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SANDY BEACH ECOSYSTEMS: VULNERABILITY, RESILIENCE AND MANAGEMENT

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OUTLINE

- **Background**
  - **beach values**
  - **beach ecology**
  - **knowledge deficit**
- **Pressures and Vulnerability**
- **Resilience as a Concept and Management Focus**
- **Messages**
- **Issues/Questions**

VALUES OF SANDY BEACHES

- **Ecocentric intrinsic values (ESD objectives)**
  - **Structural** eg species diversity
  - **Functional** eg productivity, energy and nutrient cycling, protection
  - **Holistic environment** – links to adjacent ecosystems (surf zone, ICOLLs and catchments, sand dunes, rocky reefs)
  - **Dependencies** of large species eg birds, fishes
- **Anthropocentric utilitarian values**
  - Recreation
  - Aesthetic
  - Spiritual
  - Economic
  - Protective

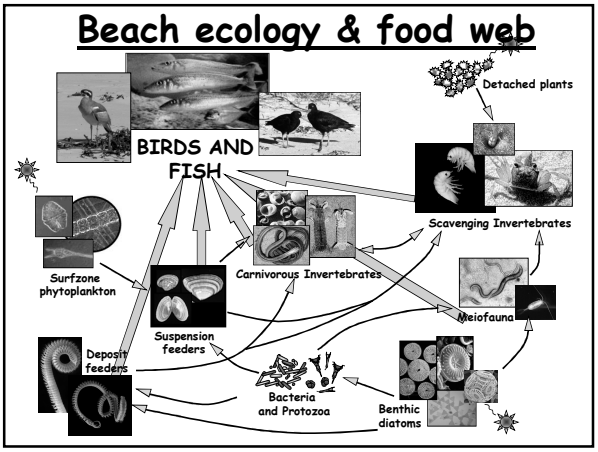
ECOSYSTEM SERVICES:

The benefits to humans provided by ecological systems.

- sediment storage and transport
- buffering against extreme events
- dynamic response to sea level rise
- water filtration and purification
- nutrient mineralization and recycling
- maintenance of biodiversity and genetic resources
- nursery areas for juvenile fishes
- nesting sites for turtles, shorebirds, pinnipeds
- prey for birds
- recreation/aesthetics
- bait and food

(Defeo *et al.* accepted MS)

Beach ecology & food web



Amphipod – *Excediceros fossor*

PRESSURES ON SANDY BEACHES

- Climate change
- Erosion
- Nourishment
- Off-road vehicles
- Beach cleaning
- Pollution
- Harvesting
- Introduced species
- Sandmining

UNDERLYING PRESSURES

- I = PLOT
- Poor planning and management
  - strategic/integrated (RAC)
  - make ESD operational
  - management framework for beaches
- Knowledge deficit
  - basic/applied science
  - prediction uncertainties

CLIMATE CHANGE

- Primary Changes (CO_2)
- 2nd Order Effects (temperature, pH)
- 3rd Order Effects (sea-level rise, storminess)
- Lower Order Effects (erosion, coastal recession, ecological change)

DIRECT EFFECTS

- **Temperature rise:**
  - Physiology / D.O. down
  - decomposition
  - geographical range
  - assemblage composition
- **Habitat change:**
  - loss of sandy beach
  - loss of dunes and vegetation
  - water table
  - pH (calcium metabolism)
- **Rain and vegetation**
- **Disturbance (storm surges):**
  - morphodynamics
  - abrasion
  - erosion / removal of biota?
  - particle size coarser
  - weed accumulation
  - short-term pulse / does it matter?

INDIRECT EFFECTS

- Estuarine flows (nutrients and sediments)
- Planktonic productivity
- Hydrology

VULNERABILITY IN GENERAL (economic, social, ecological)

- A function of :
  - exposure to pressure(s)
  - sensitivity to change and
  - capacity to adapt

  (Allen Report 2005)
- Kind of pressure - press-pulse-ramp
- Methodologies:
  - CSIRO Vulnerability Index
  - IPCC Common Methodology

VULNERABILITY OF BEACH ECOSYSTEMS

- Human population growth/seachange
- Climate change (various factors)
- Human response in developed areas (eg engineering)
- Interactive factors (eg acidity, crushing by vehicles, storminess/abrasion)
- Species:
  - undeveloped areas OK?
  - but acidity/temperature/disturbance?
  - short lifecycles and adaptation.

RESILIENCE

- Developing concept – various definitions, many related words
- Capacity of a system to absorb disturbances
- Components: resistance and recovery
- Inclusive concept - economic, social and ecological systems (linked SESs)
- Complex concept
  - spatial and temporal scales
  - takes dynamic systems view
  - understanding weak / prediction difficult
  - operationalise – resilience of what to what?
  - synergisms of multiple pressures
  - non-linear discontinuous responses – hysteresis
  - sliding baselines

COMPONENTS OF RESILIENCE:

- **Resistance**
  - habitat level
  - assemblage (structure/function)
  - population/individual (tolerance/acclimation/ adaptation/rate-of-change of warming, pH etc)
- **Recovery**
  - source of sand/colonists - refuges
  - life-history/dispersal - metapopulations
  - inter-species dependence?
  - complex concept
  - press/pulse issue

MANAGEMENT QUESTIONS:

- Will systems resist pressures?
- If not are the impacts acceptable?
- Will the system recover in an acceptable time frame?
- Will systems slowly degrade or collapse to an alternative regime/state?

We can't answer many questions but if you think research is too expensive, try ignorance.

MANAGEMENT FOR ECOLOGICAL RESILIENCE

Goal: sustain ecosystem structure, function, services

- **Identify and address all important pressures**
- **Manage demand cf supply (limits)**
- **Apply ecosystem-based management (EBM)**
  - considers interactive systems including humans
  - integrates human activities and knowledge of ecosystems at various scales / flow with nature
  - develop values consistent with resilient SESs
  - recognises ecological constraints and primacy
  - considers cumulative and synergistic effects
  - applies precautionary principle

WISDOM

'Restrict one's interventions on the world to those needed to restore harmonious relations among elements of the world.' (Sternberg 1990, p.8).

MANAGEMENT FOR COASTAL ECOLOGICAL RESILIENCE:

- Control coastal development
- Reduce anthropogenic inputs
- Create protected areas
- Preserve some areas and regulate disturbance
- Address watershed modification and pollution problems

Hobday *et al.* 2006

- Maintain dune-beach systems
- Minimise hard engineering
- Establish best-practice nourishment
- Proactive planning for beach recession in undeveloped areas

Messages

Sandy beach ecosystems are:

- Surprisingly diverse, valuable and poorly understood
- Extremely vulnerable to many pressures
- Best managed when integrated into SESs
- Strongly connected to adjacent systems – scale important

Issues/Questions

- Human growth/steady state paradigms
- Development of SESs/sustainability consciousness/behaviours/primacy
- Health status
- Resilience of what to what
- Multiple pressures and synergisms
- Mechanisms of recovery
- Adaptation/acclimation/migration ability
- What matters – limits of acceptable change