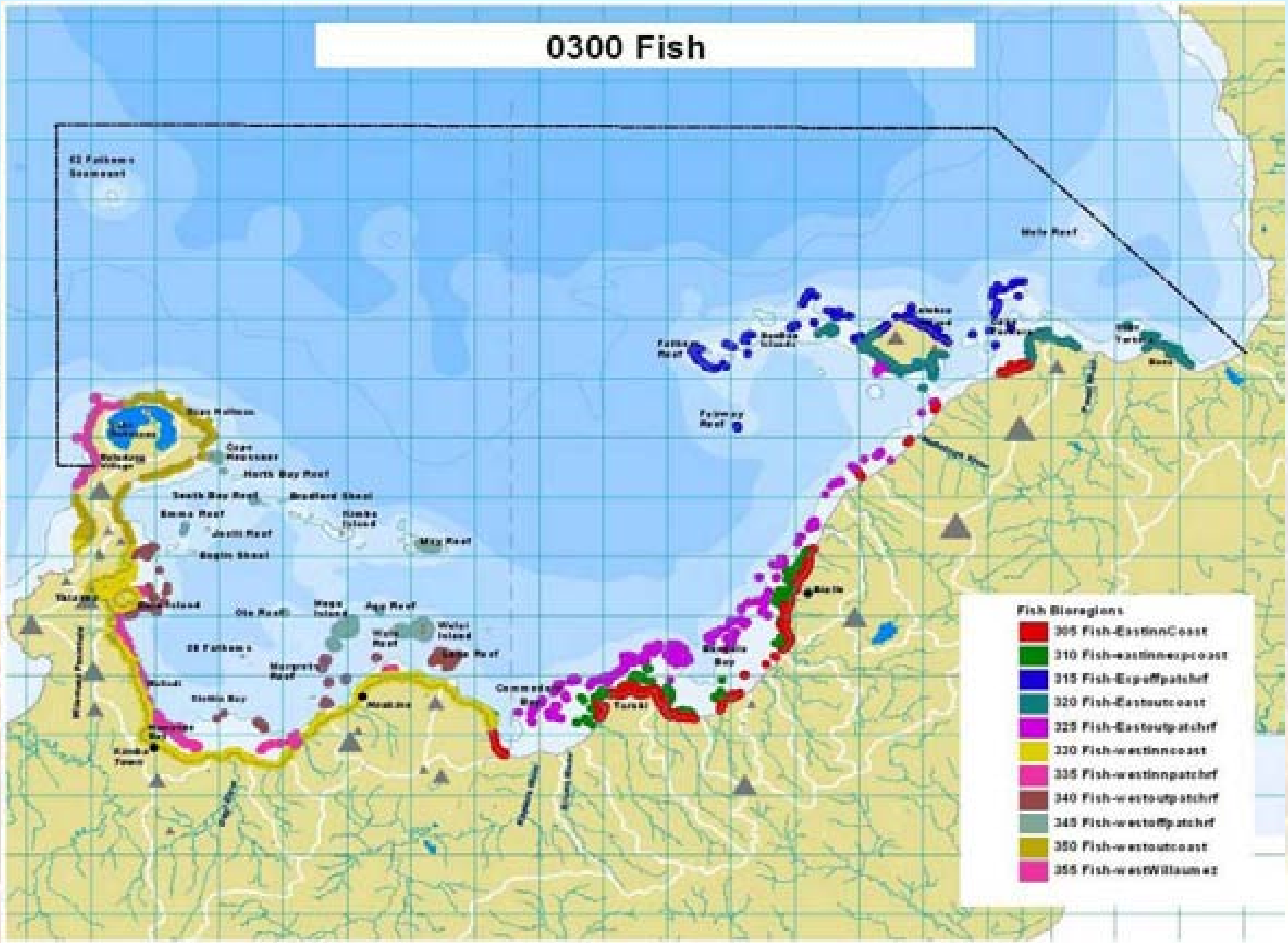
- Socioeconomic: To maximize benefits and minimize costs to local communities and sustainable industries.

Kimbe Bay: A TNC Case Study
Process for designing the Kimbe MPA Network

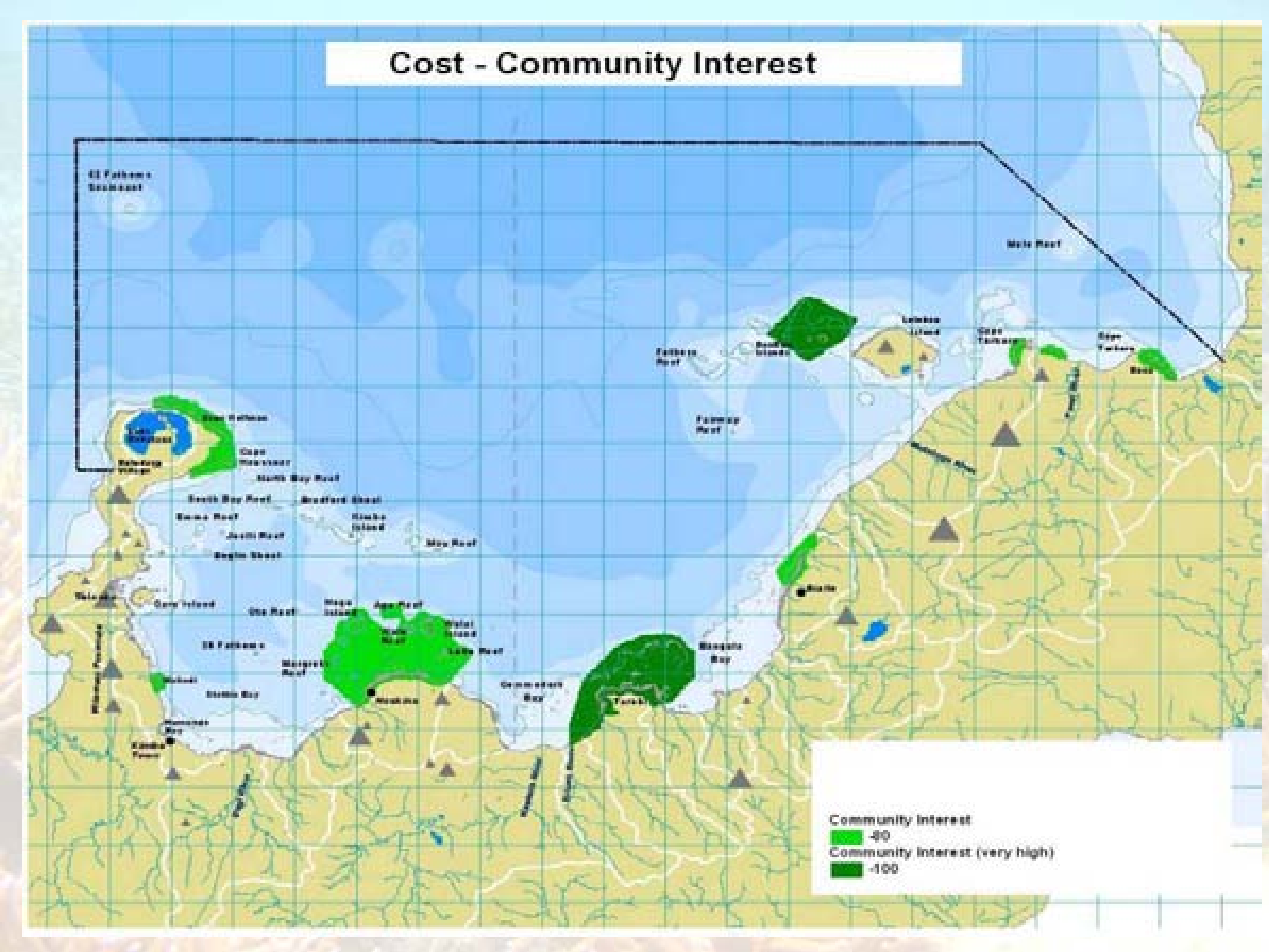
- Spread risk through representation and replication
- Identify and protect key sites

  (fish spawning, turtle nesting, resilient areas)
- Understand and incorporate patterns of connectivity
- Ensure reefs are as healthy as possible to increase resilience to climate change impacts

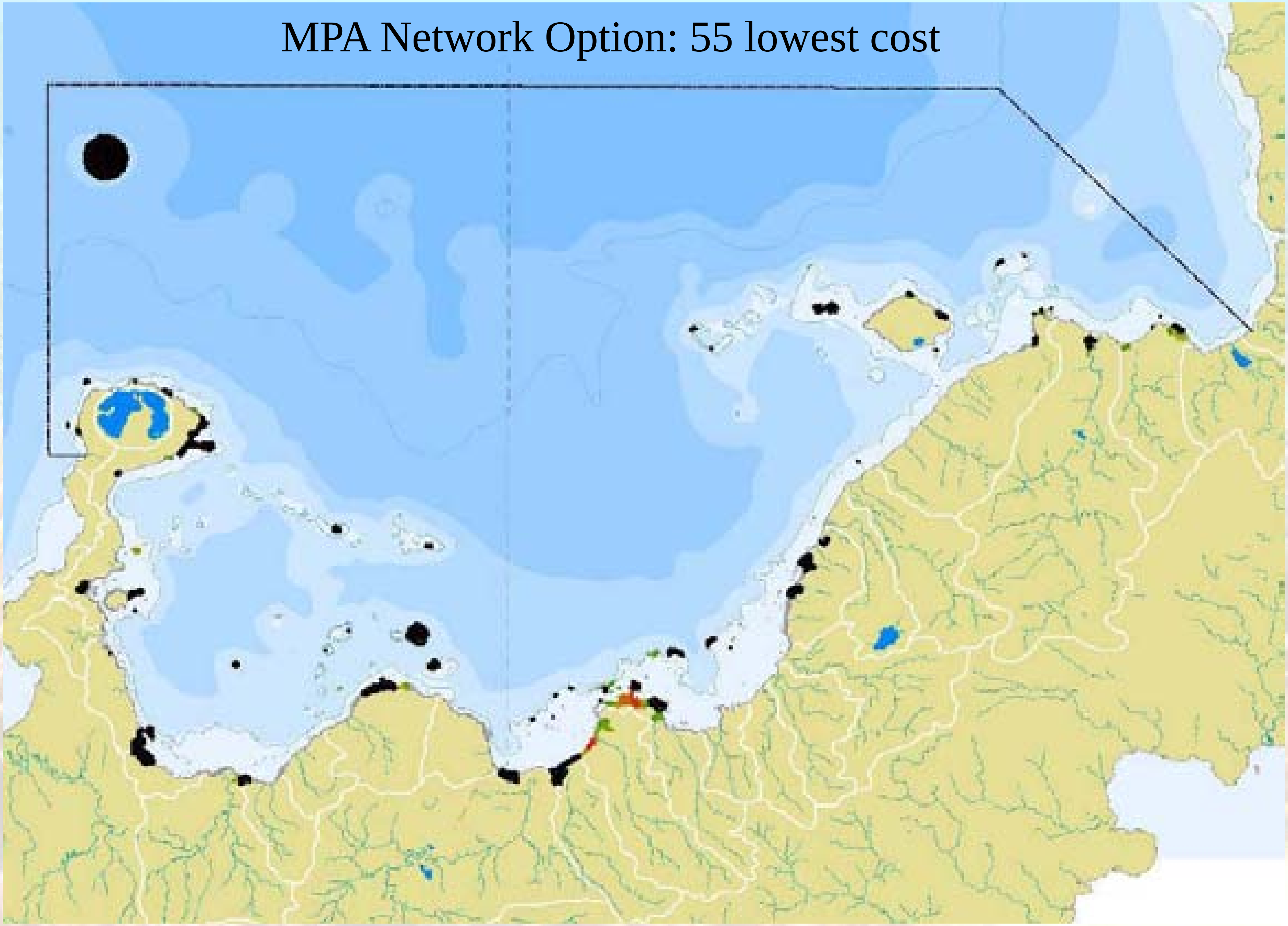

0100 Reefs
Reefs
110 Reefs-Coastal fringing
120 Reefs-Island fringing
130 Reefs-Barrier
140 Reefs-Shelf patch
150 Reefs-Deepwater oceanic and shoals
160 Reefs-Pinnacles
170 Reefs-Platform


0300 Fish
Fish Bioregions
305 Fish-EastinnCoast
310 Fish-eastinnexpcoast
315 Fish-Expoffpatchrf
320 Fish-Eastoutcoast
325 Fish-Eastoutpatchrf
330 Fish-westinncoast
335 Fish-westinnpatchrf
340 Fish-westoutpatchrf
345 Fish-westoffpatchrf
350 Fish-westoutcoast
355 Fish-westWillaumez

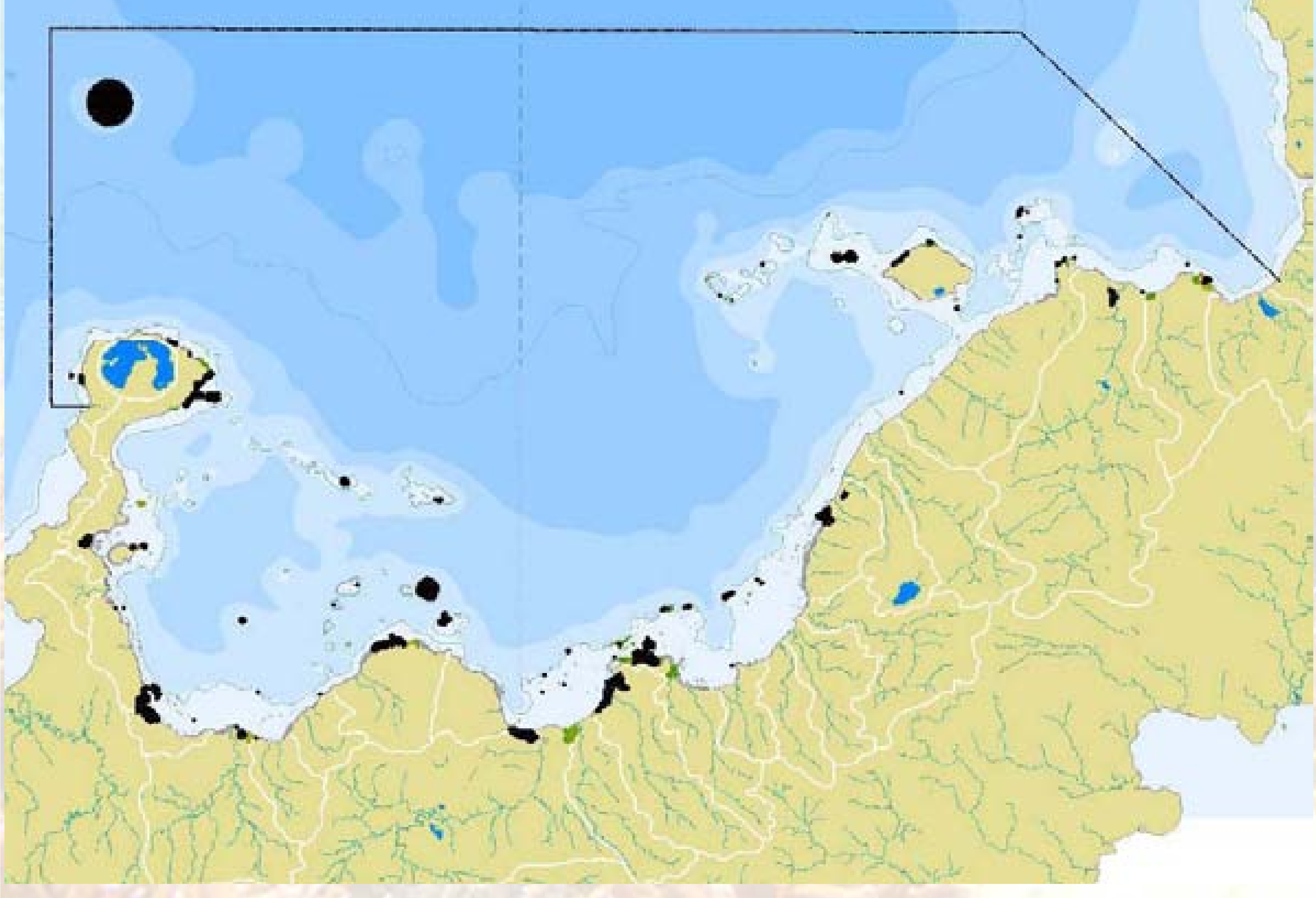

0700 Turtles
Turtles
710 Turtles-Leatherback and others
720 Turtles-Hawksbill and Green

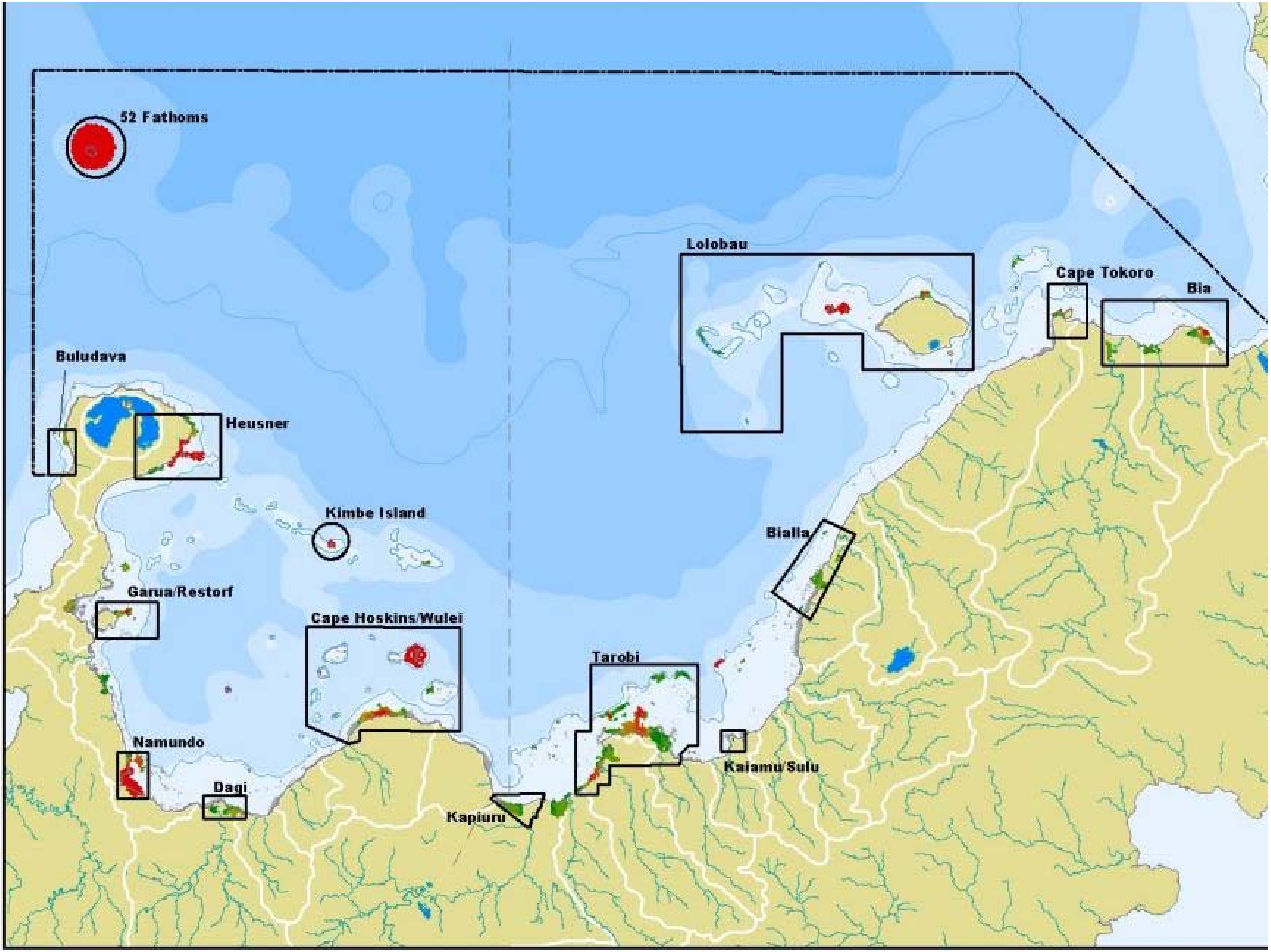

Cost - Community Interest
Community Interest
-80
Community Interest (very high)
-100

MPA Network Option: 55 lowest cost



MPA Network Option: 64 least planning units




52 Fathoms
Lolobau
Cape Tokoro
Bia
Buludava
Heusner
Kimbe Island
Bialla
Garua/Restorf
Cape Hoskins/Wulei
Tarobi
Namundo
Kaiamu/Sulu
Dagi
Kapiuru

Kimbe Bay: A TNC Case Study
Lessons Learned

Scientific design process:

- Technical but straightforward
- Expert, local, and traditional knowledge critical to design process

Application of RESILIENCE concepts:

- Protecting adjacent connected habitats straightforward
- Connectivity with habitat types still largely unknown
- Indentifying and protecting resilient sites challenging need further data

Kimbe Bay: A TNC Case Study
Lessons Learned (cont)

In Absence of Data:
- Use rules of thumb
- Spread risk
- Adaptative management


The future is worrying,
but not foretold....