In Bermuda, present rates of sea level rise exceed 1.2 mm/year, and contemporary recession of the seaward margin of mangroves has been demonstrated. The extensive coastal mangrove swamps of southern New Guinea (Irian Jaya) are also retreating from rising sea level. This demonstrates that, while low island mangroves are likely to be the most sensitive to sea level rise, continental margin mangroves will also suffer disruption and retreat. Mangroves have the capacity for extensive establishment under conditions of stable sea level, but are highly prone to retreat under conditions of sea level change.

Linking temperate and arctic zones: managing the coast for migrant birds

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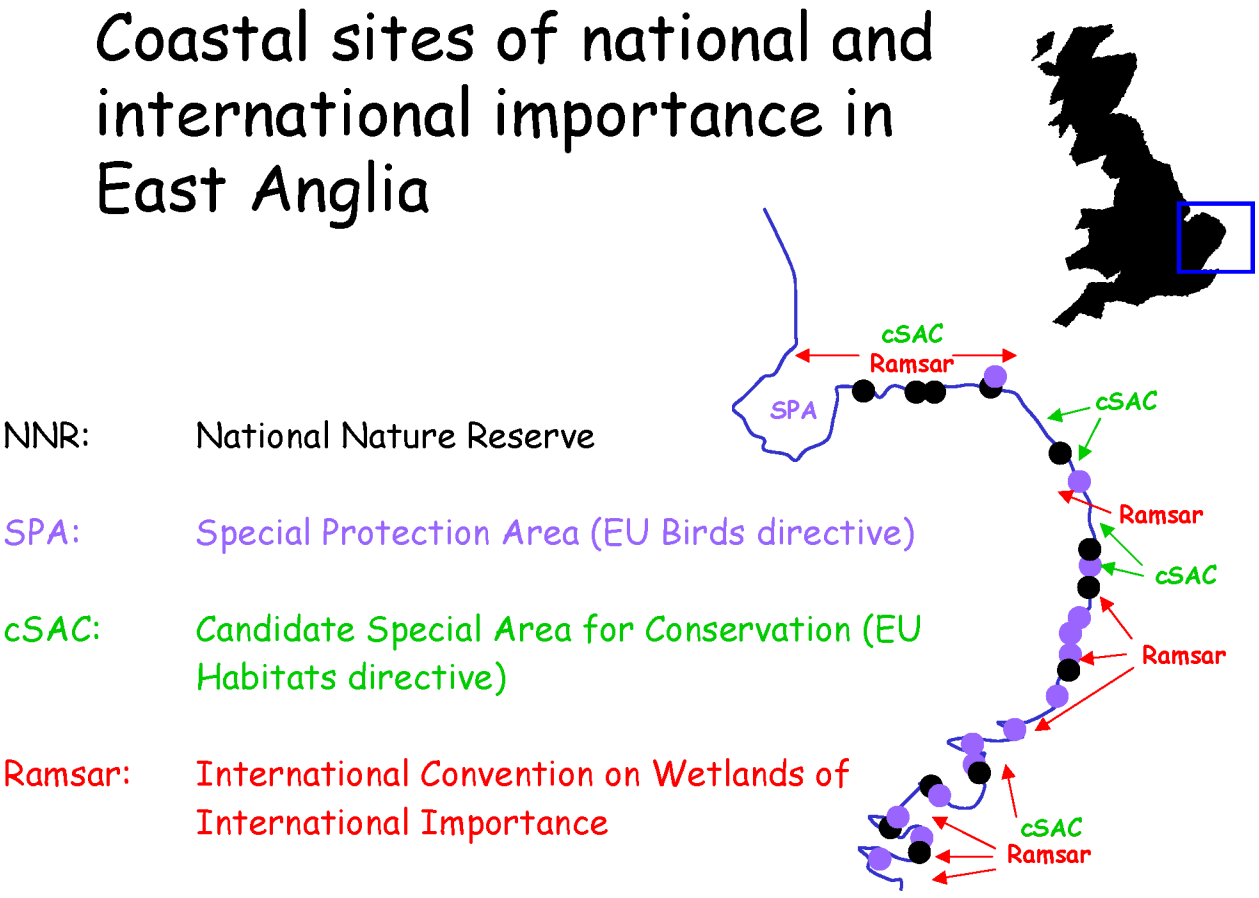
Arctic zones and low-lying coastal areas are amongst the regions that are most vulnerable to the impacts of climate change and associated sea level rise. Migrant bird species that move between arctic and coastal temperate regions on an annual basis may thus face dramatic changes to the habitats that they use at both ends of the migratory range. This is particularly true for the many high arctic breeding species that are almost entirely restricted to intertidal habitats in temperate zones during winter. Coastal management in temperate zones for migratory birds must therefore take account of both breeding and winter season processes, and any interactions between the two.

Changes in climate and sea level can potentially influence bird populations through a suite of direct and indirect routes in both the breeding and wintering seasons. For example, northward movement of the tree line in the arctic (Huntley *et al*., this volume) may reduce the area of tundra available for migrant birds at the same time that sea level rise and changing precipitation and temperature patterns may alter the structure or quality of temperate wintering areas. Whereas climate change and sea level rise may be the primary drivers of change in the arctic, in temperate zones policy responses to climate change are likely to have a more direct and immediate bearing on biodiversity. It is thus critical that policy decisions in the coastal zone are informed by species-level studies that address the complexity of the processes influencing population responses to climate change. Biodiversity conservation in temperate coastal zones is structured through a network of site designations, underpinned by national and international legislative frameworks (Figure 1). Decisions relating to the management and long-term sustainability of these sites are key in maintaining networks for migratory species.

Detailed studies of Icelandic black-tailed godwits, *Limosa limosa*, across the migratory range (Figure 2) have shown how site quality influences individual survival and breeding success and how these processes interact across locations thousands of kilometres apart. This information can be used to assess how changes to breeding and wintering habitats in response to climate change will influence population size and distribution. This provides a useful model for identifying the range of mechanisms by which climate change can influence migratory populations and for predicting population-level responses to climate change.

It is not, however, sufficient to consider the ecological responses of species to potential climate change in isolation. Coastal management for migratory species requires multi-disciplinary, integrated approaches in which models of structural changes to coastlines and consequent impacts on habitat structure and

distribution are linked to models of species' responses to climate change and sea level rise. The Regional Coastal Simulator, which is being developed at the Tyndall Centre, aims to integrate these processes to provide a tool for coastal managers to explore the consequences of sea level rise and associated policy decisions in East Anglia.



Coral reefs and global climate change: implications of changed temperatures, sea level, atmospheric carbon dioxide and cyclone regimes

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Global climate change poses a substantial risk to the biodiversity, ecosystem functioning and productivity of coral reefs worldwide, and thus threatens their socio-economic value to human societies. In addition to impacts from climatic change, coral reefs are also under pressure from human activities (eg pollution, harvesting and coastal development) and natural stressors (eg crown-of-thorns starfish and disease).

Historically, these ecosystems have typically been managed through marine protected area systems that focus on the threat from readily identifiable and 'tangible' anthropogenic activities such as fishing and development projects. Incorporating the concept of climate change into the management of marine