Prairie Pothole Wetlands: Characteristics, Functions, and Values

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Outline

I. Prairie Pothole Region (PPR)
II. PPR wetlands
III. Important concepts and processes
IV. Ecosystem services & values
Prairie Pothole Region (PPR)
PPR wetlands

- Small depressional wetlands often called potholes or sloughs
- Formed by glacial activity
- Large proportion <1 ha
- Classification systems:
  - Stewart and Kantrud 1971, Cowardin et al. 1979, Brinson 1993
  - NWI → palustrine emergent with temporary, seasonal, & semipermanent water regimes
- Classification can vary
Many faces...
Conservation

- 35-90% loss across the region
- High priority for conservation
- USDA restoration programs
  - CRP
  - WRP
Important processes and concepts

- Catchment
- Water balance
- Hydrology & climate
Wetland catchment

- Important concept because wetland “functions” are highly influenced by surrounding uplands
  - Land use / land cover
  - Soils
  - Slopes
- Precipitation runoff
- Sedimentation
- Nutrients / agrichemicals
- Waterfowl nesting habitat
Catchment water-balance

- Groundwater
- Near-surface runoff
- Surface runoff
- Direct precipitation
- Surface overflow
- Seepage
- ET (Evapotranspiration)
Hydrology

- Majority of functions / processes influenced by hydrology

Hydroperiod

- Highly variable (climate, wetland class)
- Intra-annual and interannual
- Nutrient cycling, productivity, composition of biotic communities

Groundwater relations

- Recharge, flow-through, discharge
- Water permanence, chemistry, biotic communities
Past and current research

- Waterfowl
- Hydrology / groundwater
- Vegetation
- Soils
- Ecosystem services
- Modeling
  - Hydrology
  - Vegetation dynamics
  - Land-use impacts
Ecosystem services

Ecosystem services: “the benefits people obtain from ecosystems” (Millennium Ecosystem Assessment 2005)

- The concept of ecosystem services is inherently based on the value or importance to humans, but the expression of those services is controlled by the underlying complex ecological structure and processes (Zhu et al. 2010)

- 4 main categories:
  - Supporting (e.g., soil formation)
  - Regulating (e.g., carbon sequestration/climate change)
  - Provisioning (e.g., food and fiber)
  - Cultural (e.g., recreation and education)
Functions / values of PPR wetlands

1. Waterfowl & wildlife habitat
2. Floodwater storage
3. Groundwater recharge
4. Biodiversity
5. Recreational opportunities
6. Water quality
7. Mitigation of atmospheric CO₂
8. Forage / water for livestock
Waterfowl & wildlife habitat

- Nesting habitat
- Food resources
- Brood rearing
- Migration stopover
- Sanctuary from predators
- Winter cover
Wetland complexes
Floodwater storage

- Wetland drainage / land-use change linked to increased intensity and frequency of flooding

Research:
- Flood-storage capacity of wetlands
- Impact of wetland storage (or loss of storage) on downstream flooding
Floodwater storage

- Wetlands in the Devils Lake basin of North Dakota could store approximately 72 and 41% of the total runoff volume from a 2-year and 100-year frequency runoff event (Ludden et al. 1983)
- Vining (2002) reported that pothole wetlands in the Starkweather Coulee subbasin of Devils Lake, ND were capable of storing more than 8,000 ha-m
- A complex of wetlands retained all local runoff plus 58% of additional inflow (Malcolm 1979)
- Restoring drained and farmed wetlands could increase the water retention capacity of a PPR watershed by up to 63% (Gleason and others 2007)
- Modeling the downstream impact?
Groundwater recharge

- PPR wetlands have various relations to groundwater
- Many recharge groundwater
- Slow process
- Difficult to quantify
- Pumping for irrigation

http://ga.water.usgs.gov/edu/earthgwaquifer.html
Biodiversity

- Native plants
- Birds
- Amphibians
- Invertebrates
Floristic quality

Laubhan and Gleason 2008
Recreational opportunities

- Hunting
- Bird watching
- Photography
- Education
Water quality

- Wetlands can act as filters
- Intercept runoff
- Retain excess nutrients and some pollutants
- Reduce sediment that could clog lotic waterways and affect aquatic communities
- This is a benefit for “downstream” systems; but, is it a benefit for the wetland?
Mitigation of atmospheric CO$_2$

- Climate change and elevated CO$_2$
- Soil carbon
- GHG’s
  - CH$_4$
  - N$_2$O
  - CO$_2$
- Net benefit?
Soil carbon and GHGs

Carbon sequestration
- High productivity
- Great potential
- Highly variable
  - Climate
  - Soils
  - Land use

GHGs
- CH$_4$, N$_2$O
- Highly variable
  - Climate
    - Precipitation
    - Temperature
  - Hydrology
  - Soil moisture
  - Soil NO$_3$
  - Land use
Soil carbon

Gleason et al. 2008
GHGs

![Graph showing GHG emissions in wetland zone for 2007 and 2008](image-url)
Forage & water for livestock
Summary

- PPR wetlands
- Concepts
- Processes
- Ecosystem services
- Functions & values