SPARROW Modelling: A Tool to Address Water Quality Issues in the International Red-Assiniboine River Basin

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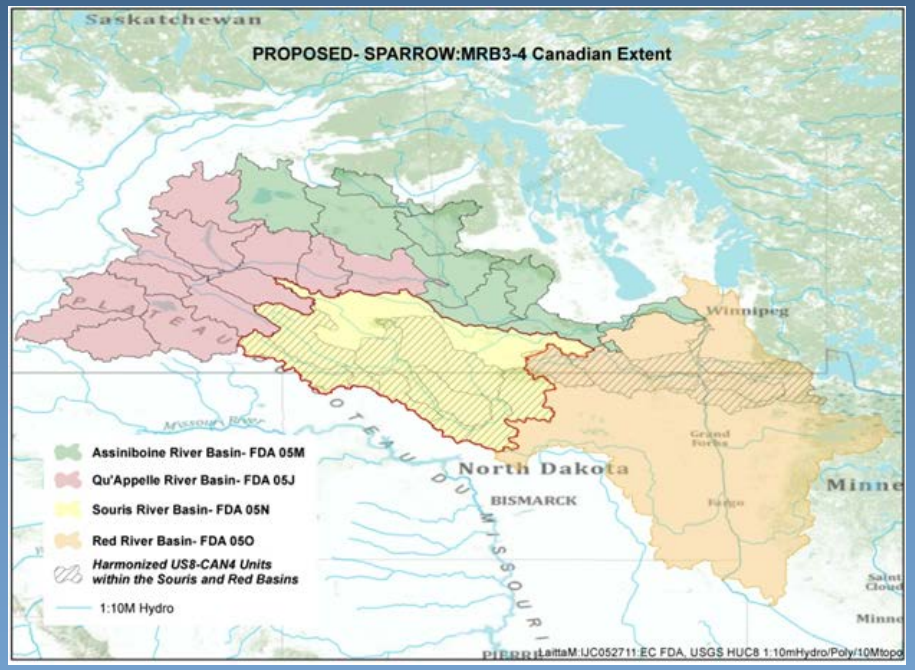

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Presentation Outline

* A Short History of the IJC…
* The IJC's International Watersheds Initiative and Water Quality Modelling
* Nutrient Enrichment and Eutrophication in the Red-Assiniboine River Basin
* The SPARROW Water Quality Model
* Red-Assiniboine Model Output and the Mapper (Online Tool)
* What's Next for Red-Assiniboine SPARROW Modelling?

Mandate and History of the International Joint Commission

Turn of the 20th century disputes:

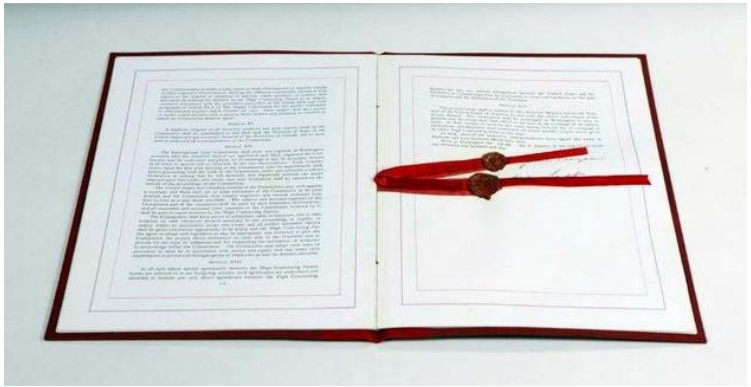
- Apportionment of water for irrigation in the St. Mary and Milk rivers
- Sewage and manufacturing wastes that led to outbreaks of cholera among other water-borne public health problems

Mandate and History of the International Joint Commission

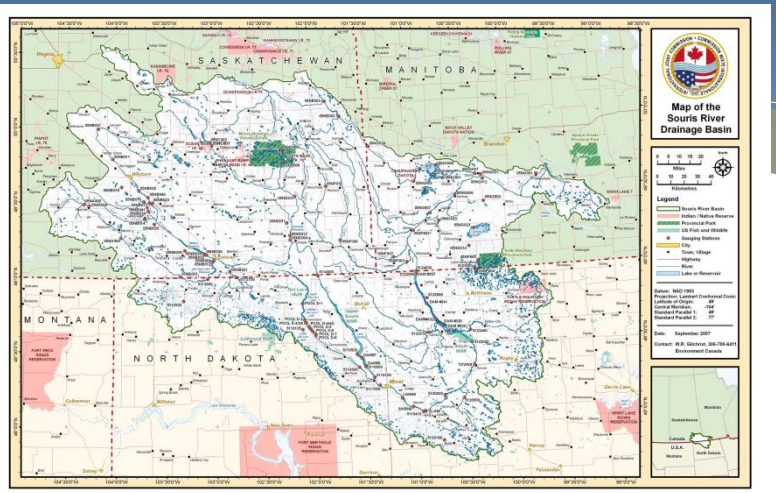
Role of the IJC

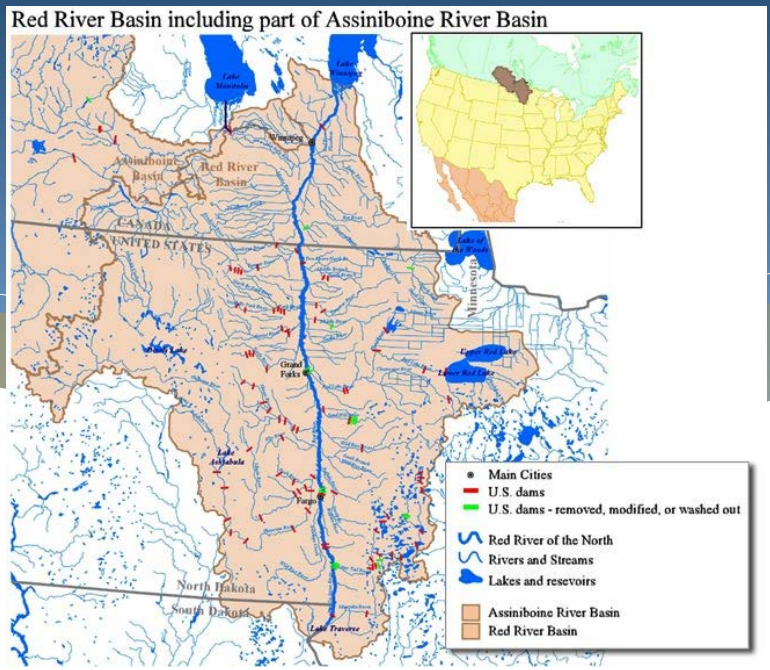
- Regulating shared water uses
- Investigating transboundary issues and recommending solutions

- The IJC is guided by the Boundary Waters Treaty of 1909
  - Includes the requirement ***"that neither country should cause water pollution in its water which will cause injury to health or property in the other country"*** (Article IV, section 2)
  - One of the earliest proactive and continuous references to water pollution in the world



Boards of the IJC





International Souris River Board

- "Mandate…to prevent and resolve transboundary disputes and ensure a more eco-systemic approach to transboundary water issues, compliance for apportionment of river flows, and oversight of flood operations"

International Red River Board

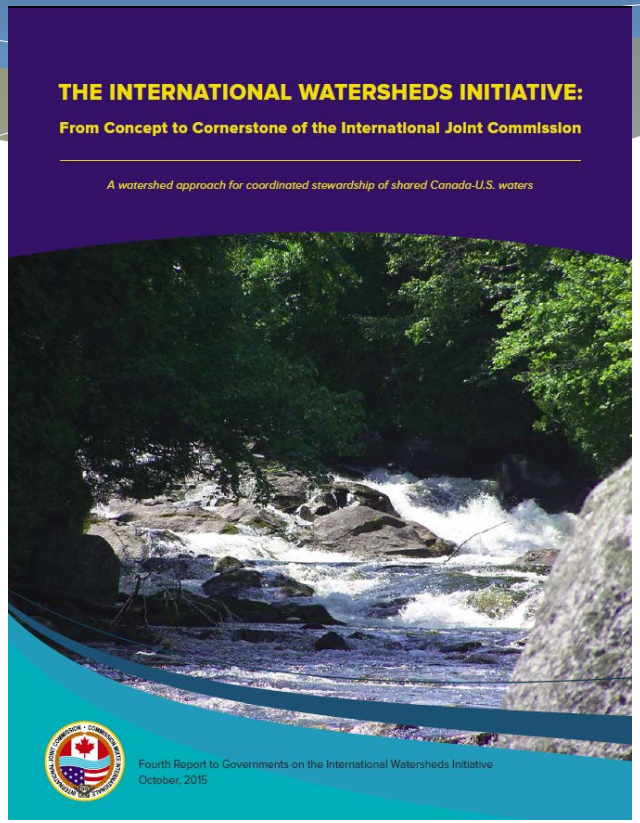
- "Mandate…to prevent and resolve transboundary disputes regarding the waters and aquatic ecosystem of the Red River and its tributaries and aquifers"
- "Activities shall focus on…water quality, water quantity and levels, and aquatic ecological integrity"

The International Watersheds Initiative and Water Quality Modelling

“The IWI is guided by an integrated, ecosystem approach that recognizes the complex interrelationships in the entire watershed.”

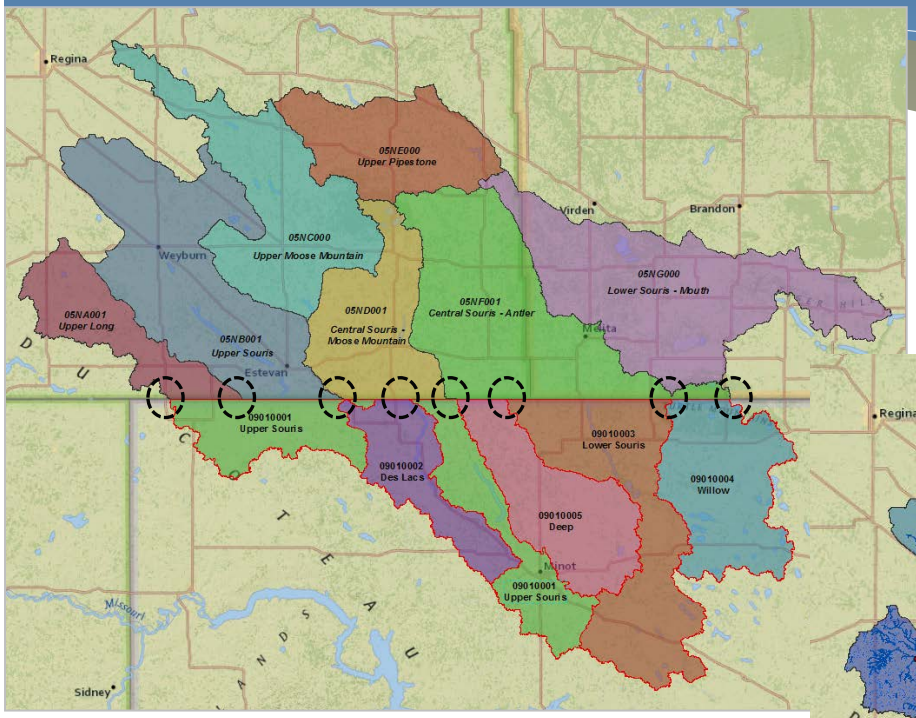
Major initiatives and activities

- Hydrographic and Geospatial Data Harmonization Task Force
- Binational Water Quality Modelling



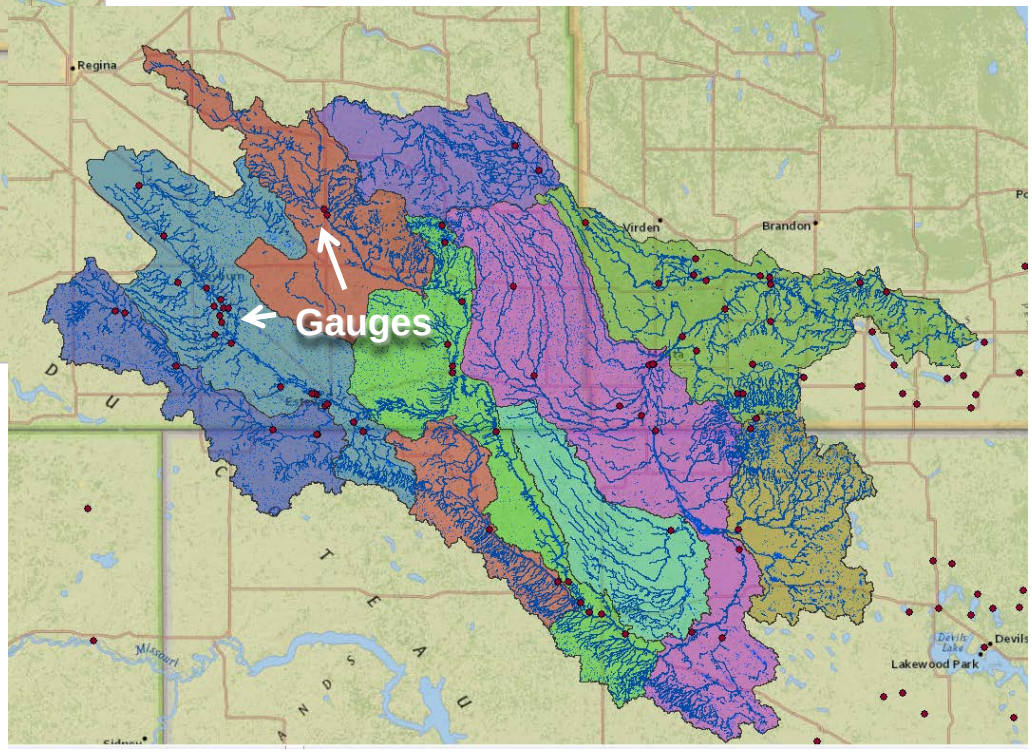
Hydraulic	Hydrologic	Water Quality	Ecological

Data Harmonization
Souris River Basin (ND, MB, SK)

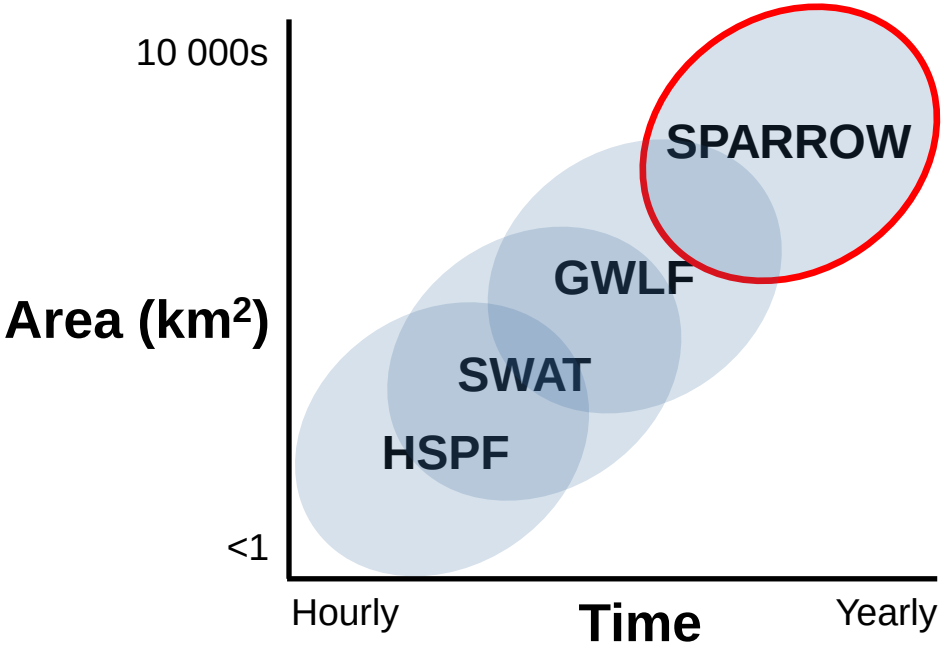


Pre-harmonization (NHN-NHD)

Harmonized Basin and Sub-basins



Water Quality Modelling

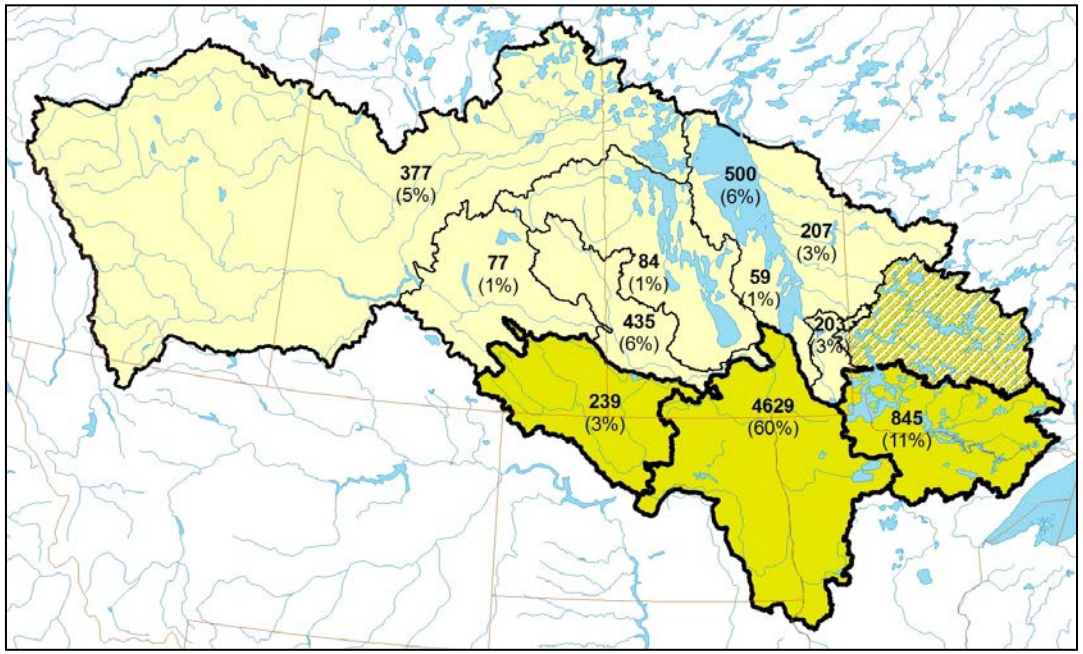


SPARROW	Spatially-Referenced Regressions on Watershed attributes
GWLF	Generalized Watershed Loading Function
SWAT	Soil and Water Assessment Tool
HSPF	Hydrology Simulation Program-FORTRAN

Nutrient Enrichment and Eutrophication in the Red-Assiniboine River Basin

Increasing frequency and severity of algal blooms in Lake Winnipeg and in lakes and reservoirs across the international Red and Souris River watersheds

Average Total Phosphorus Load (tonnes per year (per cent contribution))



1994 to 2007 – Conservation and Water Stewardship

Pelican Lake, Pembina River watershed

Buffalo Red watershed

Homme Dam

North Dakota

Eutrophication

A Water Quality Issue Across the Transboundary

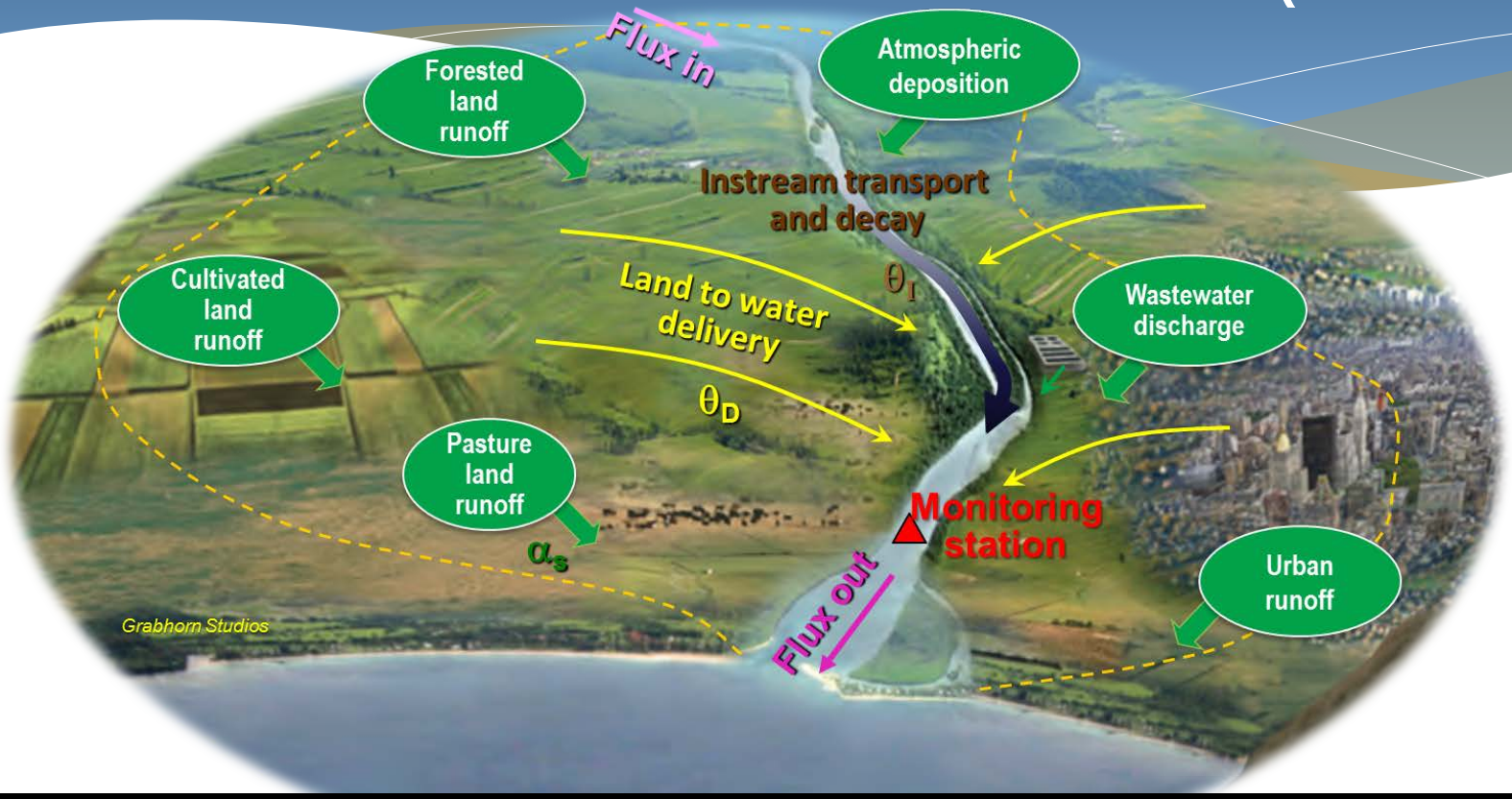
Driving forces and pressures

- Farm policy and the intensification of agriculture
  - Fertilizer and manure applications in cropping systems
  - Livestock operations (Concentrated Animal Feeding Operations, CAFOs)
- Landscape hardening (impervious surfaces, soil organic matter and permeability, wetlands)
- Aging urban and rural infrastructure
- Climate change and altered temperature and precipitation regimes
- Historical legacy of human activities (e.g. sediment burial)

The SPARROW Water Quality Model

Binational Water Quality Modelling

SPAtially-Referenced Regressions On Watershed attributes (SPARROW)

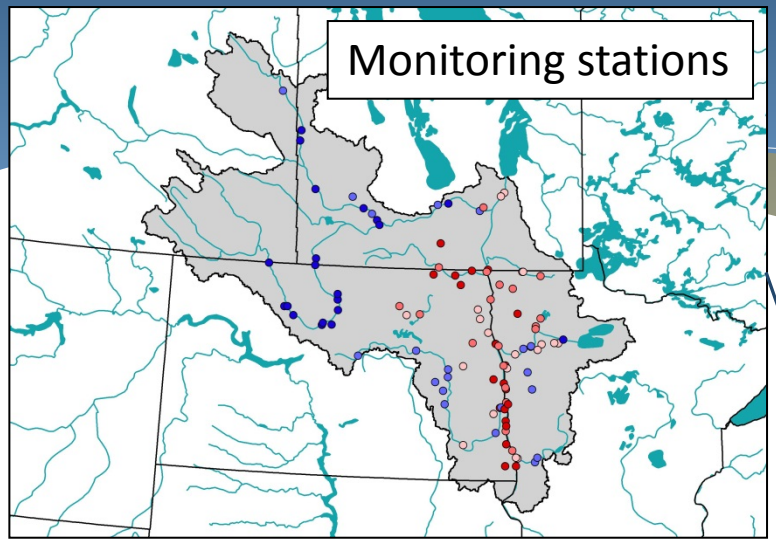


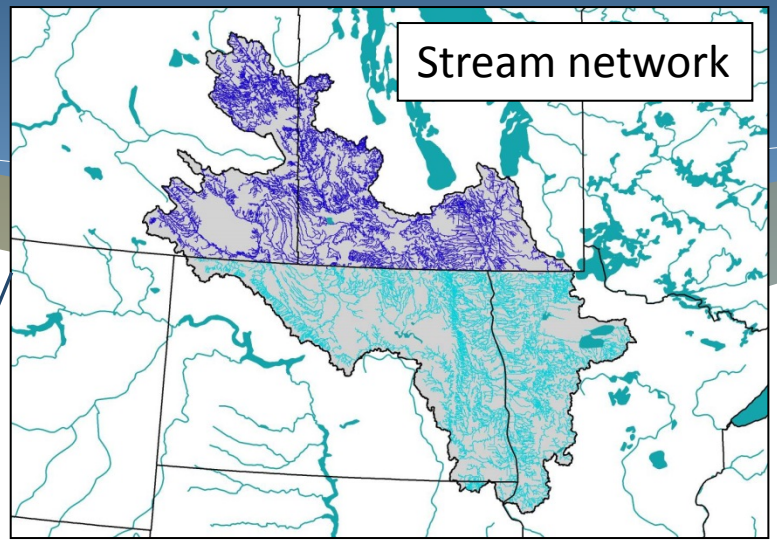
SPARROW relates **long-term trends in water quality** to **large-scale descriptors** of human activities, climate, hydrology, geology and physiography AND land-to-water and instream decay **delivery processes**

SPARROW Modelling Team – Multidisciplinary and Multi-agency

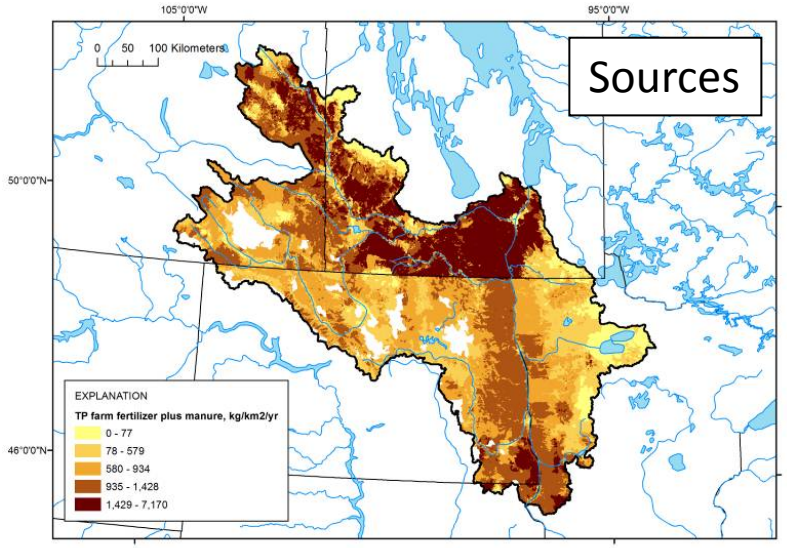
Agency	Contributors
International Joint Commission	Glenn Benoy, Wayne Jenkinson, Mike Laitta
USGS (+ state agencies)	Donna Myers, Craig Johnston, Dale Robertson, Dave Saad
National Research Council of Canada	Ivana Vouk, Martin Serrer, Richard Burcher
Environment Canada	Erika Klyzsejko, Craig McCrimmon
Agriculture & Agri-Food Canada	Jason Vanrobaeys, Pamela Joosse
Manitoba Conservation and Water Stewardship	Elaine Page, Justin Shead, Sharon Gurney
Statistics Canada	Mark Henry, Francois Soulard
Saskatchewan Water Security / Environment	O.S.(Arasu) Thirunkavukkarasu, Pam Minifie

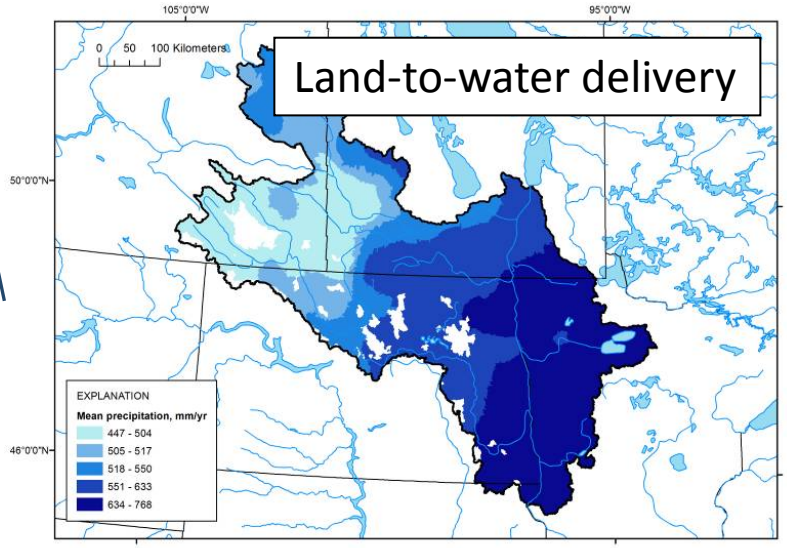
Red-Assiniboine Model: Four Key Datasets



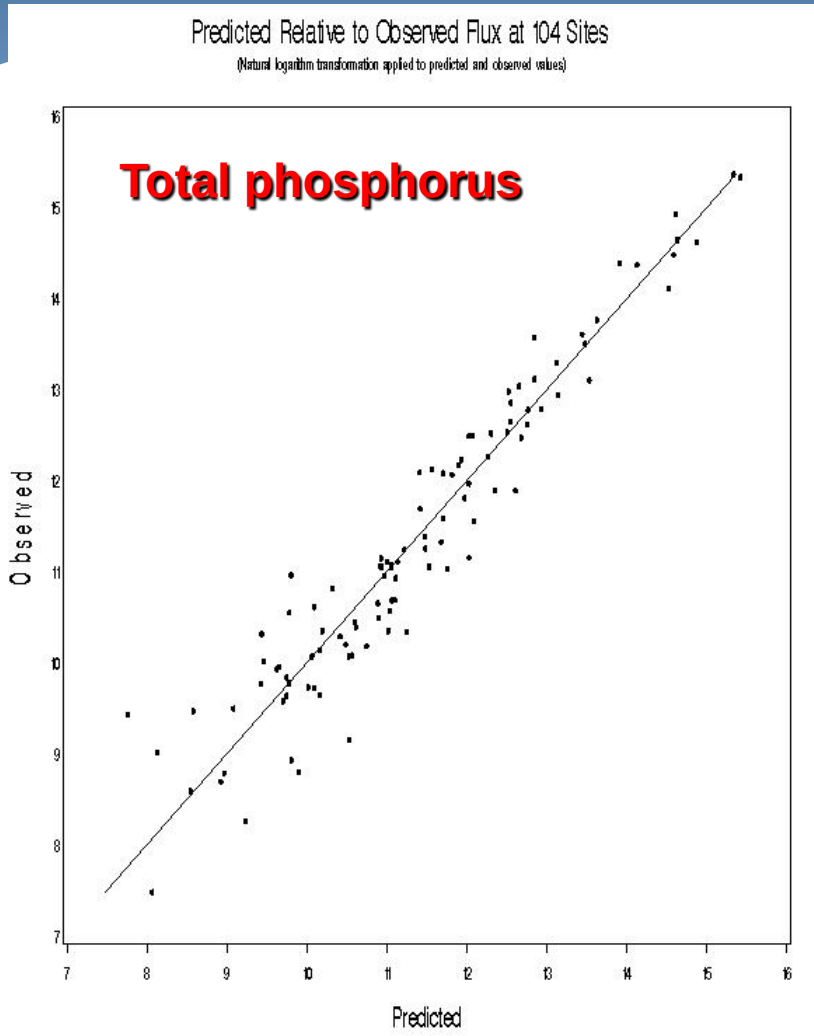


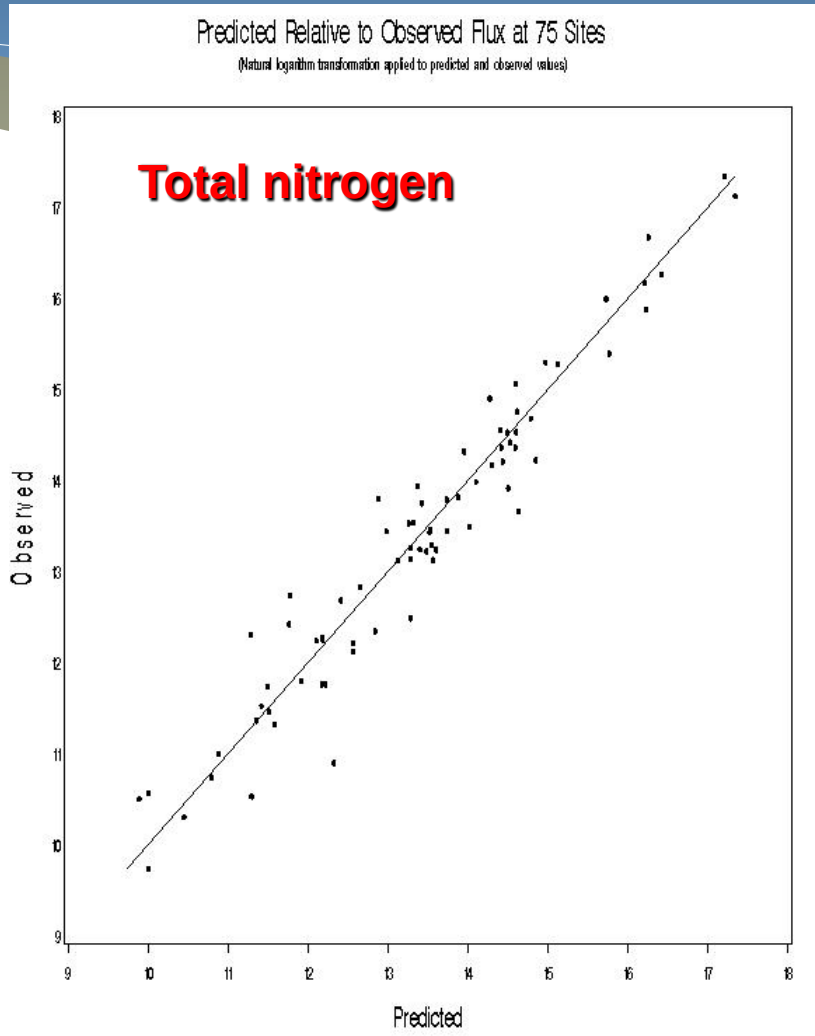
Model Development





Red-Assiniboine SPARROW Nutrient Models: Calibration (observed vs predicted flux)





Red-Assiniboine SPARROW Nutrient Models: Calibration
*** Preliminary Results ***

Red/Assiniboine Phosphorus SPARROW Model			
Phosphorus Sources		**Coefficient**	**P value**
	Agriculture (fertilizer plus manure)	0.011	0.003
	Point Sources	1.000	.
	Forest and Wetlands	6.016	0.033
	Channels (Medium sized 5-50 cfs)	0.070	0.040
Land-to-Water Delivery			
	Precipitation	0.070	0.000
Decay			
	Reservoirs	5.734	0.029
Model Statistics			
	RMSE	0.489	
	Adj r2	0.915	
	Yield R2	0.815	
	N	104	

**Note: Point sources not estimated by model

Red-Assiniboine SPARROW Nutrient Models: Calibration

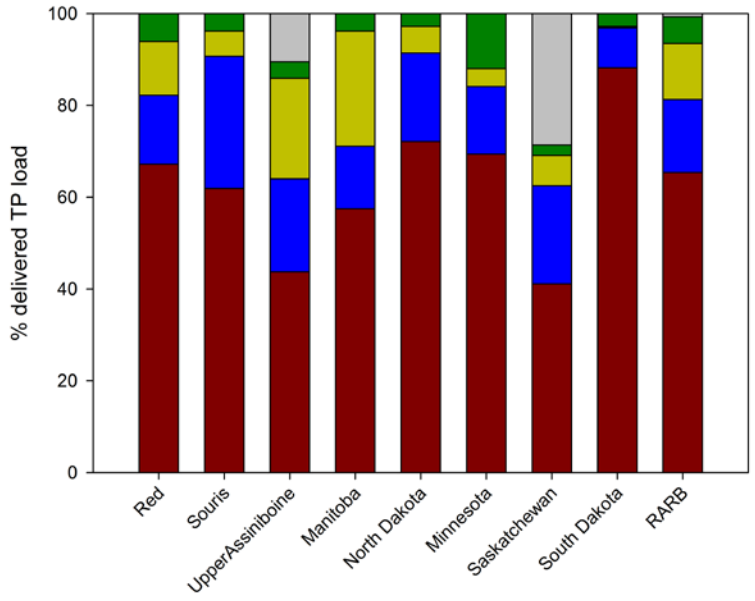
*** Preliminary Results ***

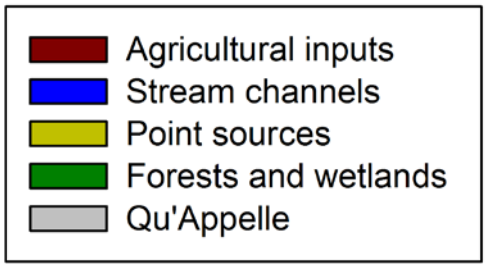
Red/Assiniboine Nitrogen SPARROW Model			
Nitrogen Sources		**Coefficient**	**P value**
	Agriculture (fertilizer plus manure)	0.032	0.004
	Point Sources	1.000	.
	Atmosphere	0.032	.
Land-to-Water Delivery			
	Precipitation	0.014	0.000
	Air Temperature	-0.573	0.000
Decay			
	Streams (continuous decay)	0.046	0.393
	Reservoirs	1.809	0.151
Model Statistics			
	RMSE	0.44	
	Adj R2	0.93	
	Yield R2	0.876	
	N	75	

**Note: Point sources and atmospheric deposition not estimated by model

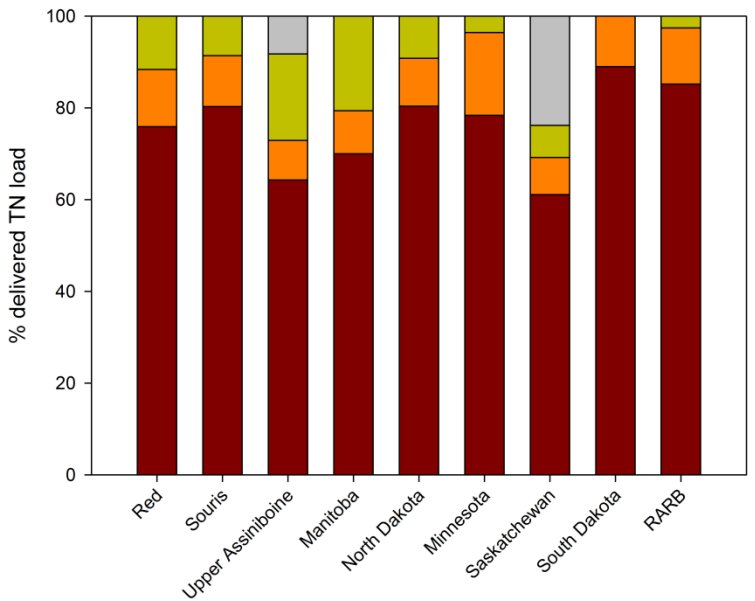
SPARROW N and P Models
*** Preliminary Results ***

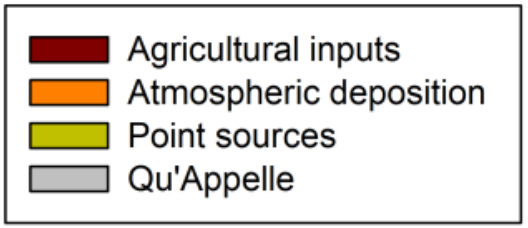
Sources of phosphorus (%)





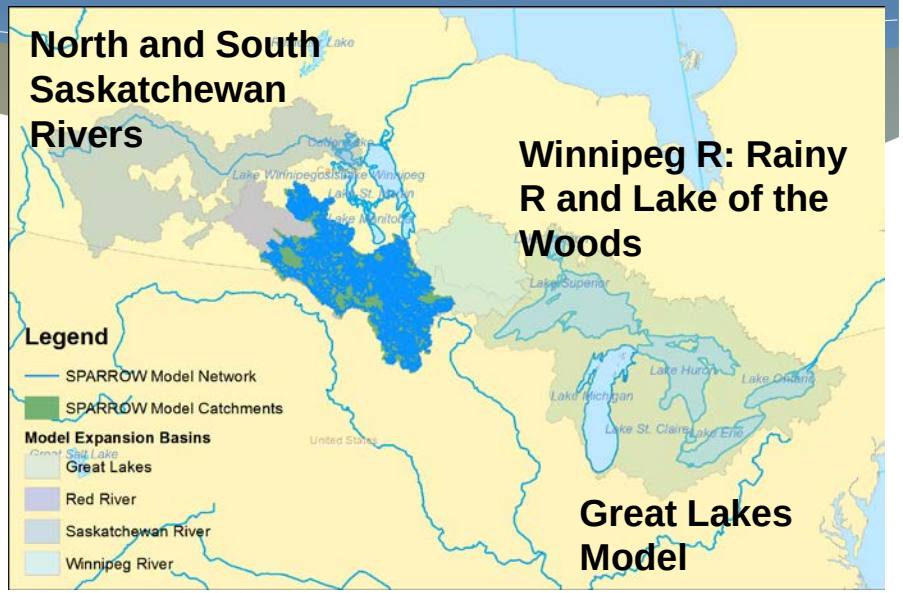
Sources of nitrogen (%)





What's Next for Red-Assiniboine SPARROW Modelling?

- Technology training and transfer to interested agencies and organizations
- Updating the "base" year from 2002 to 2012
- Comparing SPARROW model output with other models being applied in the basin (e.g. SWAT, HSPF)
- Geographic expansion to include neighbouring watersheds



Thank you…questions?

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SPARROW

http://water.usgs.gov/nawqa/sparrow/

(Fact Sheet, FAQs)

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