Eco-Hydrology of Canadian Prairie Wetlands and Management Implications: Synthesis of a 40-year Study

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Northern Pintails Anas acuta Photo: Bob Clark

Aquatic Invertebrate Gammarus lacustris Photo: Dorothy Lindeman





# Northern Prairie Region (Prairie Pothole Region)

## **Semi-arid climate**

- Precip. = 300-500 mm/yr
- **Potential ET = 700-800 mm/yr**

## Very cold winter

- Temperature down to -30 °C
- Soil frozen to 1-1.5 m

## **Glaciated plain**

# Deposition of Glacial Till (up to 300 m)

## Clay-rich Low permeability

## Undulating topography Numerous depressions



# **Snowmelt Runoff over Frozen Soil**



# Pond Depth in Wetland S109, St. Denis



## **Water Balance of Prairie Wetlands**



# **Crop Rotation in Dry-Land Agriculture**

#### oil seed

#### wheat

#### summer fallow

# **Re-introduction of Permanent Grass** Dense nesting cover for protection from predators



Gadwall Duckling (*Anas strepera*) Photo: Bob Clark Permanent grass cover Non-native brome grass (*Bromus inermis*)



# St. Denis National Wildlife Area

More than 100 wetlands with a variety of size and permanence.



Photo: Canadian Wildlife Service (CWS)

## **Effects of Dense Nesting Cover**



# **Infiltration Measurements**

# Summer (unfrozen) $\longrightarrow$ Spring (frozen)





# **Infiltration Capacity of the Top Soil**

**Measured by single-ring infiltrometers** 

Average, standard deviation, and # of samples

	Grassed			Cultivated		
	Avg.	SD	#	Avg	SD	#
Unfrozen	300	390	11	23	13	15
Frozen	19	36	6	0.3	0.6	3

unit : mm/hour

## Water Balance of Prairie Wetlands



## Hydraulic Conductivity (*K*) of Glacial Till Groundwater flow rate is proportional to *K*.



Original data: J. Hydrol. 207:42; Hydrol. Process. 18:2011

## **Groundwater Flow under Wetlands**



Shallow groundwater exchange is a major component of water balance.

Groundwater flow in low-*K* till is very slow, very minor component of water balance.

#### Rate of Water Loss Increases with Shoreline Re-analysis of 35 wetlands from Millar (1971)



## Water Depth in St. Denis Wetlands Long-term data collected by Jack Miller (CWS)



## **Summary and Implications**

Permanence of wetland ponds depends on:
(a) Runoff input – size and landuse of uplands
(b) Summer recession – groundwater exchange

→ Restoration/preservation of wetlands need to consider wetland-upland complex beyond a narrow "riparian" margin.

Eco-hydrology of wetlands is controlled by decadal wet-dry cycles, and landuse effects are very slow.

 $\rightarrow$  Long-term monitoring is essential.

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