Environment Canada Environnement Canada

Canada

Impact of Conservation Tillage on Landscape & Ecological Services – Challenges and Opportunities

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Outline

- Environment Canada Priorities
- Conservation Tillage Impacts
- Challenges, Benefits & Opportunities

Environment Canada Priorities

"Economic competitiveness"

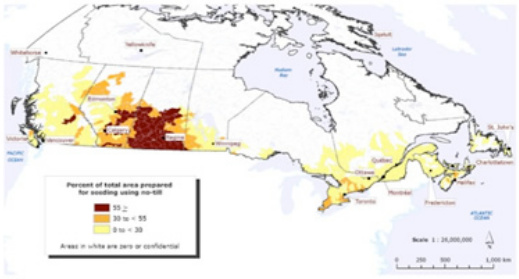
- Clean Air and Water
  – Carbon Capture
- Biodiversity Conservation

Tillage Gradients and Trade-offs

No till: "Crop is planted directly into soil with no primary or secondary tillage after harvest of the previous crop"

Increasing Natural Capital

Percentage of total area prepared for seeding using no-till, 2006.



Source: N. Hoffman, http://www.statcan.gc.ca/pub/16-002-x/16-002-x2008003-eng.pdf

Main Themes

1) Reduced emissions – Improved air quality and reduced CO_2.
2) Soil erosion reductions - Improved air and water quality.
3) Improved water quantity – wetlands.
4) Carbon sequestration.
5) Biodiversity conservation.

1. Emissions

✓Reduced emissions: ~6 liters/ha reduction per hectare in diesel for every tillage pass eliminated
(Boame, 2005, Statistics Canada, #21-004-XIE).

2. Soil erosion reduction

✓Improved air and water quality: reduced soil erosion due to wind and water

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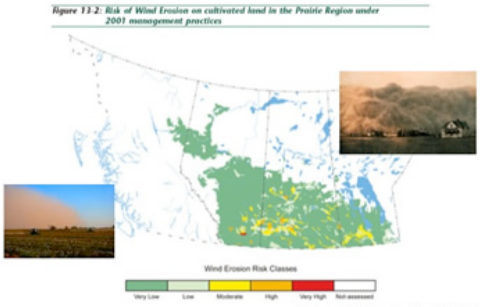
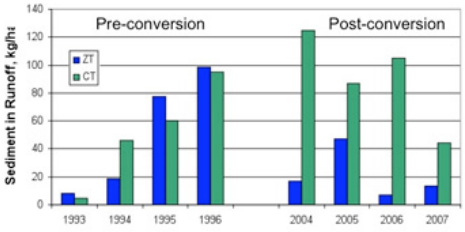
2. Reduction in wind erosion
(water erosion risk pattern is similar)



Source: Lefebvre et al. 2005, AAFC-PFRA

2. Sediment in runoff water was reduced with conversion to zero-tillage (ZT) from conventional tillage (CT)



Source: Dr. Jane Elliott and associates, NWRI, EC/AAFC

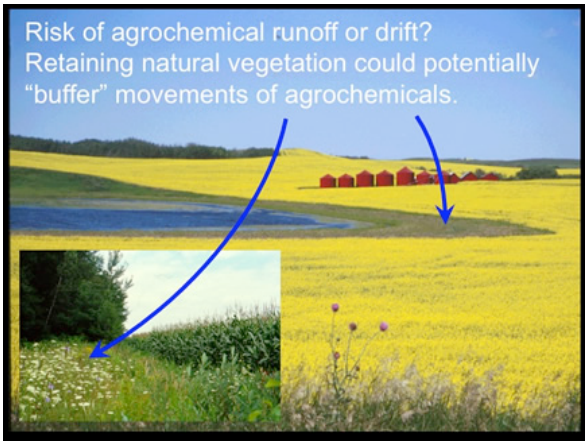
Trade-offs with no-till systems

- χ Increased mobilization of agrochemicals (e.g. herbicides) from no-till fields?
- χ Competition between producers and wetlands for water, leading to wetland loss, degradation and salinization?
- χ "Ecological traps" in wildlife species of conservation concern?

Trade-offs?

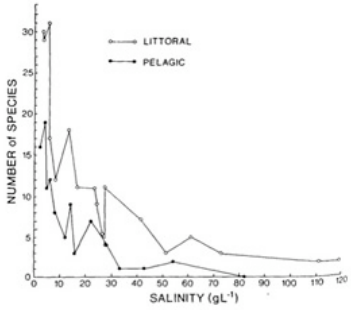
Wetland degradation

Mobile agrochemicals



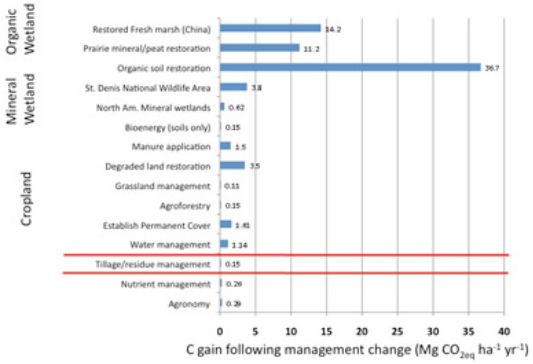
3. Water Quantity - wetlands

Reduced Aquatic Biodiversity with Rising Salinity

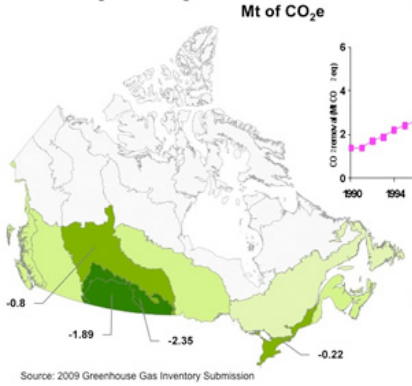


Source: D. Donald, EC

4. Carbon sequestration

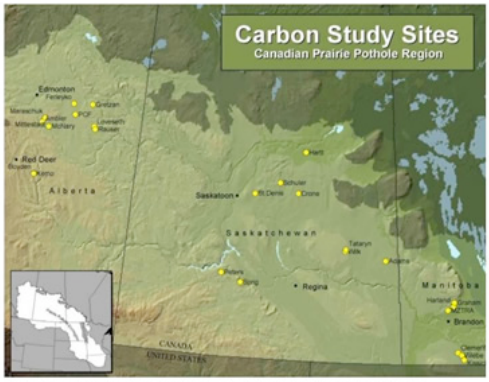


Soil Sinks associated with Changes in Tillage Practices on Canadian Cropland (2006) Mt of CO_2e



Reduced tillage intensity has resulted in the sequestration of 5.3 Mt CO_2eq in 2006

Source: 2009 Greenhouse Gas Inventory Submission



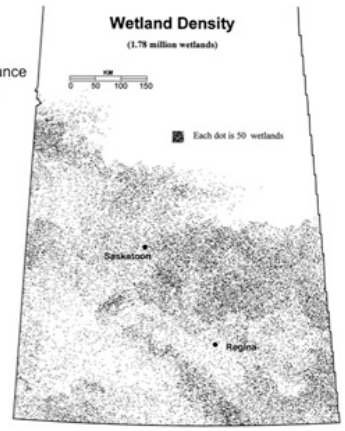
* Source: P. Badiou, DU Canada; restored wetland study.

4. Estimates of Net GHG Balance*

- C sequestration rate based on SOC difference between short-term and long-term restored wetlands = 11.8 Mg CO_{2eq} ha^{-1}
- GHG (CH_4 + N_2O) flux rate from Prairie wetlands:
  - mean = 2.2 Mg CO_{2eq} ha^{-1}
  - range (0.1 – 4.5 Mg CO_{2eq} ha^{-1})
- Restored wetlands are net sink for GHGs and sequester 9.6 Mg CO_{2eq} ha^{-1} (range, 7.3 – 11.8)

* Source: P. Badiou, DU Canada

Saskatchewan wetland abundance and distribution



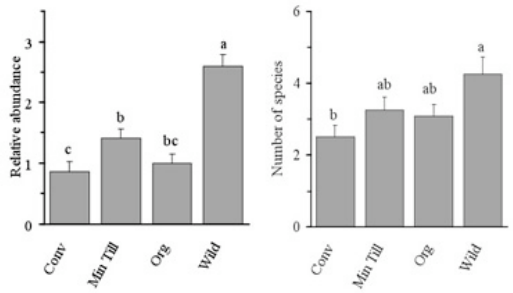
5. Biodiversity and Tillage

- ✓With increased crop residue, more bird species and nesting densities compared to conventional tillage.
- ✓Often an increase in nest success with fewer machine passes and increased cover.
- ✓With increased residue, an increase in number and diversity of insect prey (often beneficial insects).

5. Biodiversity and Tillage Trade-offs?

- Increased use of fertilizers and pesticides, including herbicides (?), may detrimentally affect wildlife, particularly amphibians and some invertebrates.
- The "devil" is in the details!
  - Amounts and products applied
  - Method and applicator experience
  - Soil types

5. Upland bird species

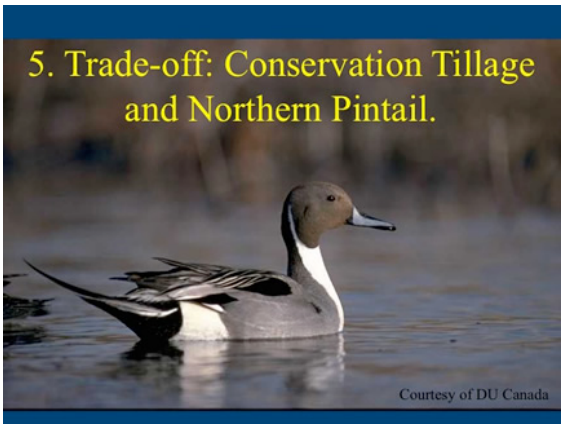


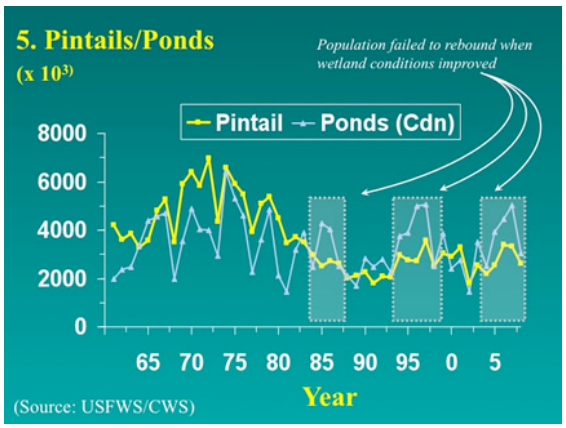
Source: Shutler et al. 2000. Conservation Biology

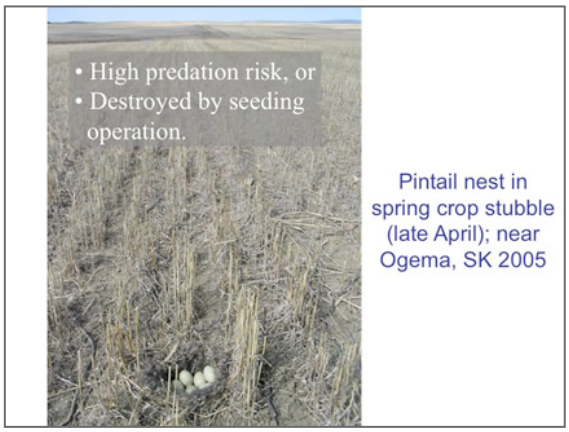
5. Reduced tillage - SK, 1991 to 1996*

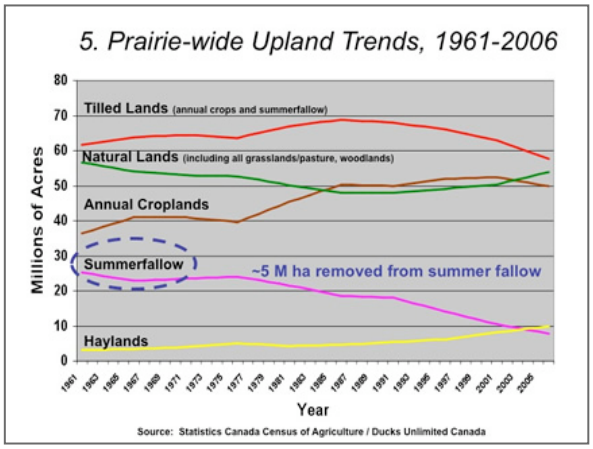
- Gain in habitat for ~233,000 songbirds!!
- Ranging from a low of 37,000 to a high of 428,000 birds

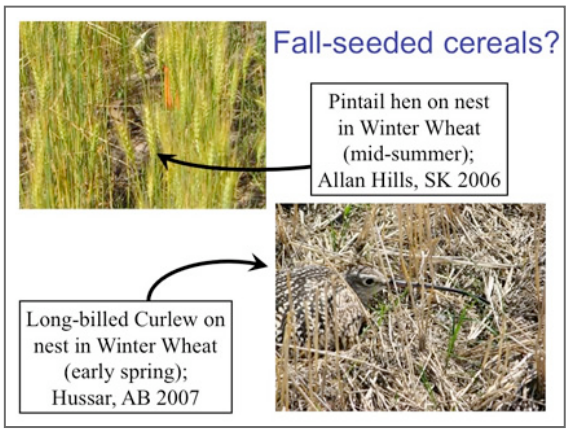
*Assumptions (Shutler et al. 2000. Conservation Biology):
- 13.6 M ha seeded, 6.8 M ha to wheat; hold wheat area constant.
- 18% reduction in conventional tillage from 1991-96
- difference between conventional and reduced tillage was from 0.03 to 0.35 birds/ha, averaging 0.19 birds/ha.

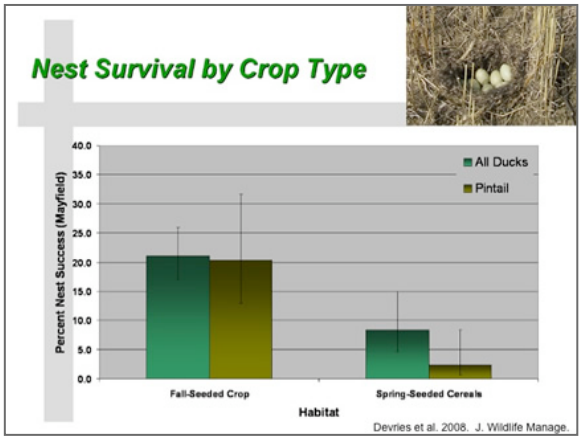

5. Trade-off: Conservation Tillage and Northern Pintail.
Courtesy of DU Canada


5. Pintails/Ponds
(x 10³)
Population failed to rebound when wetland conditions improved
Pintail
Ponds (Cdn)
8000
6000
4000
2000
0
65 70 75 80 85 90 95 0 5
Year
(Source: USFWS/CWS)


• High predation risk, or
• Destroyed by seeding operation.
Pintail nest in spring crop stubble (late April); near Ogema, SK 2005


5. Prairie-wide Upland Trends, 1961-2006
Millions of Acres
Tilled Lands (annual crops and summerfallow)
Natural Lands (including all grasslands/pasture, woodlands)
Annual Croplands
Summerfallow
~5 M ha removed from summer fallow
Haylands
Year
Source: Statistics Canada Census of Agriculture / Ducks Unlimited Canada


Fall-seeded cereals?
Pintail hen on nest in Winter Wheat (mid-summer); Allan Hills, SK 2006
Long-billed Curlew on nest in Winter Wheat (early spring); Hussar, AB 2007


Nest Survival by Crop Type
All Ducks
Pintail
Percent Nest Success (Mayfield)
Fall-Seeded Crop
Spring-Seeded Cereals
Habitat
Devries et al. 2008. J. Wildlife Manage.

Summary

- ✓ Reductions in erosion have produced substantial benefits for air and water quality.
- ✓ No-till often better than conventional tillage:
  - if machine passes during the spring-summer season are minimized,
  - pesticide use is not elevated and
  - formulations less toxic to wildlife are used.
- χ But, no-till is "no-match" for natural habitat, especially for Species at Risk.

Summary (2)

- χ Competition for snow between producers and wetlands could affect wetland permanence and impacts.
- ✓ Wetlands could contribute positively to meeting GHG targets – further assessments needed.
- ✓ No/low till generally better for songbirds
- χ Stubble can create "traps" - some bird species are attracted to these fields, and have low productivity.
- ✓ However, fall-seeded cereals like winter wheat appear particularly valuable for some priority waterfowl (Northern Pintail) and shorebirds (Long-billed Curlew, Marbled Godwit).

Acknowledgements

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