Identify and Protect Potential Refugia

An Adaptation Brief

Overview

Although climate change impacts are already being felt globally and are expected to increase over the coming century, these impacts are not equally distributed across all coastal and marine habitats. Climate change "refugia" is a term used to describe locations that are buffered from rapid changes and climate extremes, facilitating the persistence of sensitive habitats and species.

Identifying Climate and Non-Climate Vulnerabilities

Potential future changes and associated impacts of climate change on coastal and marine habitats and species include:

Warmer air and water temperatures

- → **Reduce water quality** (e.g., harmful algal blooms)
- → **Increase coral bleaching and the risk of disease**

Longer dry periods

- → **Reduce freshwater inputs, affecting salinity**
- → **Shift composition of vegetation toward upland species** (including invasives)

Ocean acidification

- → **Reduces rates of calcification in reef-building corals and other marine calcifying organisms**

More frequent and/or severe storms

- → **Increase flooding**
- → **Change turbidity, sediment flow, and salinity**

Sea-level rise and storm surges

- → **Result in more inundation and increased coastal erosion**
- → **Reduce the extent of habitat, crucially where development and other land uses also restrict inland migration**

Altered currents and upwelling/mixing

- → **Change water chemistry and nutrient content**
- → **Change larval transport and dispersal**

Climate impacts may be compounded in ecosystems already degraded by human activities, affecting factors such as habitat extent/connectivity, water quality, and species composition (e.g., presence of herbivorous reef fish).

USFWS via Flickr.

Reducing Vulnerabilities through Adaptation Actions

The following are examples of areas that could be prioritized for protection as potential climate refugia:

Beaches and dunes that are less exposed to sea-level rise and/or those dunes that may be able to migrate inland

- ✔ Buffered from higher relative sea-level rise

Mangroves adjacent to rivers/streams that provide sediment

- ✔ Higher accretion rates may allow habitat to keep pace with sea-level rise and/or migrate inland

Coastal habitats buffered from storm surge by barrier islands, oyster reefs, or other natural systems

- ✔ Increased storm protection through wave attenuation, reducing coastal erosion

Kelp forests and seagrass meadows that reduce CO_2 concentrations

- ✔ High photosynthetic rates cause local reductions in ocean pH

Coral reefs that experience greater daily temperature ranges

- ✔ Promote stress-tolerant corals that are less vulnerable to bleaching

Case Studies

The following case studies demonstrate how this adaptation strategy is being used to reduce climate change vulnerability in various regions of North America and in habitats ranging from beaches to the open ocean.

CONSERVING CALIFORNIA'S COASTAL HABITATS

California, United States

Joanna Gilkeson/USFWS via Flickr.

The Nature Conservancy and the California State Coastal Conservancy (SCC) collaborated to produce the first statewide, comprehensive assessment of the vulnerability to sea-level rise for California's coastal habitats, including beaches, estuarine marshes, rocky intertidal habitats, and tidal flats, among others. The resulting report includes high-resolution maps that **identify potential resilient strongholds, based on their high biodiversity and low vulnerability to future sea-level rise and coastal erosion**.

Coastal areas that are likely to be more resilient to sea-level rise and/or have the potential to migrate inland can be prioritized for protection, and/or management strategies can focus on maintaining habitat extent and connectivity.

For more information: ***Conserving California's Coastal Habitats project overview***

PROMOTING RESILIENCE IN THE MESOAMERICAN REEF

Mesoamerican Reef along the coasts of Mexico, Belize, Guatemala, and Honduras

In 2006, The Nature Conservancy worked with government agencies, universities, and nongovernmental organizations along the Caribbean coasts of Mexico, Belize, Guatemala, and Honduras to identify resilient sites on the Mesoamerican Reef. As the largest coral reef system in the Western Hemisphere, the Mesoamerican Reef is home to over 65 species of stony coral and over 500 species of fish. However, habitat degradation has occurred, due to overfishing, pollution, and tourism, among other impacts, and the reef is also vulnerable to the effects of climate change.

Adaptation strategies in this project include:

- **Conducting an ecoregional assessment designed to identify resilient reefs that may act as climate refugia**
- **Prioritizing resilient areas for additional protection**, with the goal of creating an ecologically connected network spanning 2.3 million hectares (over 8,800 square miles)
- **Creating a monitoring program to act as an early warning system for coral bleaching events**, which will enable deployment of a rapid response team

For more information: ***Promoting Resilience in the Mesoamerican Reef case study***

NOAA's National Ocean Service via Flickr.

IDENTIFYING POTENTIAL MARINE CLIMATE CHANGE REFUGIA IN CANADA'S PACIFIC MARINE ECOSYSTEMS

Northeast Pacific Ocean of Canada

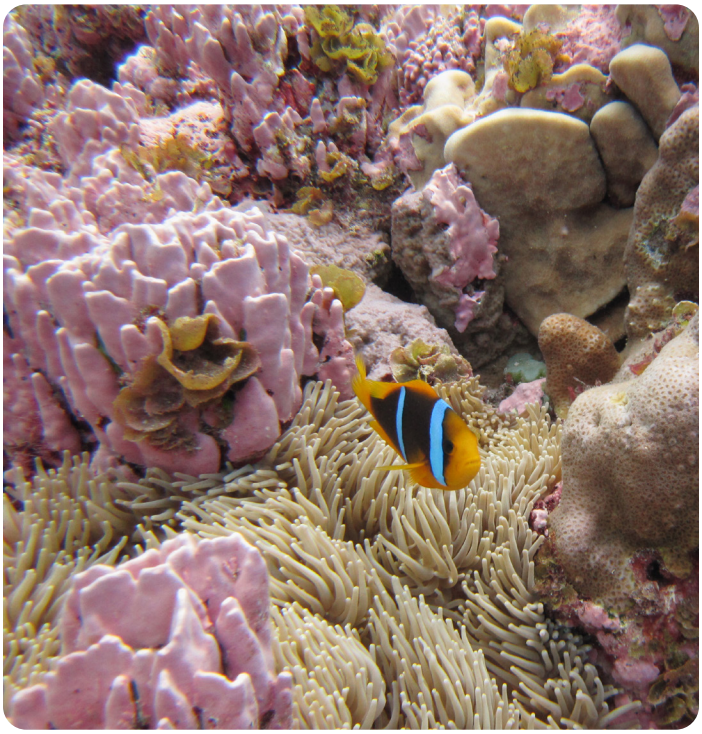
This project focused on **identifying areas of the northeast Pacific where physical conditions are stable or changing slowly compared to surrounding areas**, which may indicate potential climate refugia. Researchers analyzed the rate and consistency of change in historical data for sea surface temperature, sea surface height, and chlorophyll a.

After identifying areas where climate conditions have remained relatively stable, researchers identified general characteristics that may limit exposure to climate change and used climate models to assess projected future changes. They found that only 0.27% of the study area was expected to be insulated from significant changes in all three variables, though a larger area (11%) was stable for two of the three variables. Some of these areas overlapped with features expected to limit climate change exposure.

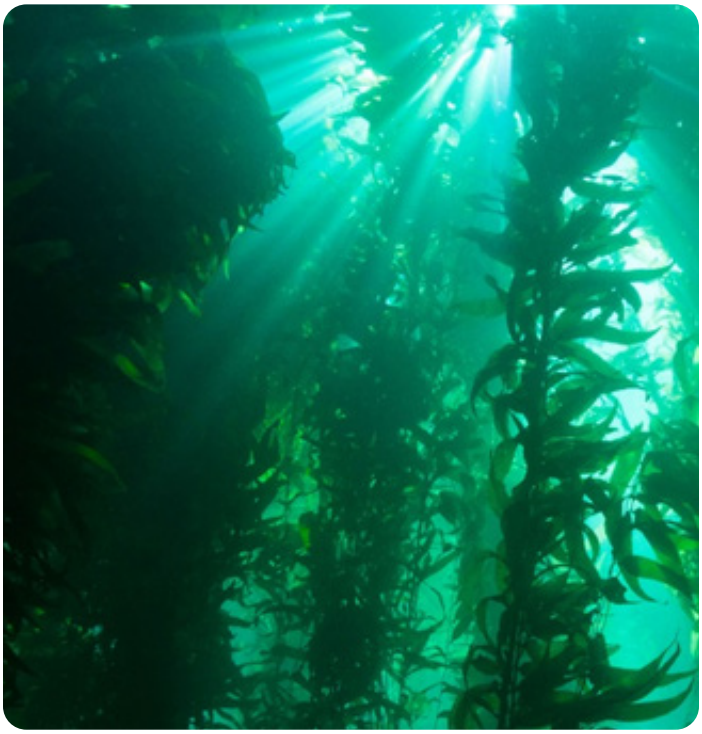
For more information: ***Identifying Potential Marine Climate Change Refugia in Canada's Pacific Marine Ecosystems case study***

Key Resources

- **Sea-Level Rise Viewer**: A NOAA web-based mapping tool that allows users to visualize sea-level rise, storm surge, flooding, and potential marsh migration along the US coast under several future climate scenarios.
- **Resilient Coastal Sites**: A report, web mapping tool, story maps, datasets, and other resources were developed by The Nature Conservancy to identify the most resilient coastal sites along the Atlantic Seaboard and Gulf of Mexico.
- **Using Climate Science to Plan for Sustainable Use of the Great Barrier Reef**: The Great Barrier Reef Marine Park Zoning Plan (Australia) mapped site resilience and potential climate refugia to prioritize sites for protection and inform future uses (e.g., recreation).
- **Florida Reef Resilience Program**: This program focused on studying the health of the Florida Reef tract, including what makes some corals more resistant than others to climate change impacts, what factors contribute to areas of high or low resistance, and why certain areas are more resilient than others.
- **Deep-water Kelp Refugia as Potential Hotspots of Tropical Marine Diversity and Productivity, Ecuador**: This peer-reviewed study describes the use of an oceanographic and ecophysiological model to identify deep-water tropical kelp populations off the Galapagos Islands, which may serve as deep-water kelp refugia.



NOAA via Flickr.



NOAA via Flickr.

This brief is based on adaptation strategies and case studies from the **Climate Adaptation Toolkit for Marine and Coastal Protected Areas (MPA Toolkit)**, an online resource created to make climate adaptation planning a simple, direct, and feasible process for marine protected area managers. The MPA Toolkit contains:

- A step-by-step guide to undertaking a Rapid Vulnerability Assessment for marine and coastal areas
- Structured and searchable adaptation strategy ideas with supporting case studies, reports and tools
- Foundational adaptation resources
- Selected experts who can be contacted for technical guidance

Find the Toolkit at https://www.cakex.org/MPAToolkit

EcoAdapt™
Meeting the challenges of climate change