

# Sandy Beaches Workshop Reports

Two workshops were held at the Fifth International Symposium on Sandy Beaches - Rabat, Morocco, 19<sup>th</sup> - 23<sup>rd</sup> October 2009. The first workshop identified high-priority questions concerning sandy beach biological research; the second addressed the issue of monitoring in theory and practice. All the conference participants contributed to the document below.

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## Workshop 1 - Sandy beach biological research: important questions for knowledge, understanding, policy and management

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Most ecosystems are under numerous and rapidly-growing human pressures. Consequently, there is a compelling need for scientifically-credible management if these systems are to sustain their ecological structures, functions and services to humans. This is especially true of sandy-beach ecosystems since they are both poorly studied and particularly vulnerable to the coastal squeeze of burgeoning coastal populations and the multiple pressures of climate change. Thus it is important to focus limited research resources on priority questions.

In seeking to identify priority questions, this workshop followed previous exercises that proposed an ecological research agenda to promote a sustainable biosphere (Lubchenco *et al.* 1991 *Ecology* **72**:371-412) or proposed priority ecological research areas relating to policy (Sutherland *et al.* 2006 *J. Applied Ecology* **43**:617-627), conservation (Sutherland *et al.* 2009 *Conservation Biology* **23**:557-567), ecosystem services (Nicholson *et al.* 2009 *J. Applied Ecology* **46**:1139-1157) and even business (Armsworth *et al.* 2010 *J. Applied Ecology* **47**:235-243). In the Rabat symposium, criteria used for the selection of questions included the filling of important gaps, developing new areas and methods of enquiry, the testing of important hypotheses, and, importantly, human utility in management for conservation, goods and services. As well, questions should be sufficiently specific and bounded to fit within reasonable spatial and temporal scales and they should be susceptible to realistic research designs.

The present workshop addressed four categories of questions:

- Basic research that underpin applied questions
- Human pressures, especially climate change
- Conservation/protected areas
- Ecosystem management, resilience and societal interactions

Some of the suggestions below are framed as questions, others nominate areas of research.

### Basic Research

#### *Biodiversity*

- What are the patterns of biodiversity at different spatial and temporal scales and their explanations?
- Do biogeographic provinces exist?
- What is the regional variation in the level of knowledge?

#### *Ecosystem structure and function*

- What are the important ecosystem functions in different kinds of beaches and at different spatial and temporal scales?
- What are the functional roles of the interstitial and microbial communities?
- Food web support provided by beach ecosystems.
- What are the patterns of energy flow and linkages between beach ecosystems and dunes, ocean, watershed and estuaries?
- Is there a relationship between ecosystem function and biodiversity?
- Does the metapopulation concept of connected sub-populations apply to beaches?

- Will loss of beach biota affect nearshore fish nurseries?

#### *Stability and resilience of beach communities*

- What are the main factors/disturbances that affect stability?
- What are the refuges that promote recovery following disturbance?
- How important are metapopulations in enabling dispersal, recruitment, recolonization and recovery?
- What are the natural ranges of temporal variation?
- How fast is post-impact recovery?
- What is the potential role of ecological restoration?
- What are the life histories of key species? Timing of recruitment? Specific adaptations?

#### **Human Pressures**

- What are the responses of beach ecosystems to human pressures (eg, climate change, vehicles, fishing, pollution, urbanisation etc)?
- Will pressures act individually or synergistically? For example, will larger storms, vehicles and lower pH interact to affect fauna?
- Are impacts likely to accumulate over time?
- How do you determine/assess impacts/recovery, especially in the absence of before-impact data?
- Are urbanized/artificial beaches substantially different from pristine beaches?
- Can we define and estimate resilience of sandy-beach ecosystems? Resilience incorporates resistance to pressures; recovery following pulse disturbances (eg, pollution) and biotic adaptation to press disturbances (eg, lower pH).
- Do regime shifts occur on beaches? What indices would we use to measure these?
- Can we address some large-scale and long-term issues by developing large networks of scientists working with standardized methods?
- How do we integrate other disciplines into beach ecology in order to better manage social-ecological systems?
- Are invasive species an issue and what are their direct and indirect effects?
- Will larger storms produce more beach wrack?
- Is more wrack good or bad for beach health?
- What are the effects of large-scale, repeated nourishment?
- Can calcifying species adapt/acclimate to decreasing pH?

#### **Conservation**

Conservation strategies should focus on systems rather than endangered species. The systems approach incorporates the beach habitat, its species, processes and people.

- What are appropriate levels of protection for different contexts including indigenous interests?
- What are the threats and pressures? The level of protection depends on these.
- What are the appropriate scales for conservation? These depend upon the objectives of conservation and the tensions that arise eg, people versus system priorities or between local, regional and national priorities.
- What are the ecological quality objectives? These correspond with conservation targets.
- What level of protection is appropriate for beaches? How can it be incorporated in legislation?
- At what point does conservation become effective? For example, should a threatening process be entirely excluded (including cultural/historical uses) or is there a tipping point/threshold below which effects are acceptable?
- What are the relevant units that could fit into a systematic conservation plan? These include spatial units (eg, surf zones, dunes etc), patterns, processes, threats and targets.
- What is an optimal reserve design to protect biodiversity?
- How do we develop conservation targets? What are the conservation targets for sandy beaches in terms of biodiversity, services and processes?
- What are appropriate setback lines (determined scientifically with participatory input from all stakeholders)?
- What incentives would facilitate conservation?
- How do we balance local objectives versus regional objectives, and who decides?
- How do we sell beach conservation to the public/decision-makers? What can be used as flagship/key/focal/charismatic species?
- What is the conservation status/vulnerability of beach species, particularly key species and rare or declining species? Which species are endemic to sandy beaches?
- What is the ecological status of those systems that are nourished and maintained only for tourism (European beaches in general)?
- Which conservation strategies are available – at which point do you adopt the strategies?

### **Beach Management**

- How do we raise awareness that sandy beaches are not just sand but valuable, diverse, dynamic ecosystems?
  - How do we generate adequate support for research and management?
  - Who are the stakeholders and users?
  - What is a healthy beach?
  - How are human management practices affecting biodiversity?
  - How do we manage anthropogenic disturbance?
  - How do we increase resilience of the dune-beach-nearshore system?
- What are the limits of acceptable change?
  - How do we increase the resilience of beaches as social-ecological systems?
  - What are the appropriate scales (spatial and temporal) of management? What are the boundaries of beaches in terms of ecological processes?
  - What are sustainable strategies for stabilizing or restoring eroding beaches?
  - What is the appropriate role of scientists – witness, advocate or both?

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## **Workshop 2 - Monitoring of sandy beaches: theory and practice**

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The processes threatening sandy beaches are of deep concern. In particular, erosion caused by sea-level rise and increased storminess threatens the very existence of some beaches. In consequence, beach biologists are being asked to propose ecological monitoring programmes to inform management. But, apart from a vague commitment to sampling through time, what does monitoring mean? A key general requirement is that monitoring must be approached as a scientific exercise aimed at testing explicit hypotheses arising from clear aims and ecological models. Four general aims were identified by Downes *et al.* 2002 (Monitoring Ecological Impacts. Concepts and practice in flowing waters. Cambridge University Press):

- Assess the ecological state of ecosystems;
- Compliance with stated standards/performance criteria;
- Detect and assess impacts/recovery/adaptive management; and
- Assess responses to restoration

Other general issues include the question of funding, ecological effect size, rapid assessment and communication with stakeholders. Funding is rarely adequate for ecological studies, especially in the long term. How do we raise the ecological profile such that monitoring is incorporated into legal mandates and adequately funded? Concerning effect size, if the purpose of monitoring is to detect change, then the magnitude of change that is unacceptable needs to be determined in order to design sampling with sufficient statistical power. This determination should

be a societal process with scientific input. Rapid assessment (via optimal surrogate indicators) is an important issue where funding is limited and there is a demand for quick results. This issue has not been investigated for sandy beaches. Finally, communication with managers, proponents and other stakeholders is often neglected.

The workshop addressed monitoring under three headings

- Long-Term Change (including baseline, health and state of the environment reporting)
- Specific Pressures – Beach Nourishment
- Specific Pressures – Coastal Armouring

Various questions and strategies were identified under each heading.

### **Long-term change**

In terms of monitoring for long-term change, there are more questions than answers. Among the more pressing questions to be answered before monitoring is initiated are the following:

- What is the optimum definition of a beach environment (littoral-active zone, intertidal and supra-littoral zone, intertidal and surf zone?) and can any subset of these be used as a proxy for a beach?
- How many beaches should be monitored in a long-term programme, and what would the basis

be for their selection (biodiversity, vulnerability, uniqueness)?

- What ecosystem services characterise a fully-functional beach relative to a degraded beach?
- Are there process-oriented proxies for ecosystem functioning that could easily be measured (nutrient cycling, community respiration, etc.)? These might more completely capture the function of the beach as a whole by integrating macrofaunal, meiofaunal, and microbial food webs.
- Is it possible to make predictions on the basis of our ecological understanding of beaches, and to use long-term monitoring programmes to test these?
- Given the dynamic nature of beaches, is the establishment of ecological baselines a useful approach? Might a better approach be to compare observed ecological patterns against those modeled on the basis of observed changes in the physical environment?
- How can societal prerogatives best be incorporated into long-term monitoring programmes?
- How can the priorities of managers be reconciled with those of beach ecologists?
- How can networks of beach ecologists best be harnessed to maximise utility of data collected?
- How can political will and funding be generated for long-term ecological monitoring of systems that are as dynamic as beaches?

#### **Specific pressures – Beach nourishment**

- What are the purposes of nourishment e.g., coastal defence, nature conservation, recreation?
- Accommodate differences in engineering practice. For example, engineering methods vary as does the location of spoil deposition on the beach.
- What is the optimum monitoring protocol?
- Ecology
- Economy
- What is the best sampling design to assess impact and recovery:
  - BACI- type where reasonable control sites are available
  - Predictive modelling where there are no suitable controls.

- What ecological indicators are appropriate to the engineering context or the resources available?

Candidates include:

- Macrofauna
- Meiofauna
- Shorebirds
- Hyperbenthos
- Nearshore fish
- Habitat approach including vegetation and geomorphology
- Ecological processes (predation etc)
- Address the issue of cumulative nourishments.
- Monitor sediment composition after nourishment.

#### **Specific pressures – Coastal armouring**

- Monitor the decision making process
  - Coastal management decisions can benefit from good technical input and processes that serve to clarify goals, benefits and impacts of armouring.
- Identify management goals and targets
  - Coastal armouring is typically used to protect infrastructure in areas inland of soft-sediment shorelines. Even if goals are met, there may be physical and ecological impacts to intertidal and subtidal areas
  - Some armouring is intended to maintain recreational beaches
  - Determine if the armouring structure meets the main management goals (i.e. protection of infrastructure). If these goals are met, then monitor unintended impacts of the structure.
- Determine costs and benefits of the armouring structures. Costs include loss or alteration of native habitats, development of non native habitats, impacts on donor habitats and carbon costs.
- The presence of multiple interacting threats and factors is a major challenge to the understanding of causation.
- Determine proper scales (spatial and temporal) of assessment and monitoring
- Use the best, cost-effective techniques available.