From Habitat Mapping to Ecological Function: Incorporating habitat into coral reef fisheries management

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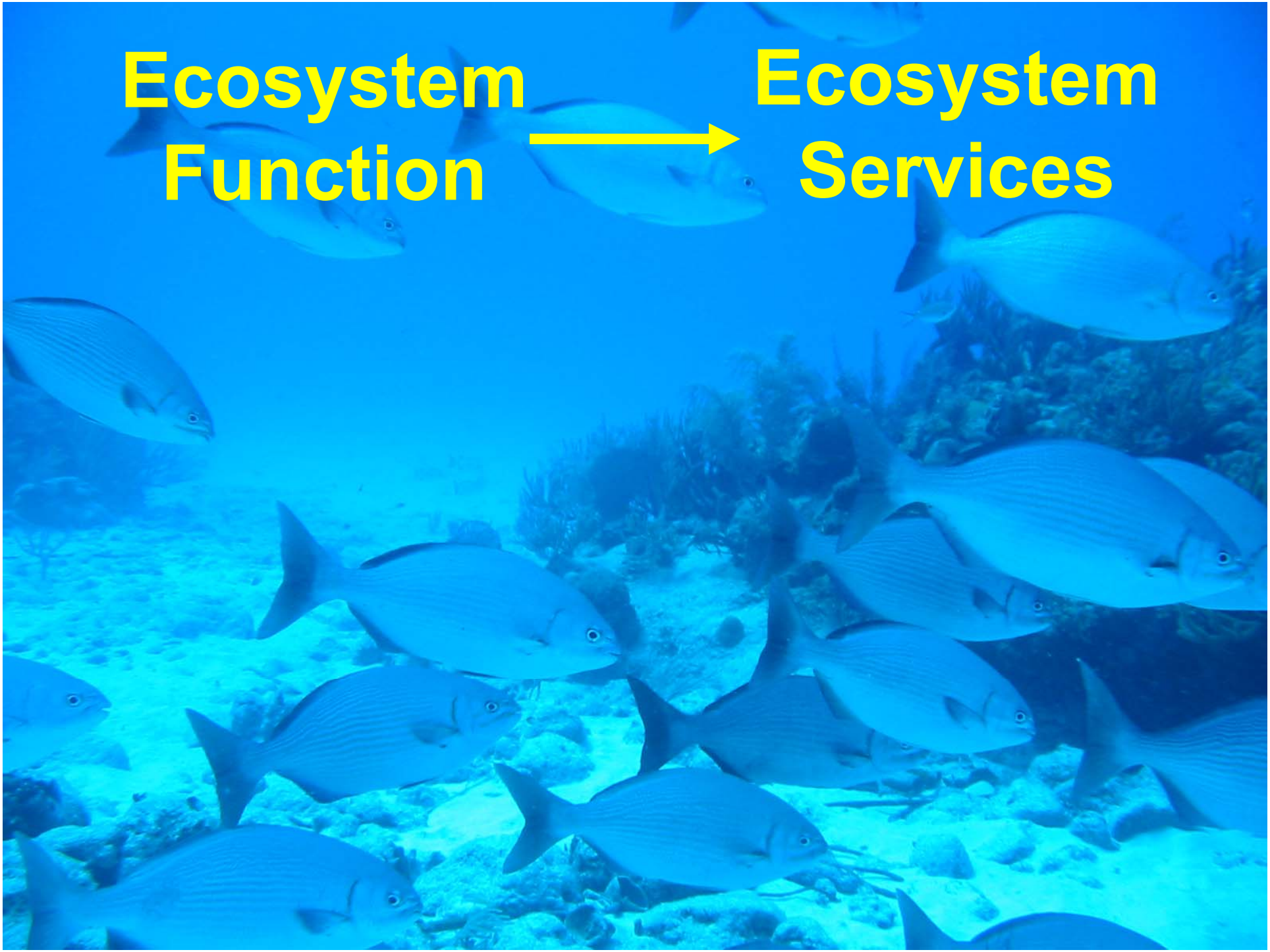
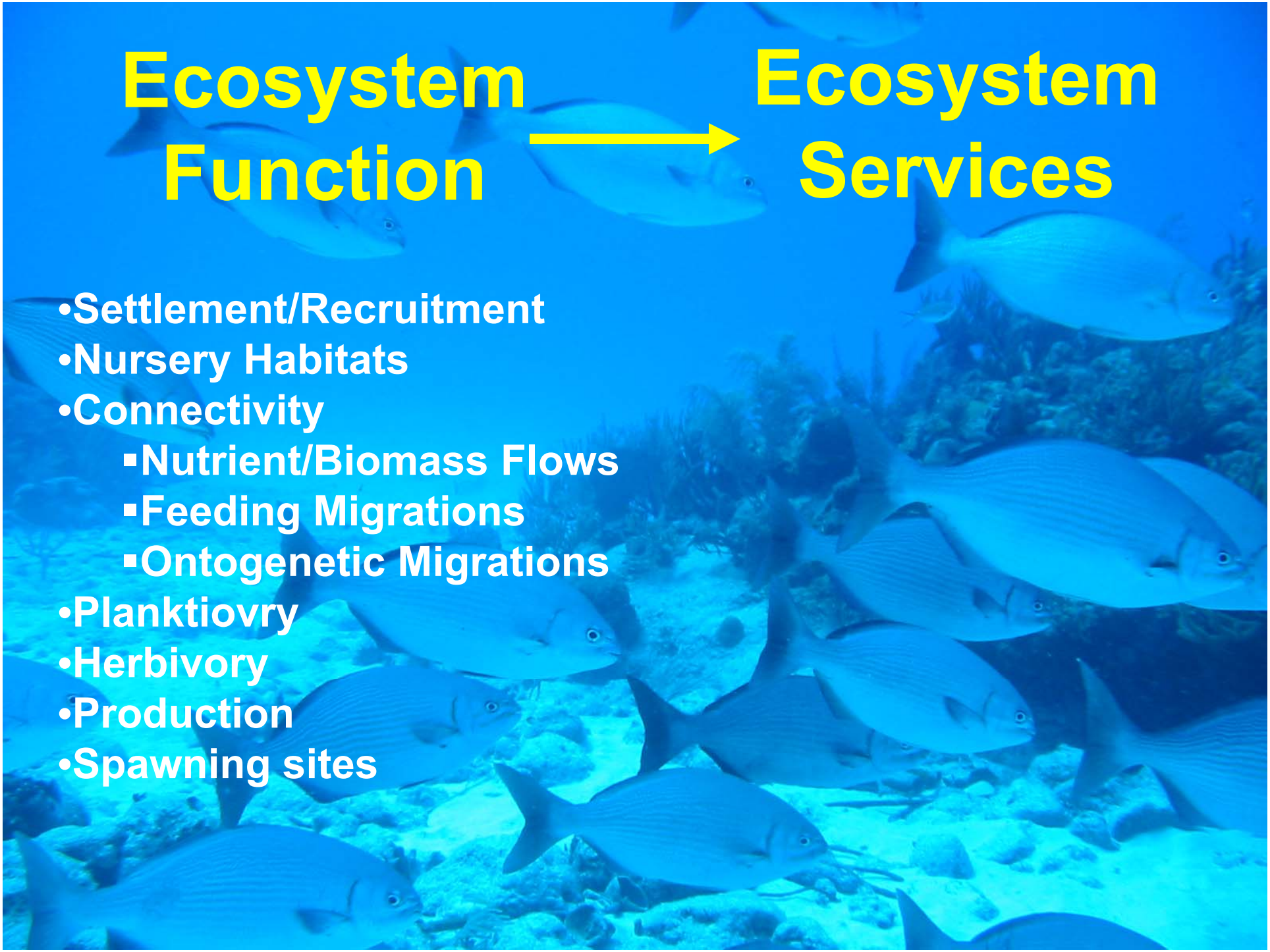
Resilience and Ecosystem-based Fisheries Management

- Ecosystem-based management must focus on the health and productive capacity of the system
- The identification and protection of key habitats will be critical for protecting ecosystem integrity and function.


Ecosystem Function
Ecosystem Services


Ecosystem Function
Ecosystem Services
•Settlement/Recruitment
•Nursery Habitats
•Connectivity
▪Nutrient/Biomass Flows
▪Feeding Migrations
▪Ontogenetic Migrations
•Planktiovry
•Herbivory
•Production
•Spawning sites

Ecosystem Function → Ecosystem Services

- Settlement/Recruitment
- Nursery Habitats
- Connectivity
  - Nutrient/Biomass Flows
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  - Ontogenetic Migrations
- Planktiovry
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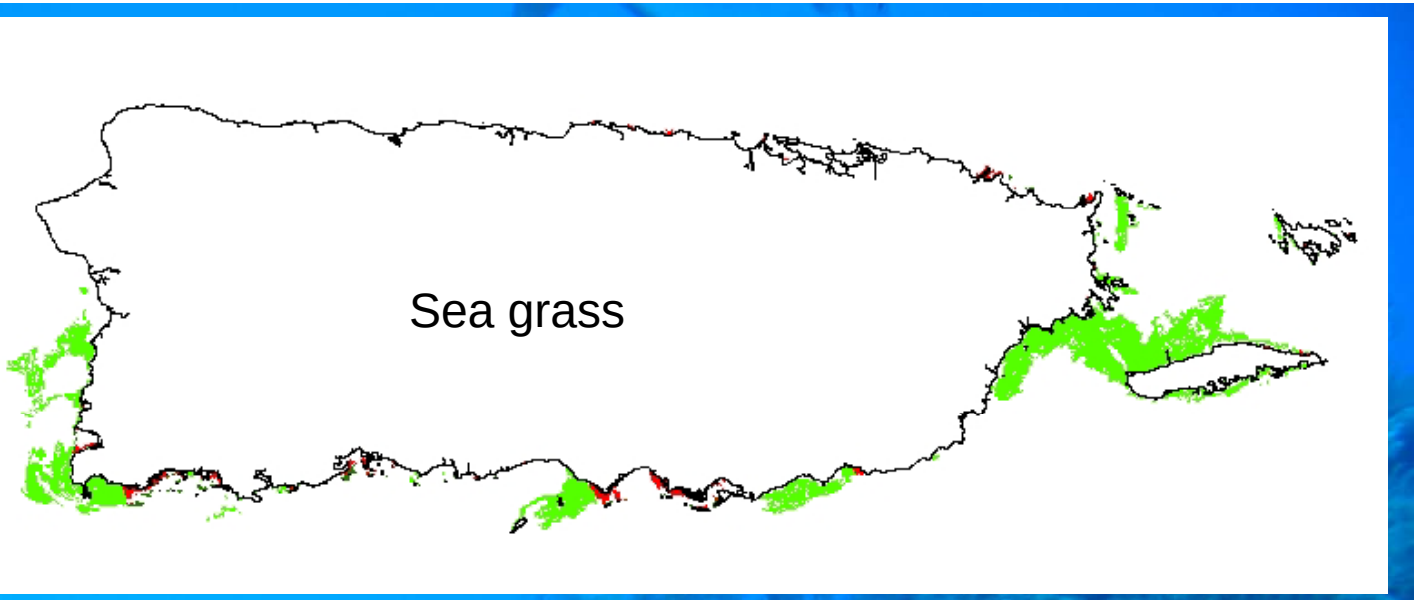
- Commercial Fisheries
- Recreational Fisheries
- Snorkeling/Diving
- Beach Sand Production
- Shoreline Protection
- Education
- Scientific Research
- Bio-active Compounds
- Passive Values
  - Hereditary Value
  - Future Use
  - Existential Value
  - Biodiversity

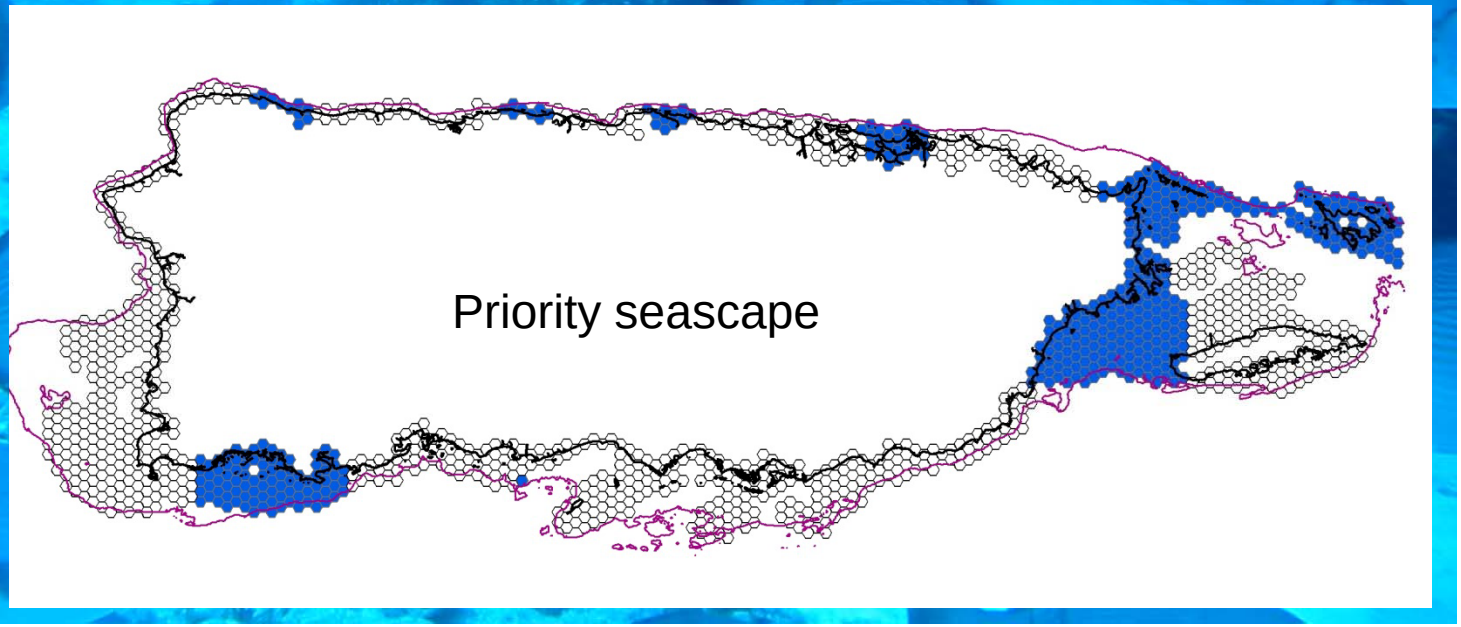
Habitat
(a surrogate for species distribution)

- Each species has habitat preferences
- Habitat preferences can shift with ontogeny
- Key habitats are shared by many species
- Key habitats are embedded in the seascape
- Spatial separation of habitats for management purposes is extremely difficult
- A more practical alternative is to target protection for prioity areas that are critical to the productive capacity of the system over large scales

From habitat protection



To seascape protection



Criteria for Identifying Priority Areas

- **Representation**
  - **All species groups included (Habitats)**
- **Replication**
  - **Have protection and spread out risk (Stratification, Clustering)**
- **Self-sustainability**
  - **Retain ecological function through networks**

- **Self-Sustaining Network → Close proximity**
  - **Size of Planning Unit (small scale)**
  - **Representation + Clustering (medium scale)**
  - **Replication + Stratification, Maximum Spacing (large scale)**

Incorporating Self-sustainability can be Enhanced

- Enhance Representation
  - Input into Model
- Define known limits of Connectivity
  - Input to Model
  - Assess output from Model

Enhanced Representation

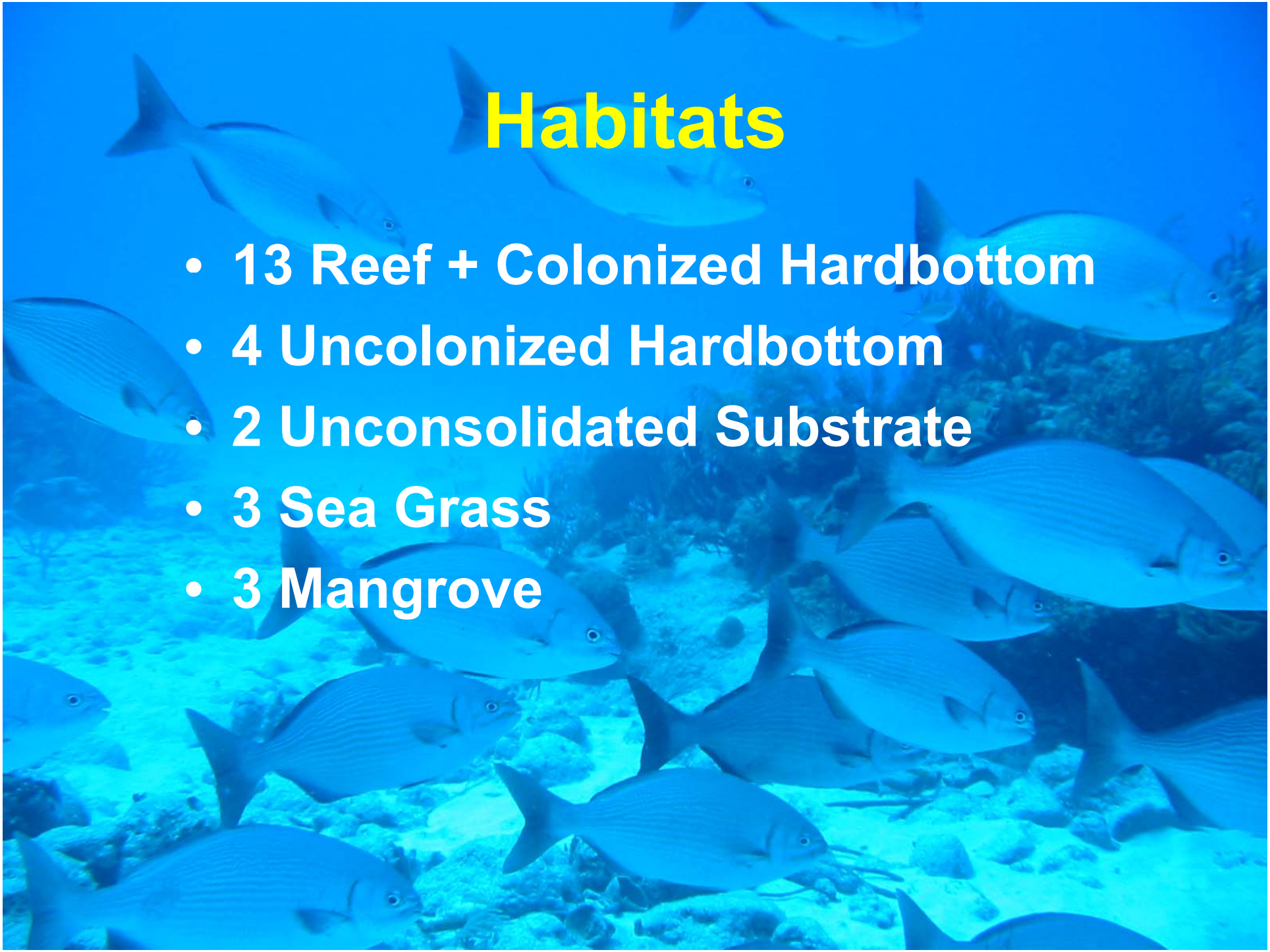
- Not all habitat patches are equal
- Habitat location is important
  - Use depth, geomorphology, shelf position to subdivide habitat
- Emphasize differential habitat use
  - Within species (e.g., ontogenetic habitat use)
  - Across species
- Process still relies on proximity
  - There are limits to connectivity

Limits to Connectivity

- Distance
  - Expected larval dispersal
  - Daily feeding migrations
  - Ontogenetic migrations
- Location
  - E.g., Coastline to Shelfedge

Application to Puerto Rico Coral Reef Ecosystems

- Data Sources
  - NOAA Habitat Maps (Area)
    - minimum mapping unit = one acre (~ 4000 m^2)
  - NOAA Environmental Sensitivity Maps (e.g, Wetlands, Linear Coastlines)


Habitats
• 13 Reef + Colonized Hardbottom
• 4 Uncolonized Hardbottom
• 2 Unconsolidated Substrate
• 3 Sea Grass
• 3 Mangrove

Sea Grass

- Backreef and reef crest
  - medium density with clean coralline sand
  - serve specific settlement/nursery functions
- Lagoon and shoreline intertidal
  - dense, with a silty bottom
  - foraging area
- Deep sea grass
  - outer shelf with associated species

Mangroves

- Coastal
  - Water quality, Lagoonal fish fauna, nursery
- Coastal edge
  - Important nursery area for reef fishes
  - Prop root communities
- Cays
  - Important nursery area for reef fishes

Reef Habitats

Reef Type & Geomorphic Zone

- Colonized pavement & bedrock
- Linear reef, spur-and-groove, large patch reef
- Small patch reefs & scattered coral
- Lagoon, Reef crest and Shoreline intertidal
- Backreef
- Forereef
- Bankshelf (outer shelf)
- Bankshelf escarpment

Other Habitats

- Rocky intertidal
- Beaches
- Mesophotic reefs (depth & slope)
- Sand
- Mud

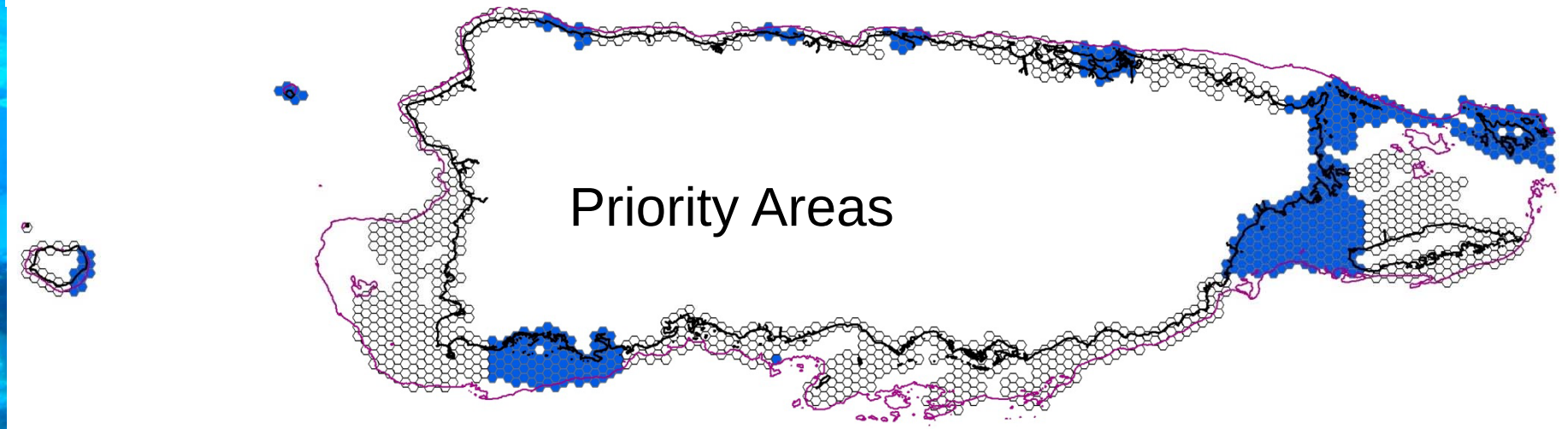
Limits to Habitat Connectivity

- Feeding migrations (100's m)
  - Small scale (within single planning unit)
  - Medium scale (clustering to force proximity)
- Ontogenetic migrations
  - Include all habitats within any single reserve
  - Extend from shoreline to shelfedge
  - Partition habitats by role and position

Limits to Larval Dispersal

- Short Dispersers
  - Cluster to have retention
- Long Dispersers
  - Set maximum distance between reserves
  - Biophysical Models, Larval Distributions
  - 40 km

Results (?)



Acknowledgements

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- The Nature Conservancy
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