

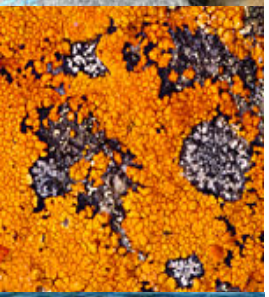

Using Marxan for Regional Marine Park Planning

Pilbara & 80 Mile Beach

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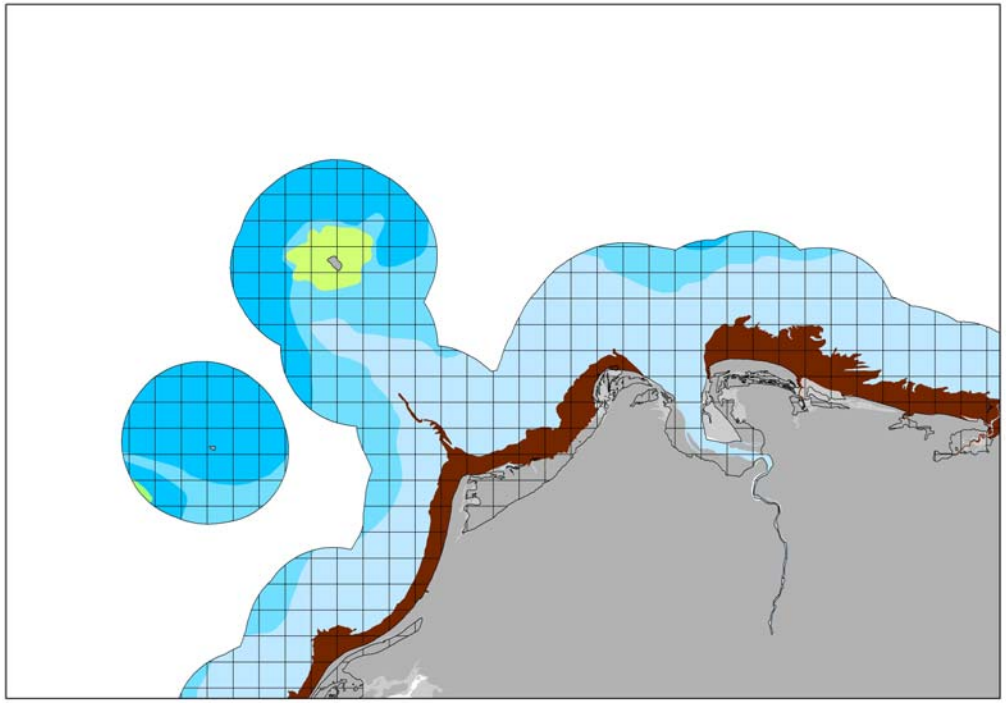
Our environment, our future

What is Marxan?

- Mathematical software that identifies many solutions to satisfy a project's goals.
- The worlds most widely used conservation planning tool (over 600 organisations in 100 countries).
- First time used in a Western Australian marine park planning process.



Ian Ball, Hugh Possingham

& Matt Watts

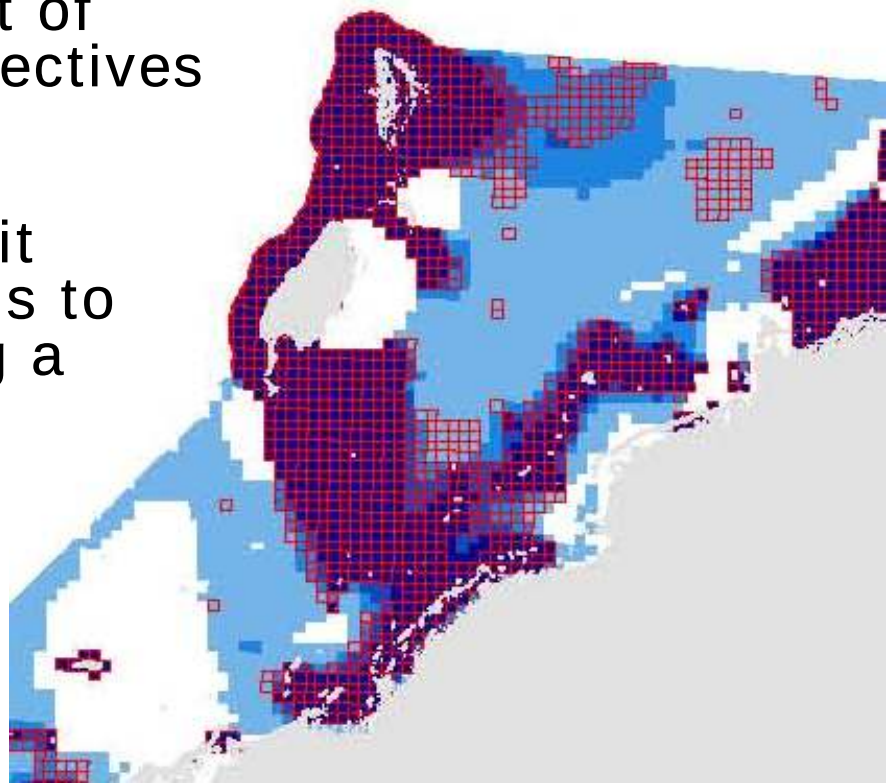
www.uq.edu.au/marxan

Ball & Possingham (2000)

Possingham *et.al.* (2000)

Why Use Marxan?

- **Flexible** – it can be applied to a wide range of projects e.g. reserve design, land/water NRM etc .
- Satisfies **multiple objectives** – it can deal with a large amount of spatial data and multiple objectives with competing interests.
- **Efficient** and **repeatable** - it provides many good solutions to complex problems, providing a number of options.
- **Measures success** against objectives**.**



Nuts & Bolts

- Algorithm strives to minimise the reserve score:

Reserve score =

$$\sum_{PUs} Cost + \sum_{PUs} Boundary \times BLM + \sum_{ConsFeat} Penalty \times SPF$$

- Study area divided into planning units (PU) and each PU is assigned a **cost** (e.g. hectares) and **status** (i.e. available, not available, already selected).
- **Boundary lengths** between PUs are calculated.
- Amount of each '**conservation feature**' (e.g. area of habitat, human use) in each PU is calculated.
- 'Conservation features' are assigned a **target** (e.g. hectares or % of total) and a '**species penalty factor**' (SPF) for not achieving the target.

Spatially Explicit Goals

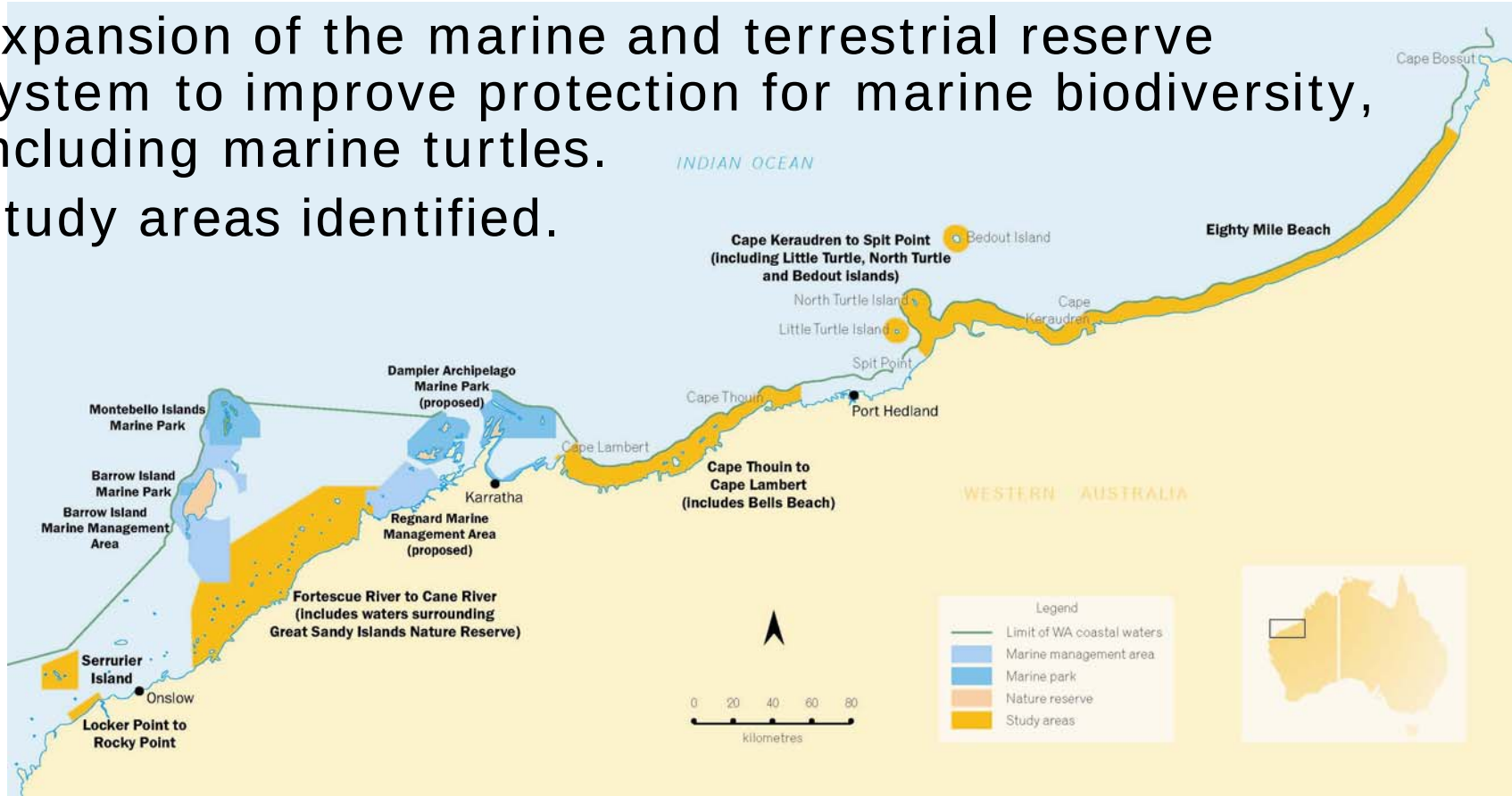
- The most important step in using Marxan is the development of spatially explicit goals e.g.:
  - **Representation** and **replication** of features, habitats & species (e.g. 2,000 ha of seagrass)
  - **Complement** and build on existing reserves (e.g. select all existing reserves)
  - **Minimise impacts** on human activities (e.g. avoid 50% of the highly fished areas)
  - Minimise **economic costs** (e.g. avoid highest $ commercial fishing areas)
- Marxan is flexible in achieving these goals, but it must have the data to do it. Flexibility from:
  - **PUs**, **costs**, **BLM**, **SPF**

Nuts & Bolts

- Starts with random configuration of PUs then adds or subtracts PUs and recalculates the score. If the score is lower the PU is kept, if its higher its not kept … continues until a near optimum score is reached.
- ~5 million iterations per run to achieve near optimum score.
- Calculates 100 runs (each run is a potential different reserve configuration)
- Outputs:
  - mathematically '**best solution**'.
  - '**selection frequency**' (irreplaceable areas).
  - **missing values report** (success against goals and targets).
- Iterative analysis and interpretation.

Pilbara/80Mile Beach

- Late 2006, Cabinet decision on environmental offsets for the Gorgon development on Barrow Island Nature Reserve.
- Expansion of the marine and terrestrial reserve system to improve protection for marine biodiversity, including marine turtles.
- Study areas identified.

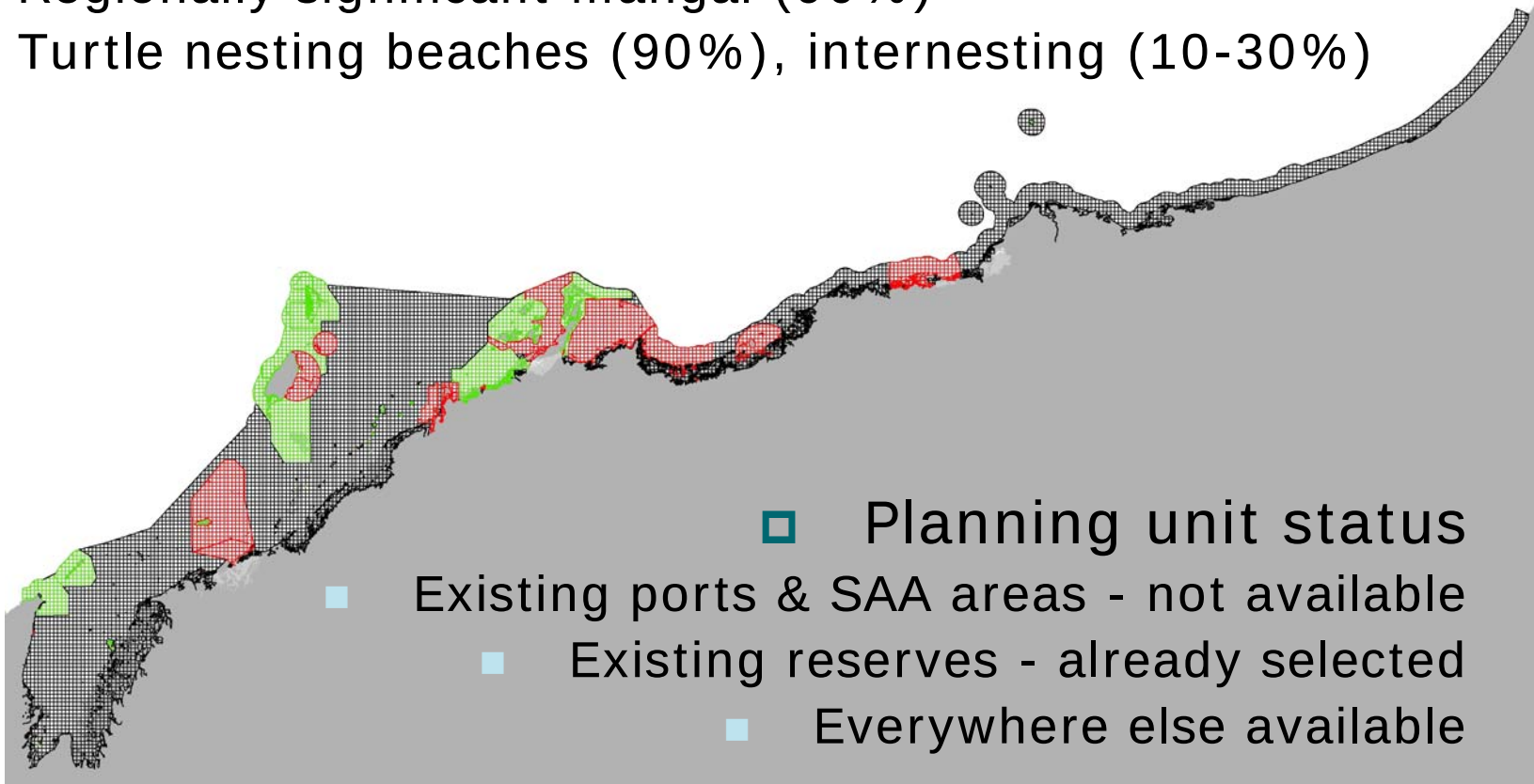


Pilbara/80Mile Beach

- Developed **goals** and gathered **data** (resource assessment phase)
  - 21 ecological and social goals
  - Data on habitats, biodiversity surrogates, species, tenure, culture and human usage
- **Community engagement**
  - Govt. Interagency Working Group
  - Aboriginal engagement program
  - Peak Body Fishing Consultation Group
  - Community information sessions

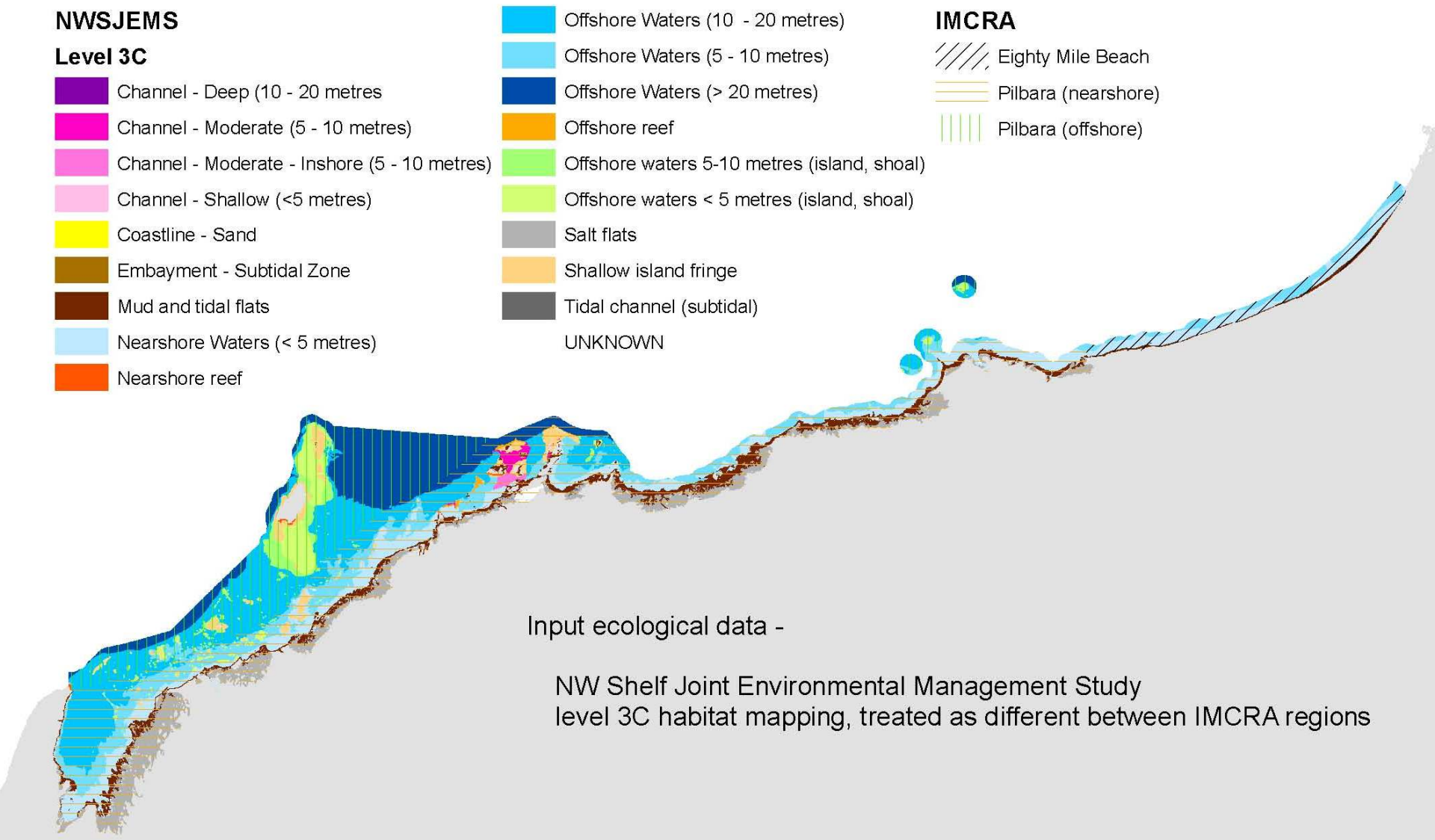
Marxan Scenarios

- Conservation features & targets
  - Habitats & biodiversity surrogates (depth, sediment cells) within IMCRA bioregions (10-30%)
  - Regionally significant mangal (90%)
  - Turtle nesting beaches (90%), internesting (10-30%)



- Planning unit status
  - Existing ports & SAA areas - not available
  - Existing reserves - already selected
  - Everywhere else available

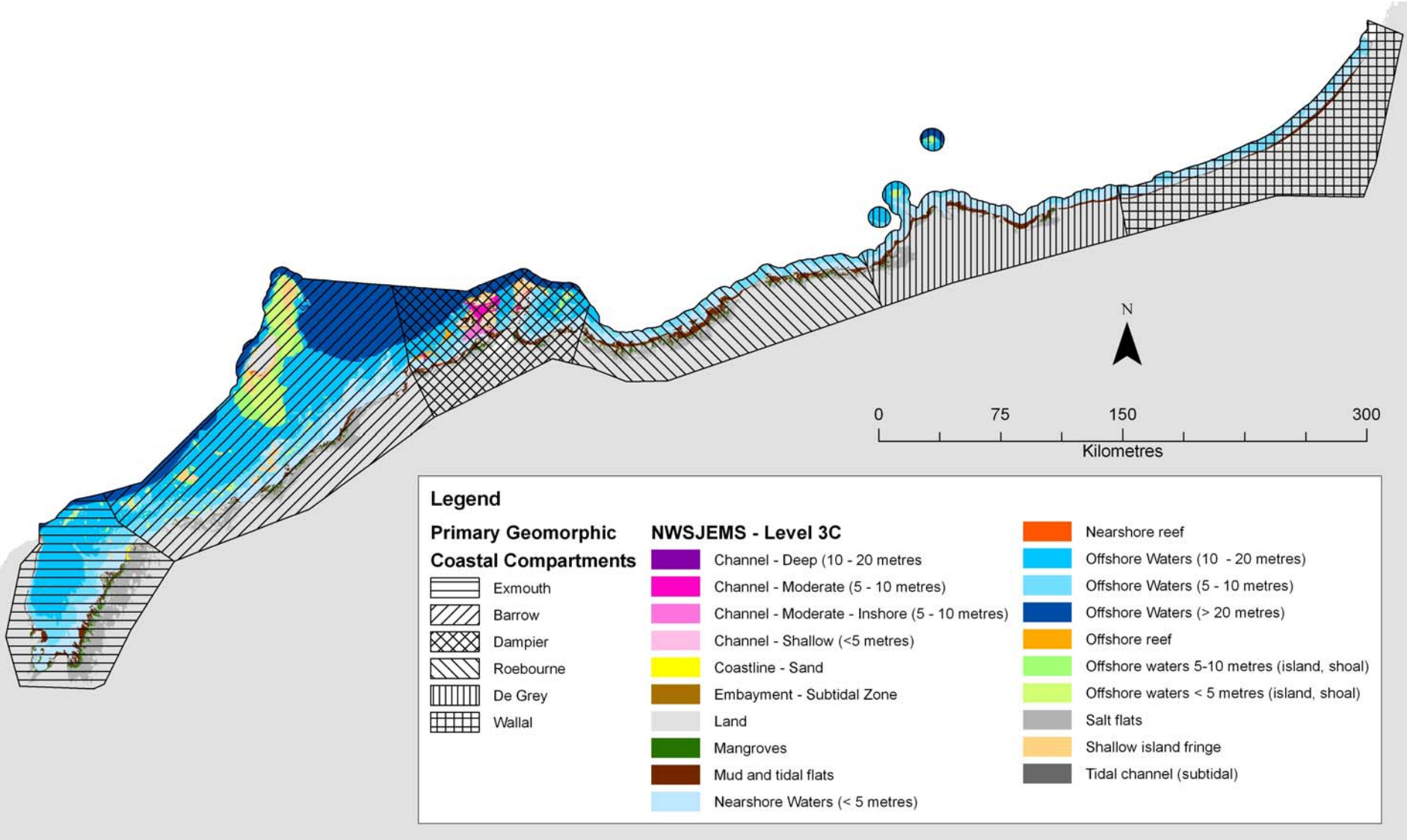
Habitats & Biodiversity Surrogates



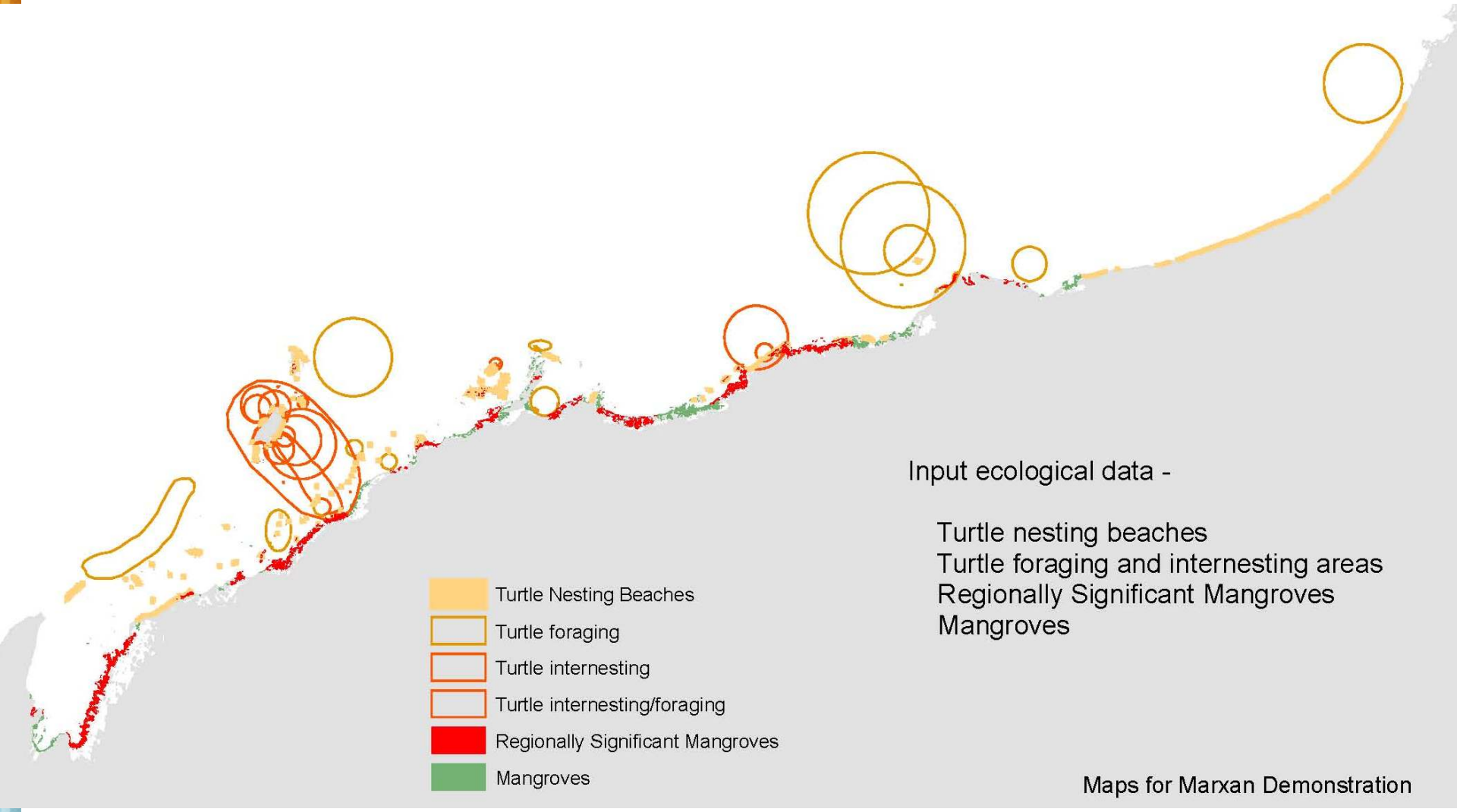
Input ecological data -

NW Shelf Joint Environmental Management Study
level 3C habitat mapping, treated as different between IMCRA regions

Sediment Cells



Turtles & Mangal

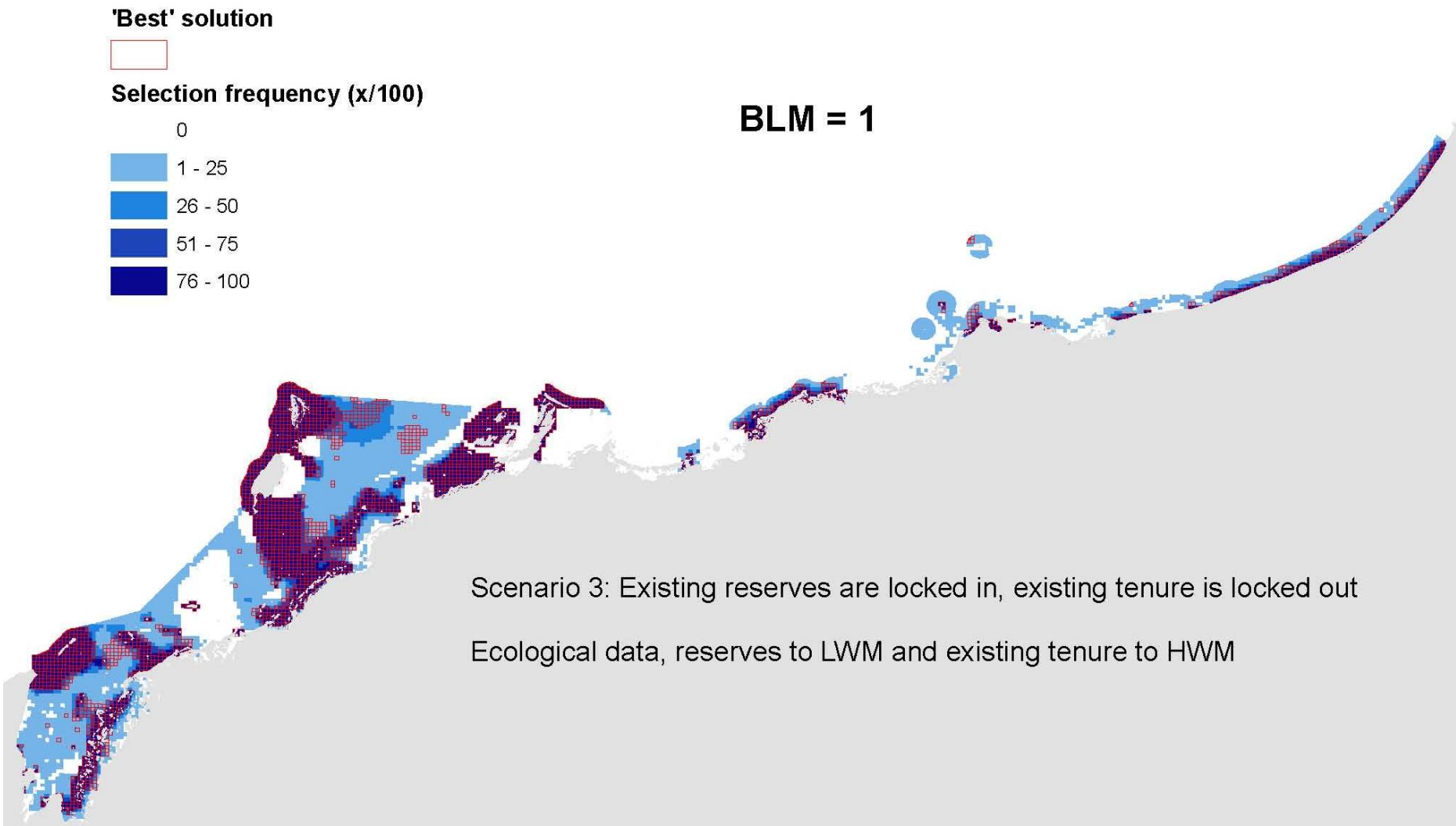


Input ecological data -

Turtle nesting beaches
Turtle foraging and internesting areas
Regionally Significant Mangroves
Mangroves

Maps for Marxan Demonstration

Example Scenario



Scenario 3: Existing reserves are locked in, existing tenure is locked out

Ecological data, reserves to LWM and existing tenure to HWM

Measuring Achievement of Goals

Conservation Feature	Area (ha)	Excluded Area* (%)	Aspirational Target Area** (ha)	(%)	Reserved Area*** (ha)	(%)
Barrow_Mud and tidal flats	14404.6	17%	4321.39	30%	8547.23	59%
Barrow_Nearshore Waters <5 metres	118068	10%	35420.5	30%	49964.9	42%
Barrow_Nearshore reef	957.1	19%	957.1	100%	773.09	81%
Barrow_Offshore Waters 10-20 metres	421600	23%	126480	30%	63453.5	15%
Barrow_Offshore Waters 5-10 metres	149203	15%	44760.9	30%	42966.9	29%
Barrow_Offshore Waters >20 metres	313668	2%	94100.4	30%	33162.3	11%
Barrow_Offshore waters 5-10 metres island, shoal	59808	27%	17942.4	30%	25765.7	43%
Barrow_Offshore waters <5 metres island, shoal	91715.9	13%	27514.8	30%	72245.4	79%
Barrow_Salt flats	51878.4	2%	15563.5	30%	34934.1	67%

Decision Support – Not Solution

- Due to data constraints site specific habitat field data and human usage data wasn't used in the Marxan scenarios.
- Final reserve locations and zoning were developed using:
  - Marxan scenarios and GIS data
  - Habitat field survey data
  - Human usage data and knowledge from the Interagency Working Group, Fishing Consultation Group and Native Title working groups.
- Marxan was then used to report on the resultant reserve against the goals.
- Outcome-based management plan was drafted using risk assessment approach.

Strengths of Marxan

- **Goal setting** – provides a framework for decisions about conservation priorities.
- **Clarity of offsets** – provides clear report on achievements and shortfalls which allows identification of offsets.
- **Open** and **transparent** – stakeholders can see how their data is going to be used and have a say in how its interpreted.

Weaknesses of Marxan

- Users require good **technical skills** – GIS and data analysis.
- **Data hungry** – requires consistent data across the study region on what? where? how much?; doesn't consider data uncertainty and bias.
- **Time** and **complexity** – requires time to assemble data and analyse outputs.

- **Decision support tool; not the solution.**
- **No substitute for community engagement and using GIS as an easy interactive tool.**