Sustaining Marine Resources in a Changing Climate

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Climate change is already impacting marine ecosystems and the communities & economies that depend on them.

- These impacts are expected to increase.

- There is much at risk domestically and internationally (food, jobs, revenue, human health, security, heritage etc).

  - Food: 1.5 billion people (world-wide)
  - Fisheries Jobs: 43.5 million (world-wide), 1.3 million (US)
  - Fisheries economies: $200 B in sales/income impacts (US)
  - Coastal economies: 60 % GDP (US)
  - Transportation: Shipping, commerce, safety
  - International relations and security issues
Diverse audience for marine-climate products and services

- Living marine resource scientists and managers
  - Federal govt (NOAA, USFWS, USGS, EPA)
  - State govts (35 State Fish and Wildlife Agencies)
  - Indigenous govts (Tribal Fish and Wildlife Agencies)
  - Academic partners (NSF, Sea Grant, universities)

- Ocean use scientists and managers (DOI, DOD, DOT, DHS-USCG)
- Ocean-dependent industries (energy, aquaculture, fishing, tourism, shipping)
- Ocean-dependent communities & economies (local, state, regional)

Increasing demand for regional products and services

- What has changed? Why has it changed?
- How will it change? When will it change?
- How prepare? How reduce impacts?
Impacts of Climate Change on Marine Ecosystems

**Climate Changes**
- ↑ temperature

**Physical Impacts**
- ↑ sea surface temperature
- Δ stratification
- ↑ extreme weather events
- Δ circulation
- ↑ incidence of hypoxia
- Δ salinity
- ↑ sea level rise
- ↑ ocean acidification

**Biological Impacts**
- Δ distribution
- Δ abundance
- Δ phenology
- Δ survivorship
- Δ productivity
- ↑ incidence of disease
- Δ invasive species

**Social Economic Impacts**
- Δ ocean dependent activities (location, timing, type)
- Δ revenues & economics
- Δ industry diversity
- Δ subsistence use
- Δ human health risks

**International Impacts**
- Δ trans-boundary species
- Δ highly migratory species
- ↑ partnerships
- Δ treaties
- Δ transportation
- Δ security

**Mitigation Efforts**
- ↓ emissions, ↑ sequestration

**Adaptation Efforts**
Reduce existing stressors, manage for resilience, seek beneficial opportunities etc
Observed or Projected Climate-related Changes in U.S. Marine Ecosystems
Over past 40 yrs:
• 60% major fish stocks have shifted distributions poleward (1 mile yr$^{-1}$) and/or deeper (0.8 ft yr$^{-1}$).
• Species shifting at different rates (25-200 miles poleward)
• Also changes in abundance, phenology, species assemblages
• Why changing? Future changes?

Source: Nye JA et al. (2009), Hare et al. (2010)
Will Some Species Thrive In A Changing Climate?

Projected Increase in Atlantic Croaker Populations

PROJECTIONS:

• Increased juvenile recruitment.
• 50-100 km northward shift in distribution.
• 60-100% increased biomass.
• 30-100% increased maximum sustainable yield.
• Potential increased fisheries?

Triangles = fishing rates at maximum sustainable yields (FMSY).

From Hare et al 2010.
How will fish catch change by 2100?
The Challenge 3: Lack of integrated products and services

**What has changed?**
- OBSERVATIONS
  - climate
  - oceans
  - Biological resources
  - Social & economic

**Why did it change?**
- RESEARCH
  - climate
  - oceans
  - Biological resources
  - Social & economic

**How will it change?**
- PROJECTIONS
  - climate
  - oceans
  - Biological resources
  - Social & economic

**Spatial scales:**
- regional to basin

**Time scales:**
- annual to decadal

**Products**
- Fishery management plans
- Protected species & area management
- Public & private investments

**Decision Makers**
- Why change?
- What changed?
- Future change?
- What action to take?
Vision:

Marine resource managers and other decision-makers will have access to, and sufficient knowledge to apply, best available information to manage large marine ecosystems in a changing climate.

Strategy:

Build and sustain core set of products & services:

– coordinated observations,
– targeted research &
– integrated physical-biological models.
1. **Delivering ocean data & products (Global Ocean Observing System):**
   - SST products based on satellite data and in-situ validation network.
   - Salinity data from Argo (to 2000m depth) to assess salinity variability.
   - Continuous high resolution regional observations from remote, moored and shipboard platforms (Bering Sea, Calif Current etc).
   - Growing ocean acidification observation network.

2. **Advancing assessments & projections:**
   - New modeling tools (e.g., Earth System Models, Cobalt)
   - Regional projections (Bering Sea, Calif Current, North Atlantic)
   - Rapid assessment protocol – fisheries climate vulnerability

3. **Building understanding and capacity:**
   - Targeted research on ocean-climate linkages (NMFS, OAR, NOS)
   - New support for application of climate info in marine management (COCA, RISA)
   - Needs Assessment (Climate Ready Marine Resource Management)
Focus Area Organization

Executive Working Group

- Director, NMFS/Science & Tech (Chair)
- Director, OAR/CPO
- Director, OAR/GFDL
- Director, OAR/ESRL
- Director, OAR/PMEL & AOML
- Director, NESDIS/NODC
- Director, NESDIS/NCDC
- Director, NWS/CPC
- Director, NOS/NCCOS

* PROPOSED

Project Lead

- Roger Griffis, NMFS/Science & Tech

Working Group

Advisory Group & external partners

Project Plan

Regional Pilots

Execution Agreements
Key Scientific and Technical Issues

- **What are the critical observing requirements** (physical, biogeochemical, etc) for early warnings and projections of climate impacts in marine systems?
- **What are the key physical, chemical and biological indicators** to track?
- **How integrate observations and modeling** with sufficient spatial and temporal resolution to enable skillful marine ecosystem predictions?
- **What are the best modeling tools/approaches** to provide regional scale projections of climate impacts on marine resources?
- **What changes & impacts have already happened?**
- **How well can we project climate impacts** on species or users?
- **What spatial and temporal resolution is most useful** to decision-makers – and can we deliver at these scales?
- **Can the resource management process incorporate and respond** to information on past and future climate impacts?
1. **FOCUS AREA:** Regional projections of climate impacts on marine resources

2. **PRODUCT LINE:**
   - Impact assessments (to date)
   - Risk assessments (outlooks, projections)
   - Spatial scale? Temporal scale? Species? Format?

3. **ISSUES:**
   - Integrating efforts across NOAA
   - Integrating efforts with non-NOAA partners (e.g., other feds, academia, regional ocean observing systems, state agencies)
   - Engaging decision makers
   - Engaging ocean-dependent sectors, users
   - Leveraging federal, state and non-govt science enterprise
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Stock assessment model reveals low/declining recruitment.
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Fishery Management Council’s Science and Statistical Committee (SSC) receives warning

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Help?
Council adopts SSC recommendation to reduce pollock harvest based on assessment and continuation of poor (warm) environmental conditions.

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Quota cut from 1.6 to 0.8 million tons.