Wetlands in an era of rapid environmental change

Susan Galatowitsch, University of Minnesota
Fisheries, Wildlife, & Conservation Biology
Wetlands are a global resource
Wetlands of North America

240 Mha
Current Extent
Wetland Ecosystem Services

**Ecosystem Services (ES) related to Wetlands**

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
<th>Supporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodplain recession agriculture</td>
<td>Flood attenuation and protection</td>
<td>Ecotourism</td>
<td>Biodiversity</td>
</tr>
<tr>
<td>Fresh water supply</td>
<td>River flow regulation</td>
<td>Services meeting aesthetic, emotional, ethnic or spiritual needs</td>
<td>Carbon sequestration and storage</td>
</tr>
<tr>
<td>Food source (fishery, birds, wildlife)</td>
<td>Improvement of water quality</td>
<td></td>
<td>Groundwater recharge</td>
</tr>
<tr>
<td>Grazing area for cattle</td>
<td>Nutrient cycling and sediment retention</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

....aka Wetland Functions and Values
Wetlands are diverse

This diversity reflects the wide array of environments wetlands occupy.

Environments

Climates + Landforms
Climate governs key wetland attributes
Changes in atmospheric conditions

precipitation

Climate vs weather?

Climate change:

Trends over a few decades

Weather Change:

Shifts in conditions over minutes to weeks
Climate affects all facets of a wetland’s water budget—either directly or indirectly.

**Figure 18.** Components of the wetland water budget. \( P + SWI + GWI = ET + SWO + GWO + \Delta S \), where \( P \) is precipitation, \( SWI \) is surface-water inflow, \( SWO \) is surface-water outflow, \( GWI \) is ground-water inflow, \( GWO \) is ground-water outflow, \( ET \) is evapotranspiration, and \( \Delta S \) is change in storage.
Climate & wetland biota

Direct Effects:
Seasonality of wet & dry phases, Rates of biological reactions, Organismal stress

Indirect Effects:
Water & soil chemistry, Organismal stress
Wetland changes linked to climate change

Natural causes

Wetland change in a North Dakota ephemeral wetland (Yansa et al 2007)
Climate change – Primary human trigger:

$\uparrow CO_2 \hspace{10mm} temp \uparrow$

Image source: Climate Central
Recent Significant Climatic Trends in the Eastern Great Plains

Seeley - 2013

TEMPERATURE: Warmer with seasonal shifts

DEWPOINTS: Change in frequency of tropical-like atmospheric water vapor.

MOISTURE: Greater variability, higher fractional thunderstorm contribution
How warmer global & regional temperatures affect wetland water sources

- Changes in distribution of ppt—more deluges & drought
- Seasonal changes to ppt patterns
- Greater water loss due to higher ET
- Land use changes—strong influence
- Changes to regional water balances—strong influence
- High volume runoff assoc. with storms

What are the effects to wetland hydrology & ecology?
Example:

Predicted ecological changes to Minnesota wetlands
Galatowitsch et al. 2008

- Reduced extent of shallow wetlands
- Shorter duration of flooding in wetlands
- Lower water table in peatlands, increased fires
- Influx of new exotic species in lakes

Photo source: BBC
Projected effects on breeding waterfowl

Johnson et al. 2005

Figure 2. Model simulations that locate the most favorable wetland conditions for breeding waterfowl under historic and alternative future climates (Johnson et al. 2005).
“No regrets” decisions during a time of high climate uncertainty.

Climate Vulnerability Assessment Framework
MN DNR 2011
Amount of change: down-scaled projections

What does this mean to management decisions on specific sites?

Viner 2012
Aim: No-regrets management strategies to reduce climate change risks

Expandere WMA
363 ha, 14 m relief
Large *Cypripedium* population

Linked habitat suitability & population models to simulate climate change-management scenarios
How likely is a 90% decline in population?

“No regrets” strategy:
Controlling invasive species in the vicinity of small white lady slipper populations should reduce vulnerability to climate change effects ... up to a point!
- Manage invasive species, monitor changes to lady slippers
- Protect groundwater flow by purchase, restoration
- Develop plans to deploy “high risk” actions—irrigation & translocation.

What should happen now?
No regrets” decisions during a time of high climate uncertainty

Non-climate stressors: invasive species, land use impacts, etc.

Central Platte River wetlands – FWS photo
SUMMARY:
Assess potential effects of climate change to all aspects of wetland water budgets;

Look for ways to minimize:
- direct effects (stress from environmental extremes),
- indirect effects (changing water regimes),
- multiple stressors (e.g., invasive species x climate);

Don’t defer: seek “No regrets strategies now!