a principled approach to estimating potential loss of ecosystem services from wetlands on domesticated landscapes

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Session B21H:
Connecting the landscape to aquatic ecosystem endpoints:
Linking Watershed Processes with Ecosystem Services and Sustainability

wetlands are being lost at an alarming rate in domesticating landscapes throughout North America

"up to 70 percent of wetlands have been degraded or lost in settled areas of Canada"

Warner, Asada. 2006. Knowledge gaps and challenges in wetlands under climate change in Canada. In: Price M, J Bhatti, M Apps (Eds). Climate change and managed ecosystems. CRC Press, Boca Raton, FL.

2

“domestication” of landscapes in Alberta

agricultural intensification and urban development in south

Tockner, Pusch, Gessner, Wolter. 2011. Domesticated ecosystems and novel communities: challenges for the management of large rivers. Ecohydrol. Hydrobiol. 11(3-4):167-174

3

“domestication” of landscapes in Alberta

oil sands extraction in north

Tockner, Pusch, Gessner, Wolter. 2011. Domesticated ecosystems and novel communities: challenges for the management of large rivers. Ecohydrol. Hydrobiol. 11(3-4):167-174

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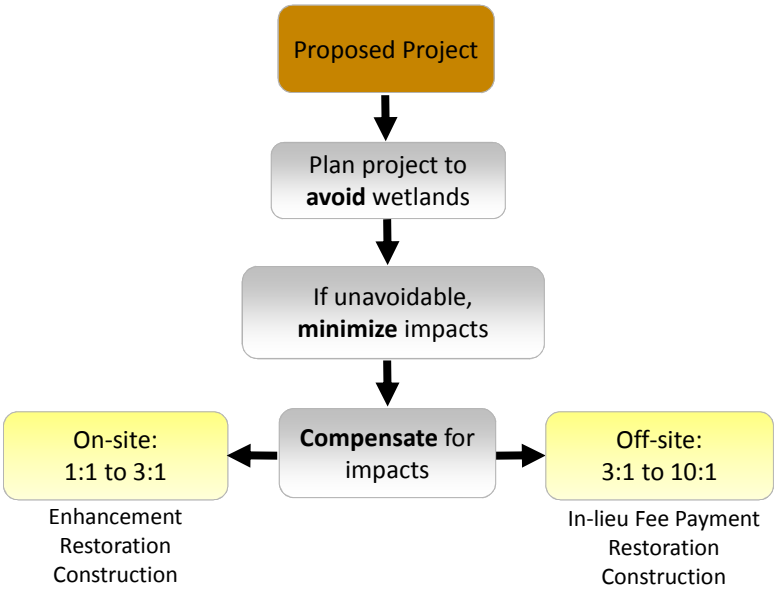
reporting from the front lines of wetland policy development in Alberta

1993	1999	2008	2011	2013 Anticipated Wetland Policy (based on **FUNCTION**)
Interim Wetland Policy (based on **AREA**)	Water Act	Wetland Policy Recommendations (rejected by industry)	Wetland Policy Intent (addressed 2008 industry demands)	

1993 interim wetland policy framework



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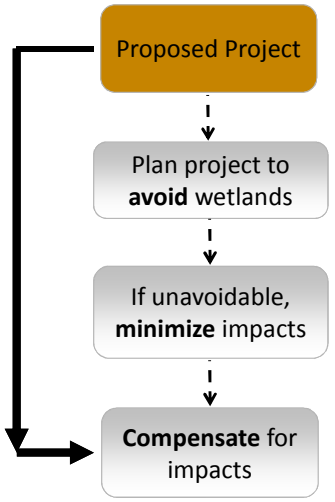
1993 interim wetland policy framework



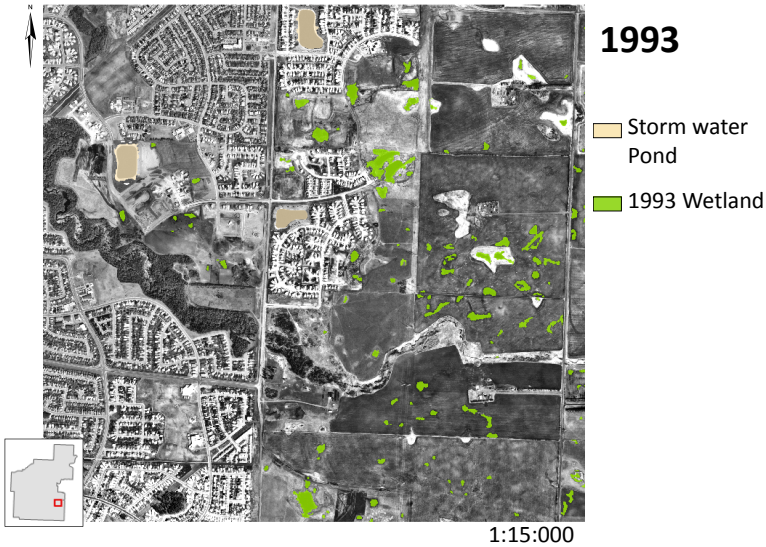
Failure to Avoid

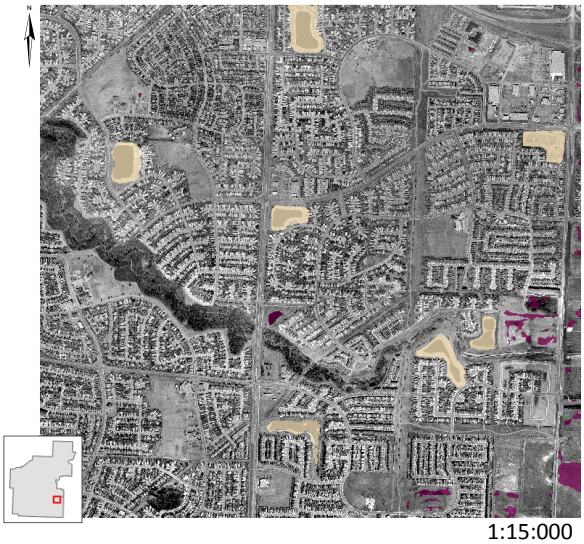
"What we found is that avoidance just doesn't seem to be an option for most [permit applicants] out there. They've already planned their project … it's very difficult to work around that."

Approval Writer, June 2009

Clare, Krogman, Foote, Lemphers. 2011. Where is the avoidance in wetland law and policy? Wetlands Ecology and Management. 19(2): 165-182

7



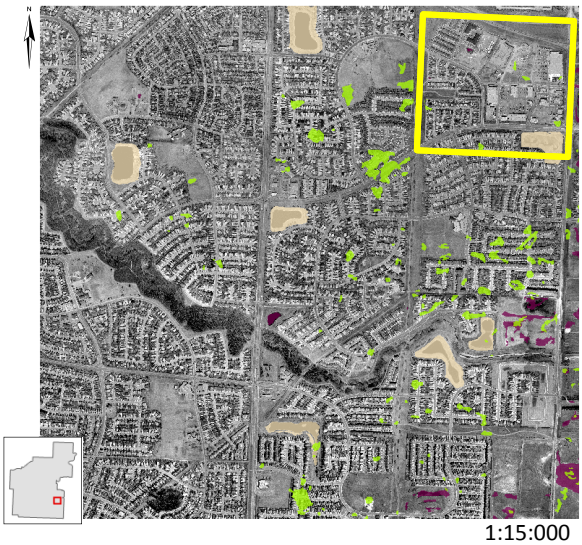


2009

Storm water Pond

2009 Wetland

1:15:000



1993 vs. 2009

Storm water Pond

1993 Wetland = 15.4 ha

2009 Wetland = 6.6 ha

57% absolute loss of wetlands (8.8 ha)

94% of those lost lacked an approval!

1:15:000

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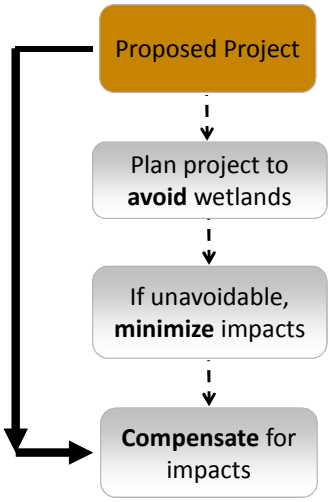
wetland policy framework



Factors contributing to the failure to avoid:

- **wetlands are undervalued**
- poor planning in advance of development
- lack of agreement on what constitutes "avoidance"
- techno-arrogance in the restoration of wetlands
- Inadequate enforcement and compliance monitoring

Clare, Krogman, Foote, Lemphers. 2011. Where is the avoidance in wetland law and policy? Wetlands Ecology and Management. 19(2): 165-182.

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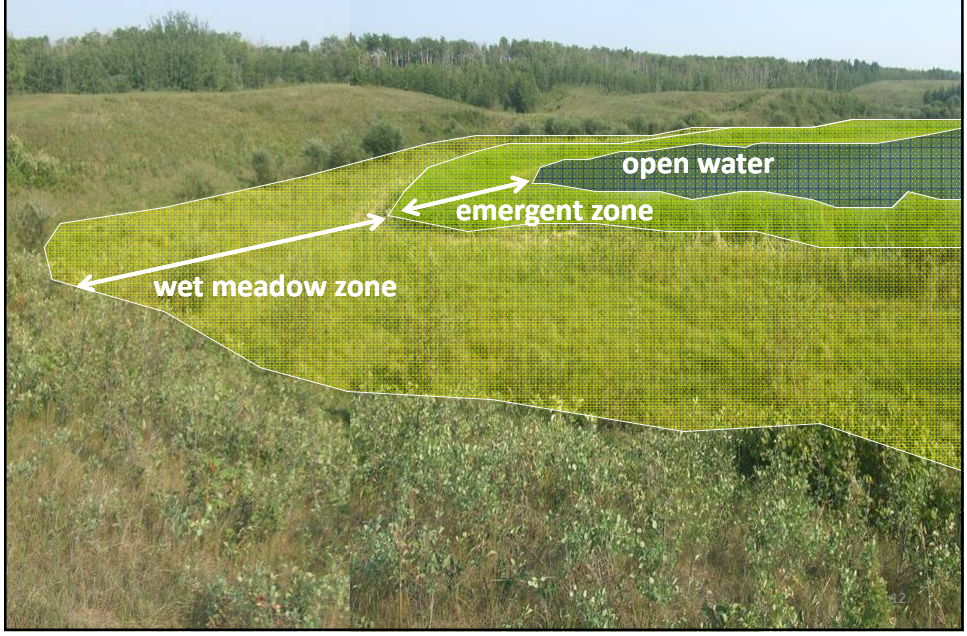
but first we need an accurate wetland inventory



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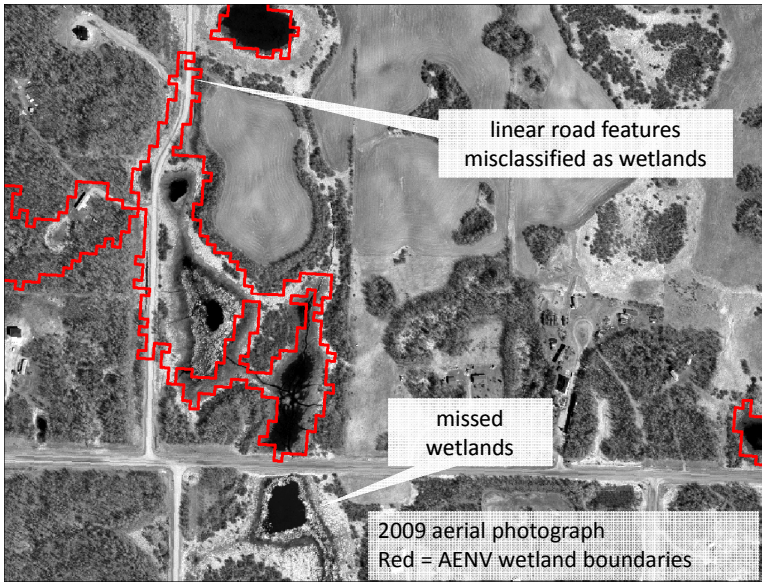
government's wetland inventory
(released March 2012)



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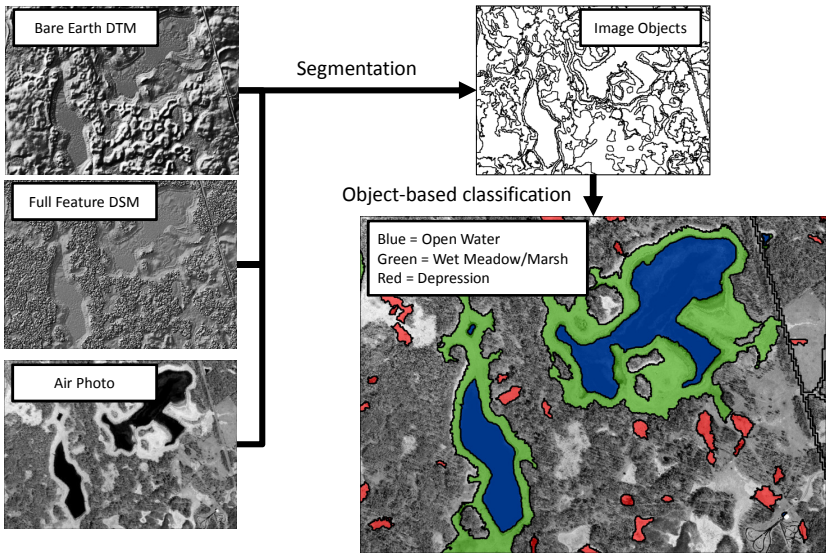
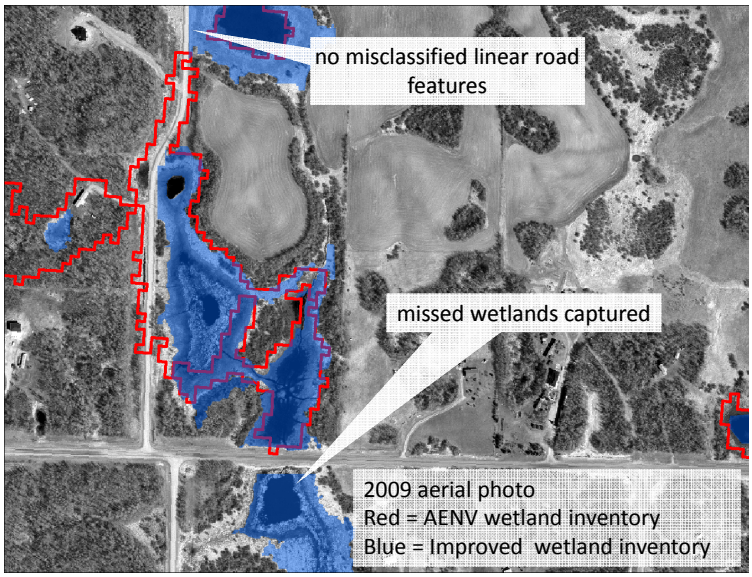


Aldred, Creed. An object-based wetland mapping method. In Preparation.

improved wetland inventory
(based on 2009 data)



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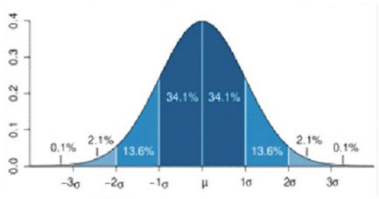
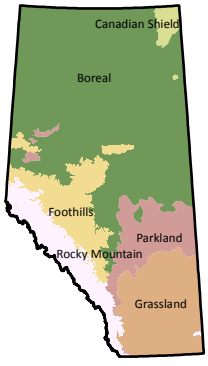
eco-hydrological principle #1

respect spatial heterogeneity

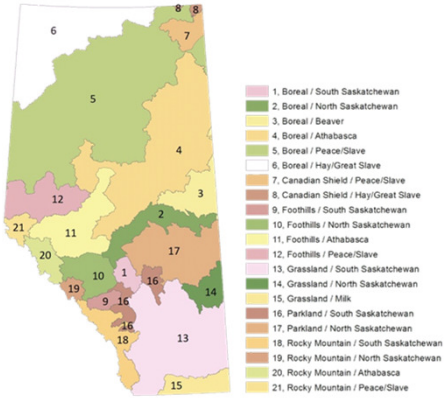
Alberta is a *really* big province…





Ecological regions

Hydrological basins

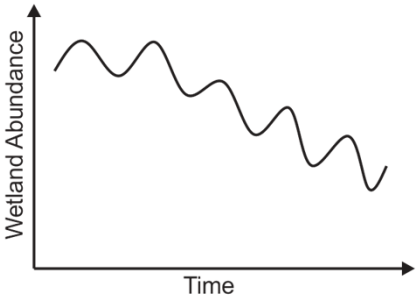


Devito, Creed, Gan, Mendoza, Petrone, Silins, Smerdon. 2005. A framework for broad-scale classification of hydrologic response units on the Boreal Plain: is topography the last thing to consider? Hydrol. Processes 19: 1705-1714.

16

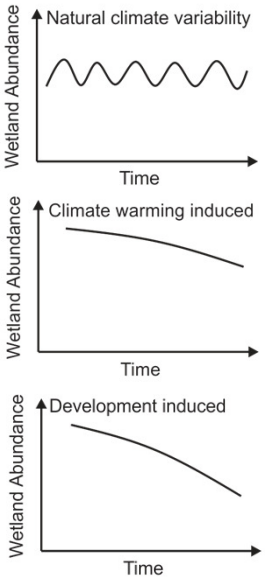
eco-hydrological principle #2

respect temporal variability



Anthropogenic *vs.* natural causes of changes in abundance?

Contemporary *vs.* historical abundance?



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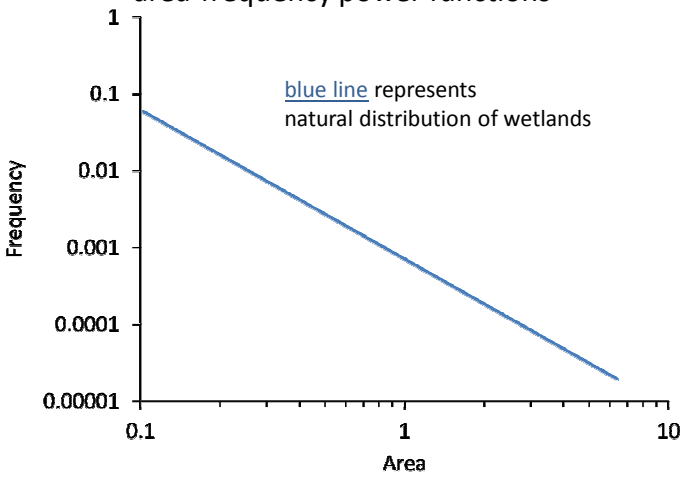
eco-hydrological principle #2

respect temporal variability

estimating historic wetland loss using area-frequency power functions



Zhang, B., Schwartz, F.W., Liu, G. 2009. Systematics in the size structure of prairie pothole lakes through drought and deluge, Water Resources Research, 45, WR006878

18

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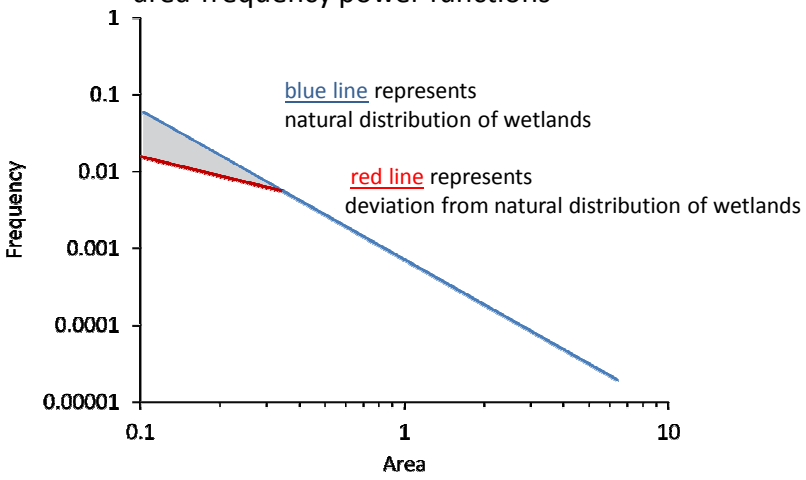

Zhang, B., Schwartz, F.W., Liu, G. 2009. Systematics in the size structure of prairie pothole lakes through drought and deluge, Water Resources Research, 45, WR006878

19

eco-hydrological principle #2

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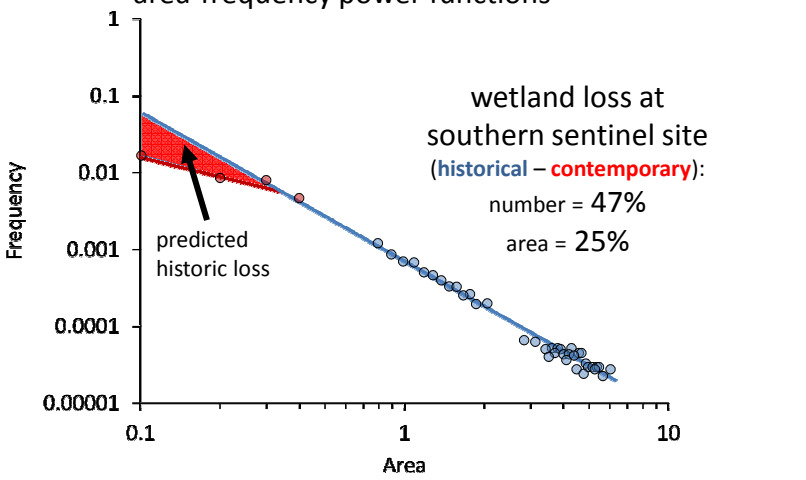

Zhang, B., Schwartz, F.W., Liu, G. 2009. Systematics in the size structure of prairie pothole lakes through drought and deluge, Water Resources Research, 45, WR006878

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wetland functions

- Hydrological Health
- Water Quality Improvement
- Ecological Health
- Human Uses

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wetland functions

- Hydrological Health
- Water Quality Improvement
- Ecological Health
- Human Uses

principles of hydrological health

1. Consider the hydrological system
2. Conserve recharge functions
3. Conserve storage functions
4. Conserve hydrologic connectivity
5. Conserve hydrologic synchronicity
6. Maintain redundancy and diversity of hydrological function to ensure hydrological resilience

Creed, Sass, Bulttle, Jones. 2011. Hydrological principles for sustainable management of forest ecosystems. *Hydrol. Process.* **25**, 2152–2160.

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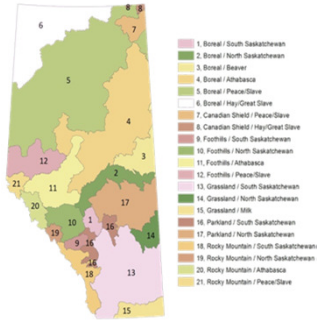
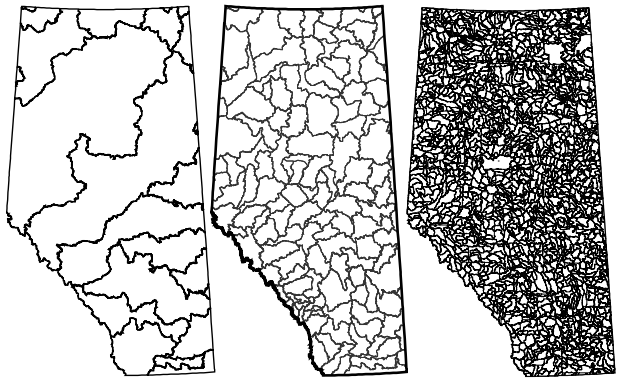
hydrological principle #1

consider the entirety of the hydrological system at relevant scales for hydrologic processes





scales include wetland, surrounding buffer (100m to 10,000 km), 1st to higher order hydrological systems (defined by surface and subsurface flow systems)

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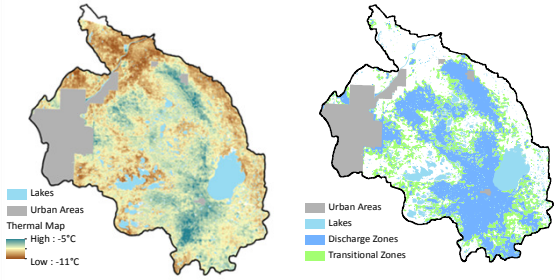
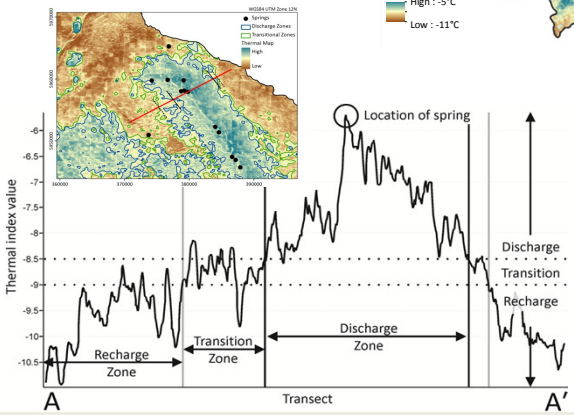
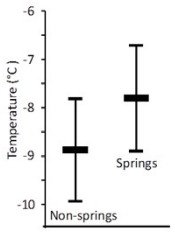
hydrological principle #2

conserve hydrological features with critical recharge functions





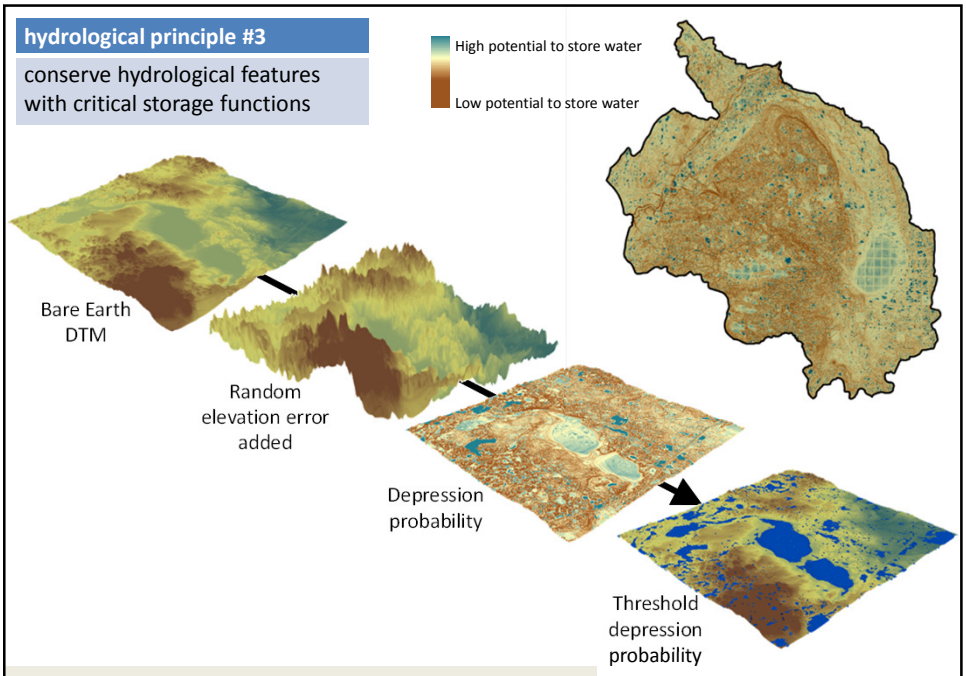


Sass, Creed, Riddell, Bayley. Mapping potential groundwater recharge and discharge wetlands using thermal satellite imagery. To be submitted to Wetlands.

24

hydrological principle #3

conserve hydrological features with critical storage functions



Lindsay, Creed, Beall. 2004. Drainage basin morphometrics for depressional landscapes. Water Resources Research 40: W09307.

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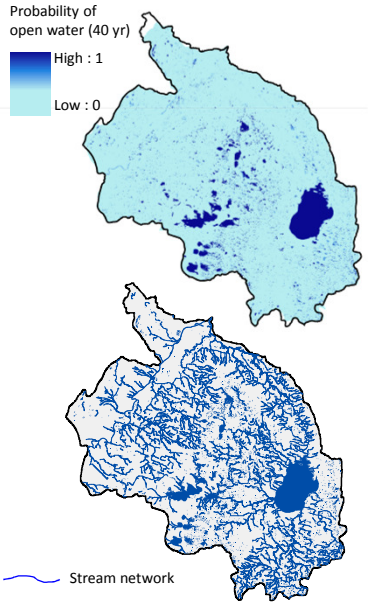
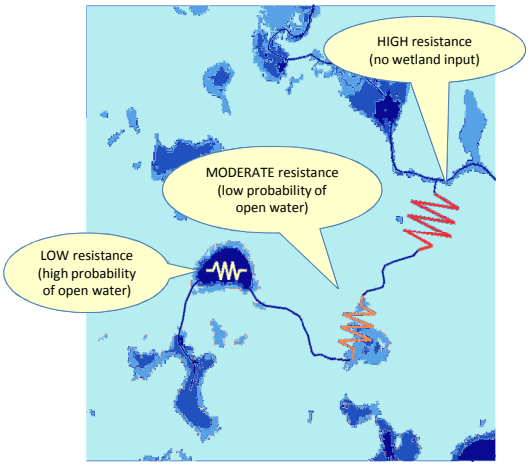
hydrological principle #4

conserve hydrologic connectivity



"Circuit*scapes*"



McRae, Beier. 2007. Circuit theory predicts gene flow in plant and animal populations. PNAS 104: 19885-19890.

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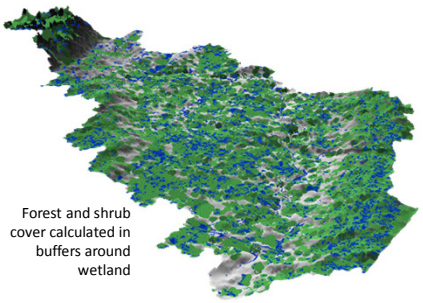
hydrological principle #5

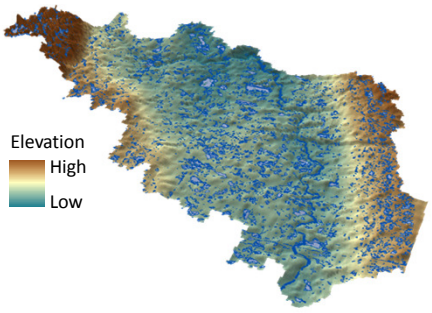
conserve hydrologic synchronicity

Surface flow is slowed by woody vegetation

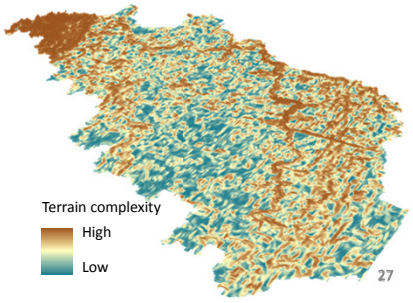


Forest and shrub cover calculated in buffers around wetland

Headwater wetlands influence flow over a longer downstream area to desynchronize flood flow



Surface flow is slowed by complex terrain



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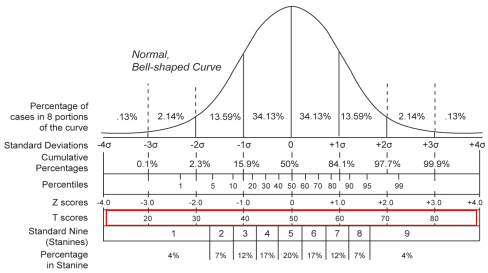
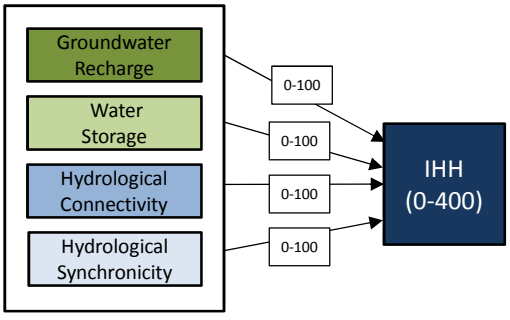
hydrological principle #6

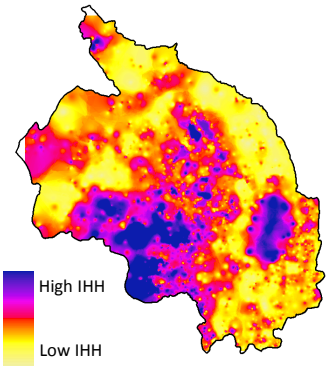
maintain diversity and redundancy of hydrological features that contribute to a resilient system

generating normalized metrics to allow direct comparison between metrics

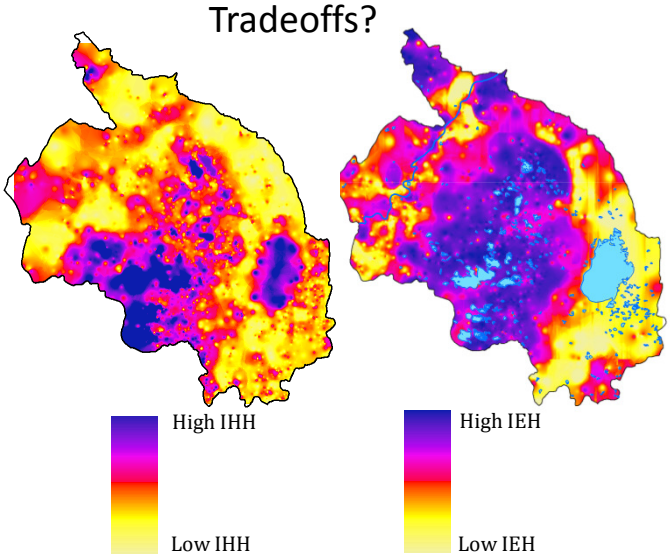


Hydrological Health = potential for





Indicator of Hydrological Health (IHH) vs. Indicator of Ecological Health (IEH) Tradeoffs?



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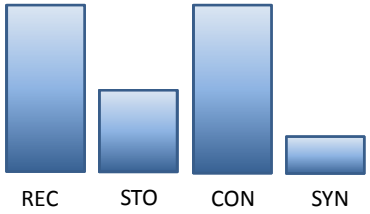
check to make sure we do NOT hardwiring the system to pick winners and losers!

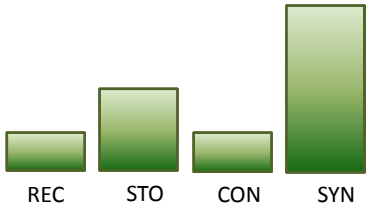
30

check to make sure we do NOT hardwire the system to pick winners and losers!

permanent, large, open water

temporary, small, swamp/fen/bog/marsh





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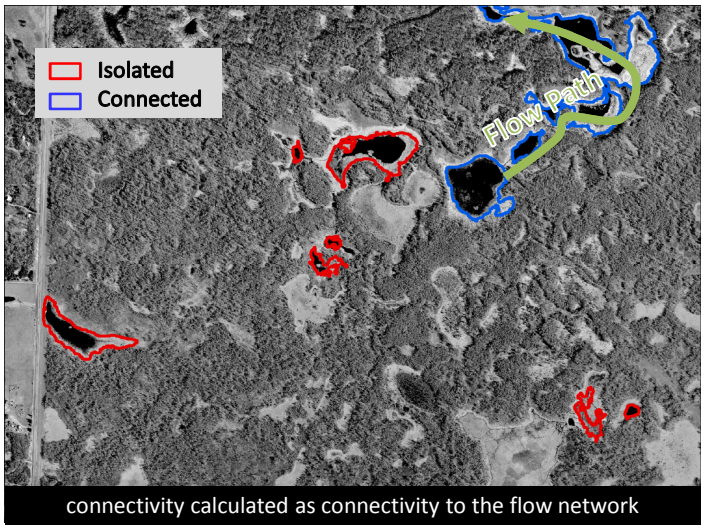
and that we DO consider feedbacks at landscape scale

State of continual flux

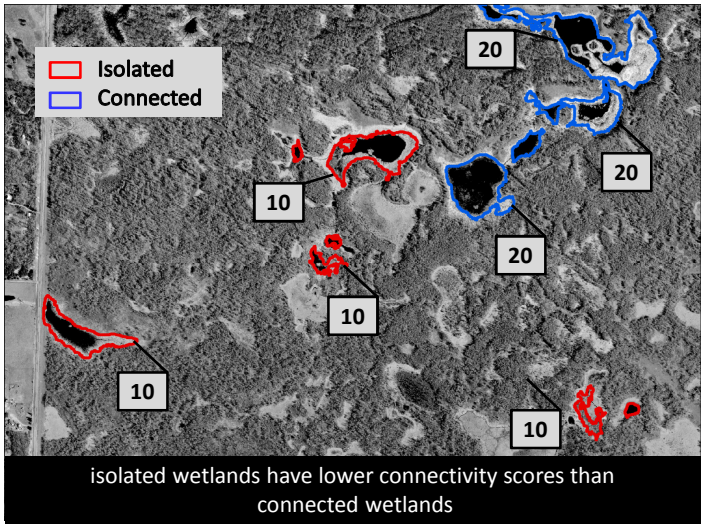


connectivity calculated as connectivity to the flow network

32

and that we DO consider feedbacks at landscape scale

State of continual flux



33

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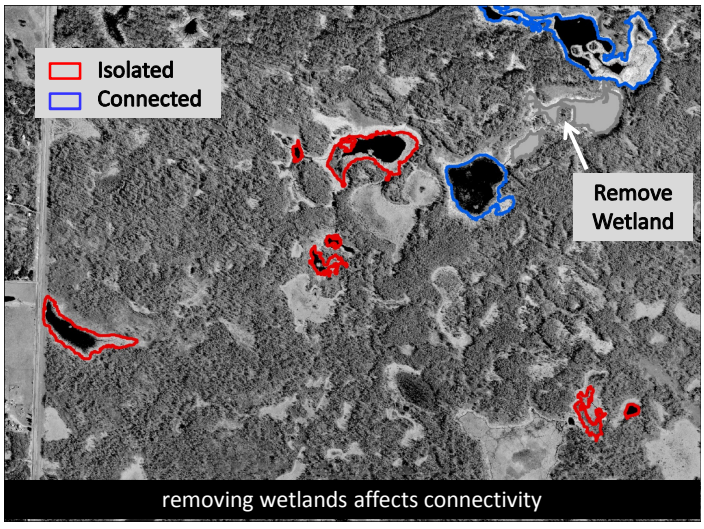
State of continual flux



34

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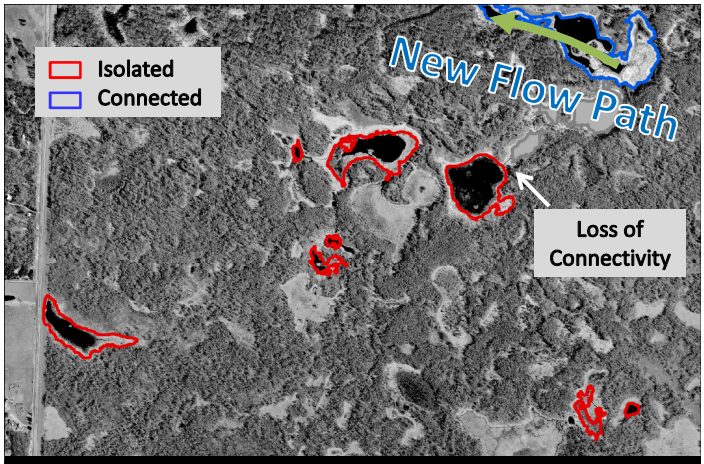
State of continual flux

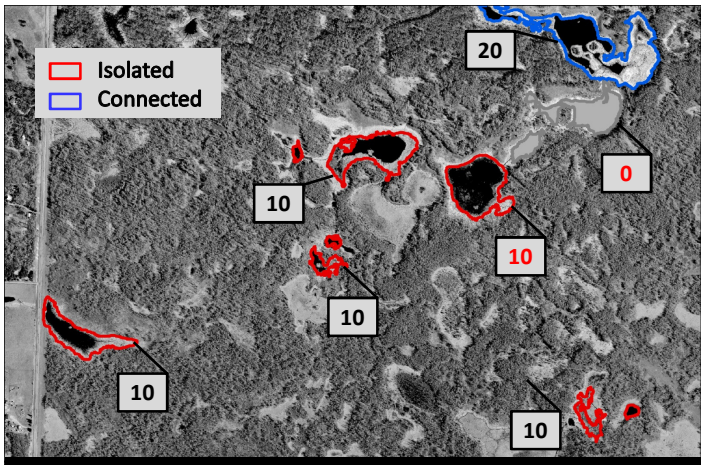


upstream wetlands lose connectivity when downstream wetlands drained

35

and that we DO consider feedbacks at landscape scale

State of continual flux

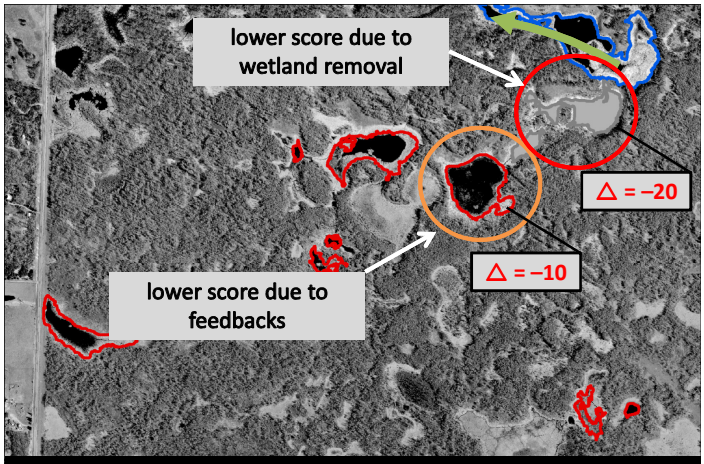


reduction in connectivity score at the removed wetland and the upstream wetland

36

and that we DO consider feedbacks at landscape scale

State of continual flux



we can calculate cumulative effect of wetland removal (i.e., removal loss (-20) + feedback loss (-10))

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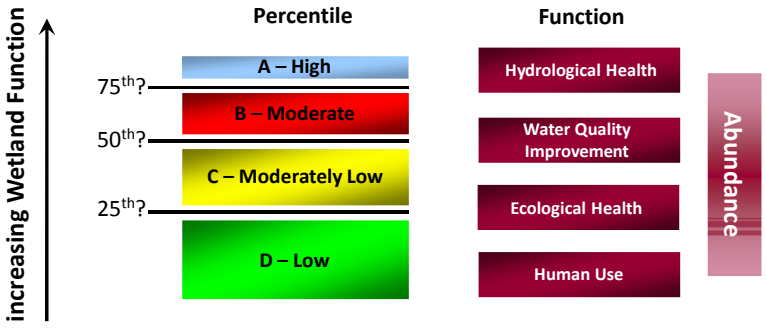
relative wetland function assessment system

function is defined by management categories of A (High) to D (Low)

thresholds for categories need to be defined



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how do we decide on trade-offs for a specific wetland?

For the wetland function assessment system:

- should metrics be equally weighted?
- should functions be equally weighted?
- should trade-offs be made among assessment units (e.g., sacrifice in north, spare in south)
- **Who decides?**

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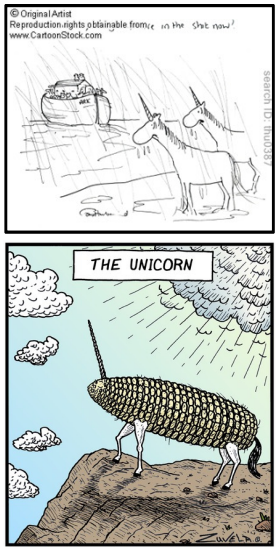
Image: http://www.cartoonstock.com/

what is “good” value?

we need to set targets for wetland policy

should we be managing for a **mythical past** and/or a **designer future**?



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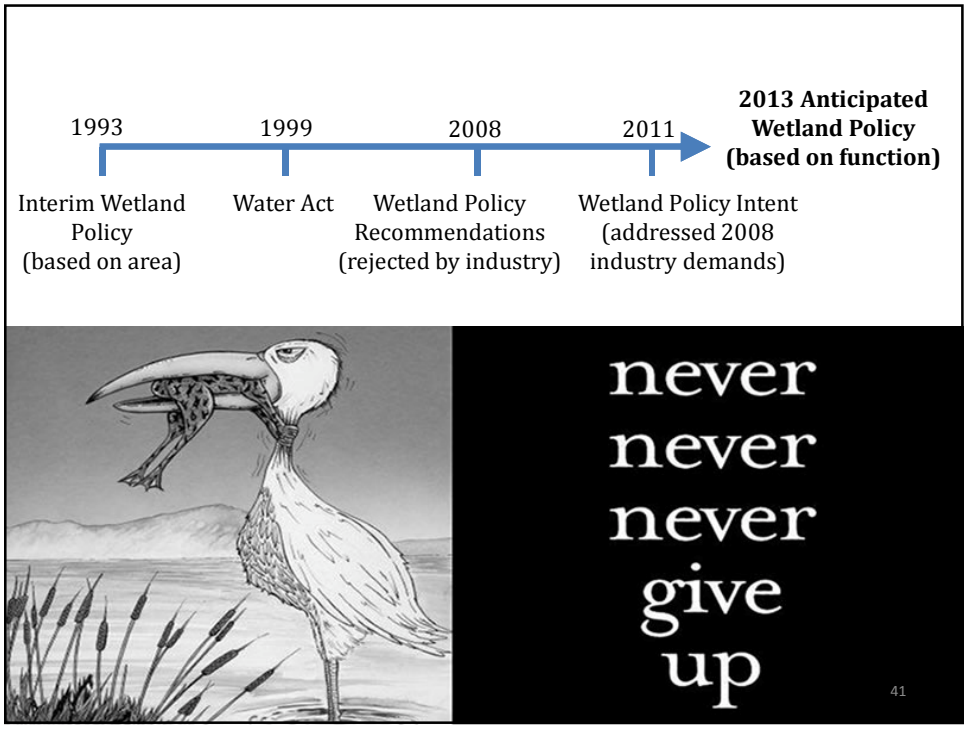
1993
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2013 Anticipated Wetland Policy (based on function)
Interim Wetland Policy (based on area)
Water Act
Wetland Policy Recommendations (rejected by industry)
Wetland Policy Intent (addressed 2008 industry demands)
never
never
never
give
up
41