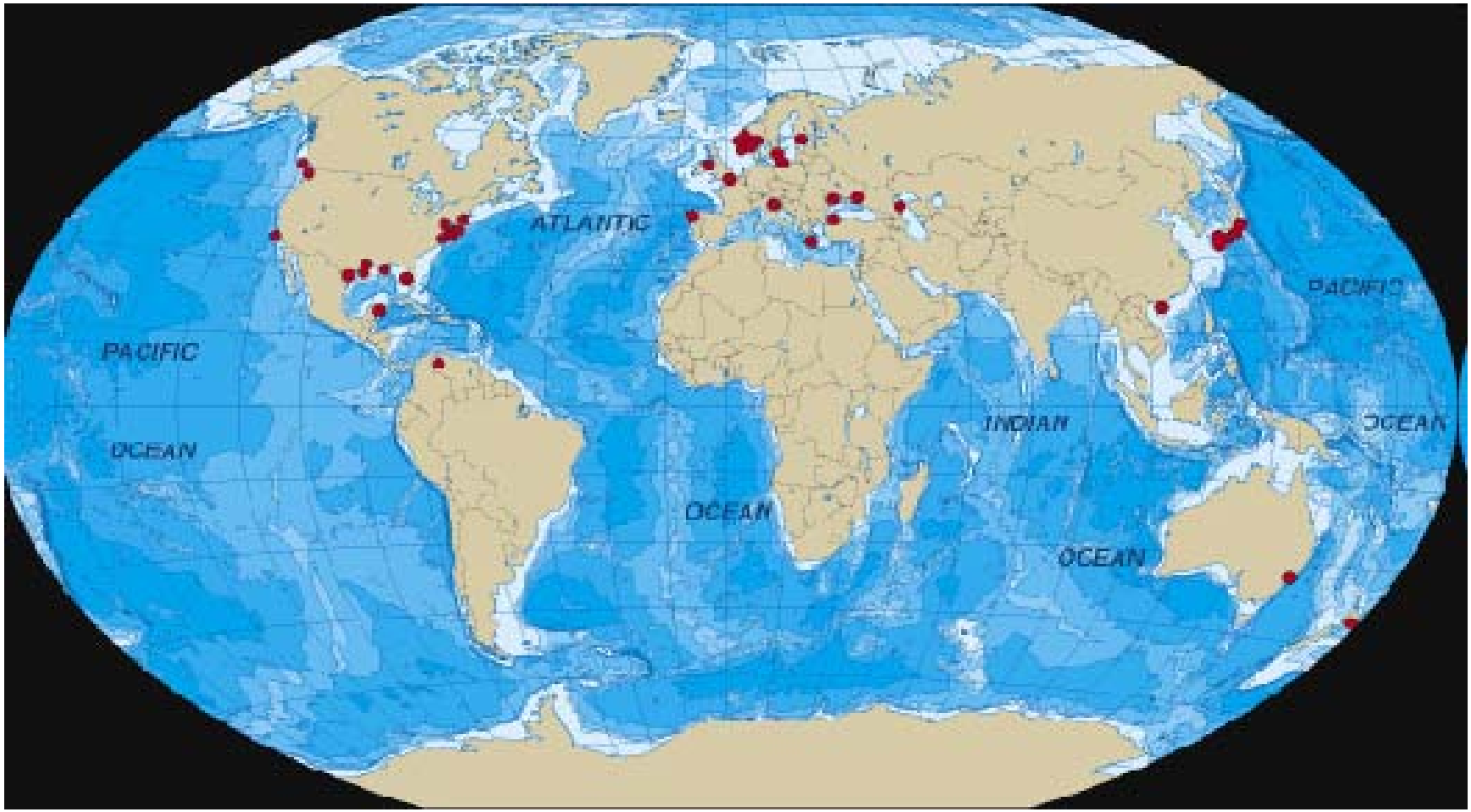
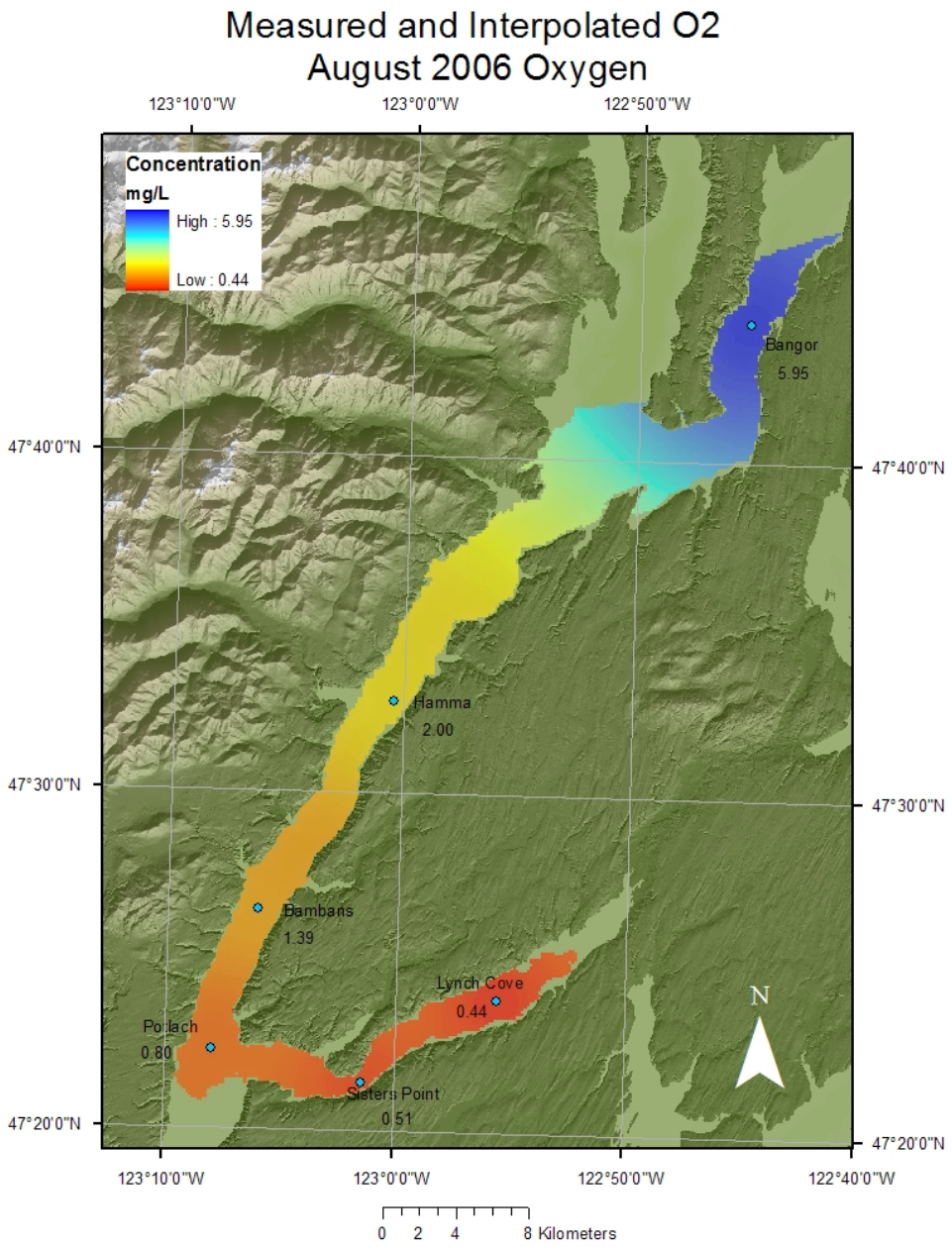
From watersheds to the sea in Puget Sound: the (inferred) dynamics of chemical export

J Scott Bechtold
UW School of Aquatic and Fishery Sciences

Jeffrey Richey
UW School of Oceanography

Occurrence of Dead Zones



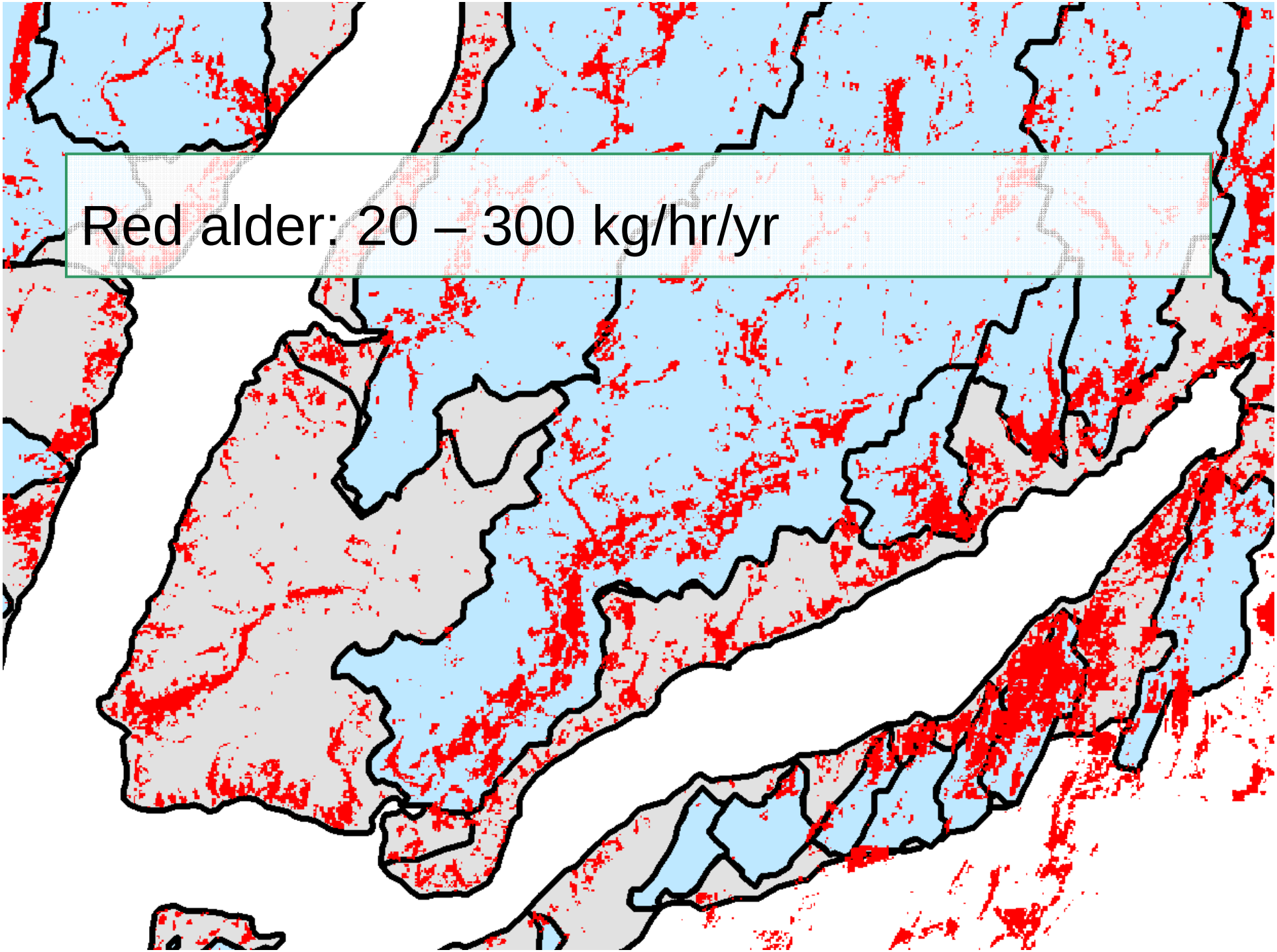

Measured and Interpolated O2
August 2006 Oxygen
123°10'0"W
123°0'0"W
122°50'0"W
122°40'0"W
47°40'0"N
47°30'0"N
47°20'0"N
Concentration
mg/L
High : 5.95
Low : 0.44
Bangor
5.95
Hamma
2.00
Bambans
1.39
Lynch Cove
0.44
Pollach
0.80
Sisters Point
0.51
N
0 2 4 8 Kilometers

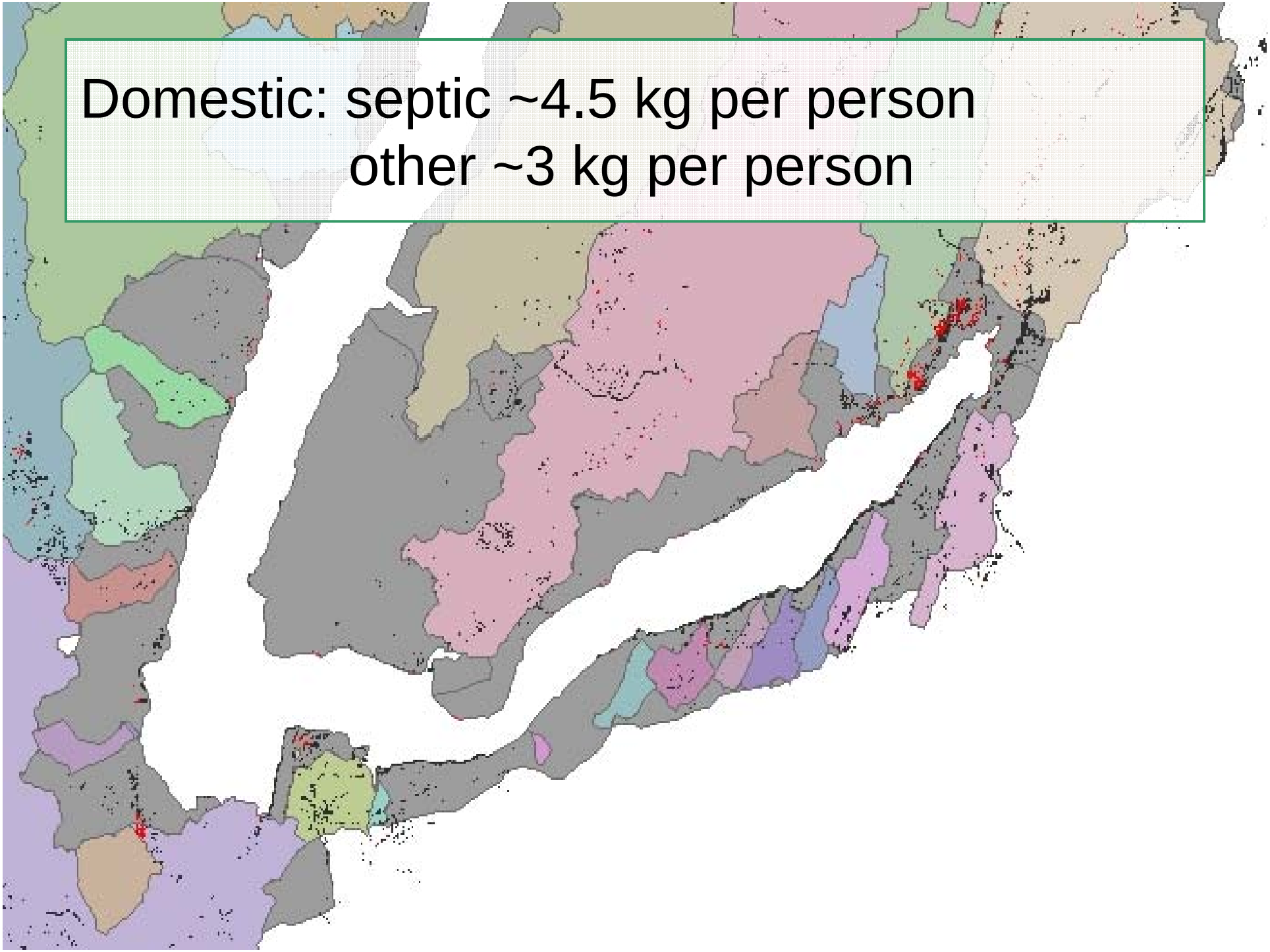
Hood Canal Dissolved Oxygen Program

Marine measurements and modeling

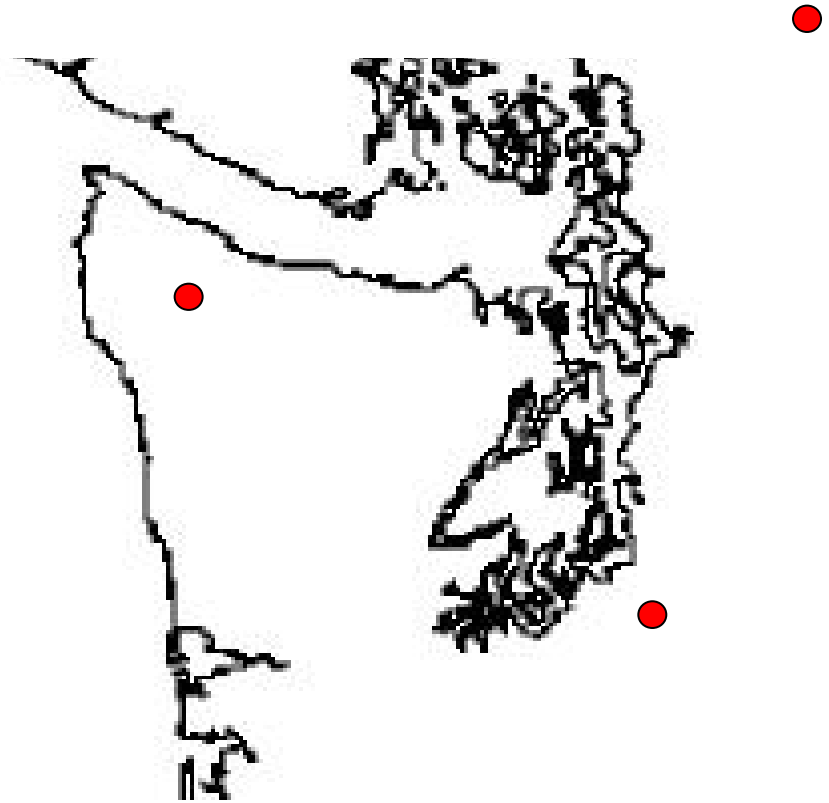
Freshwater flows and nitrogen loading

- -measurements
- -simulation modeling

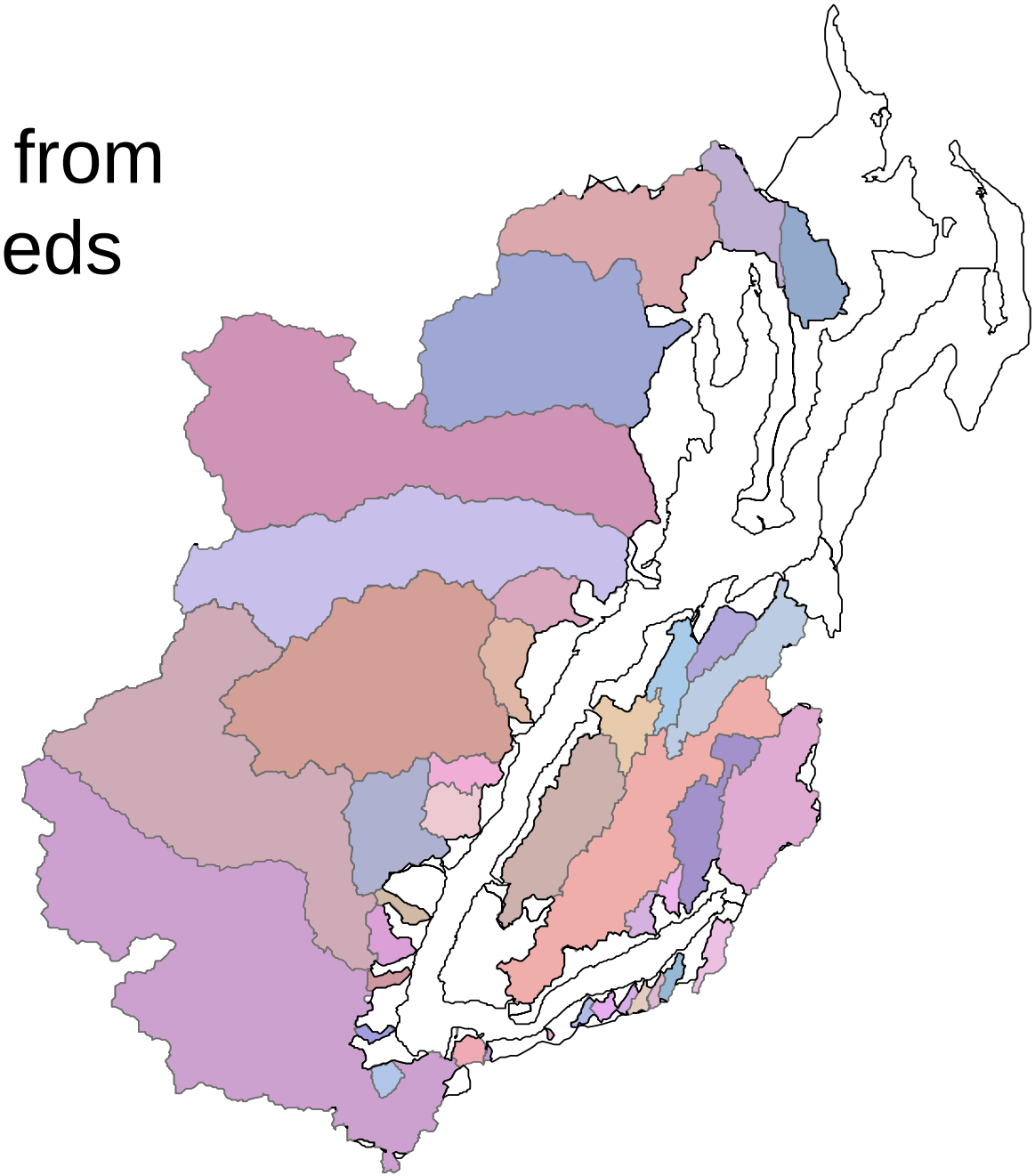

Red alder: 20 – 300 kg/hr/yr


Domestic: septic ~4.5 kg per person
other ~3 kg per person

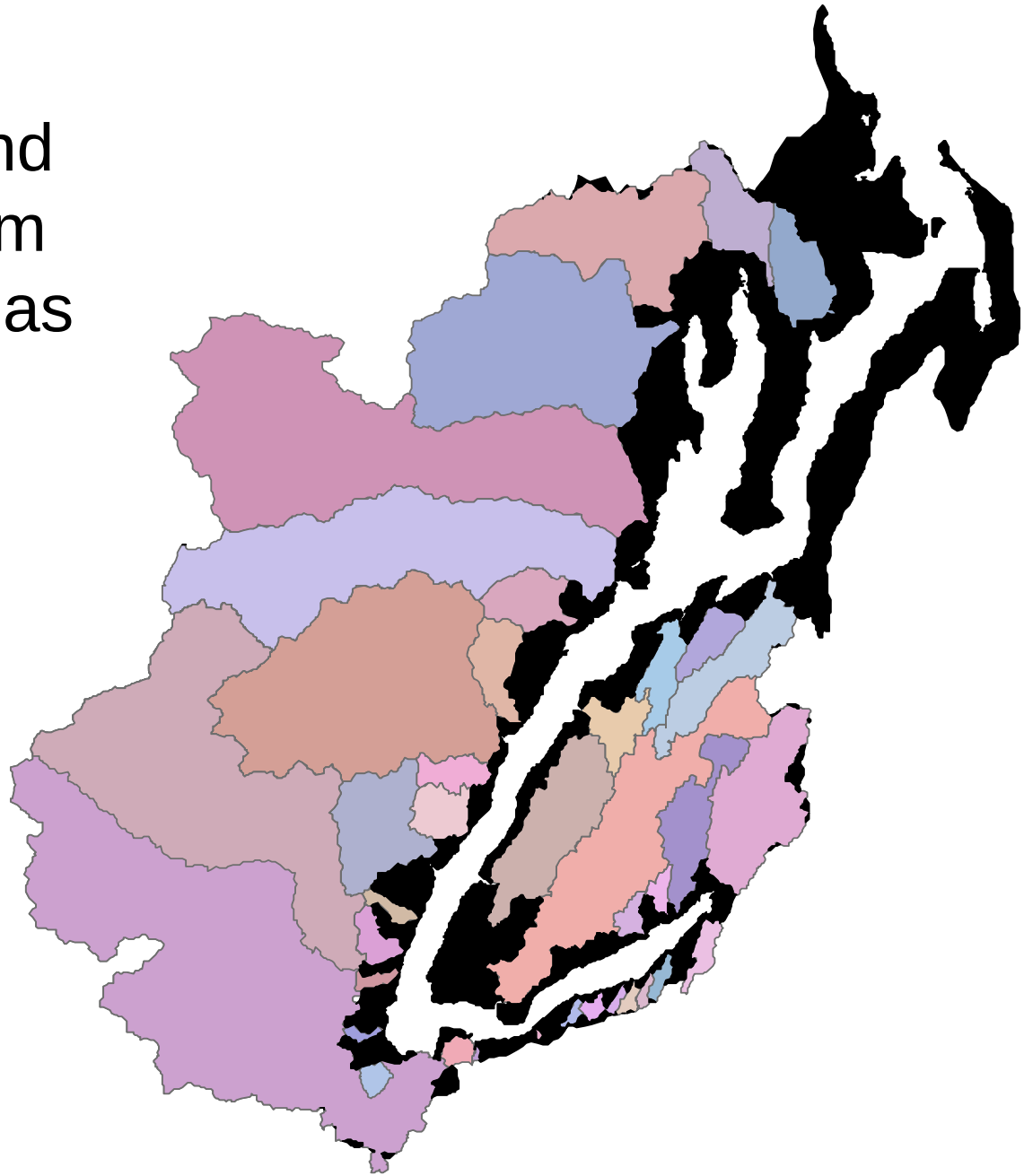
Atmosphere: 1.5 kg per hectare



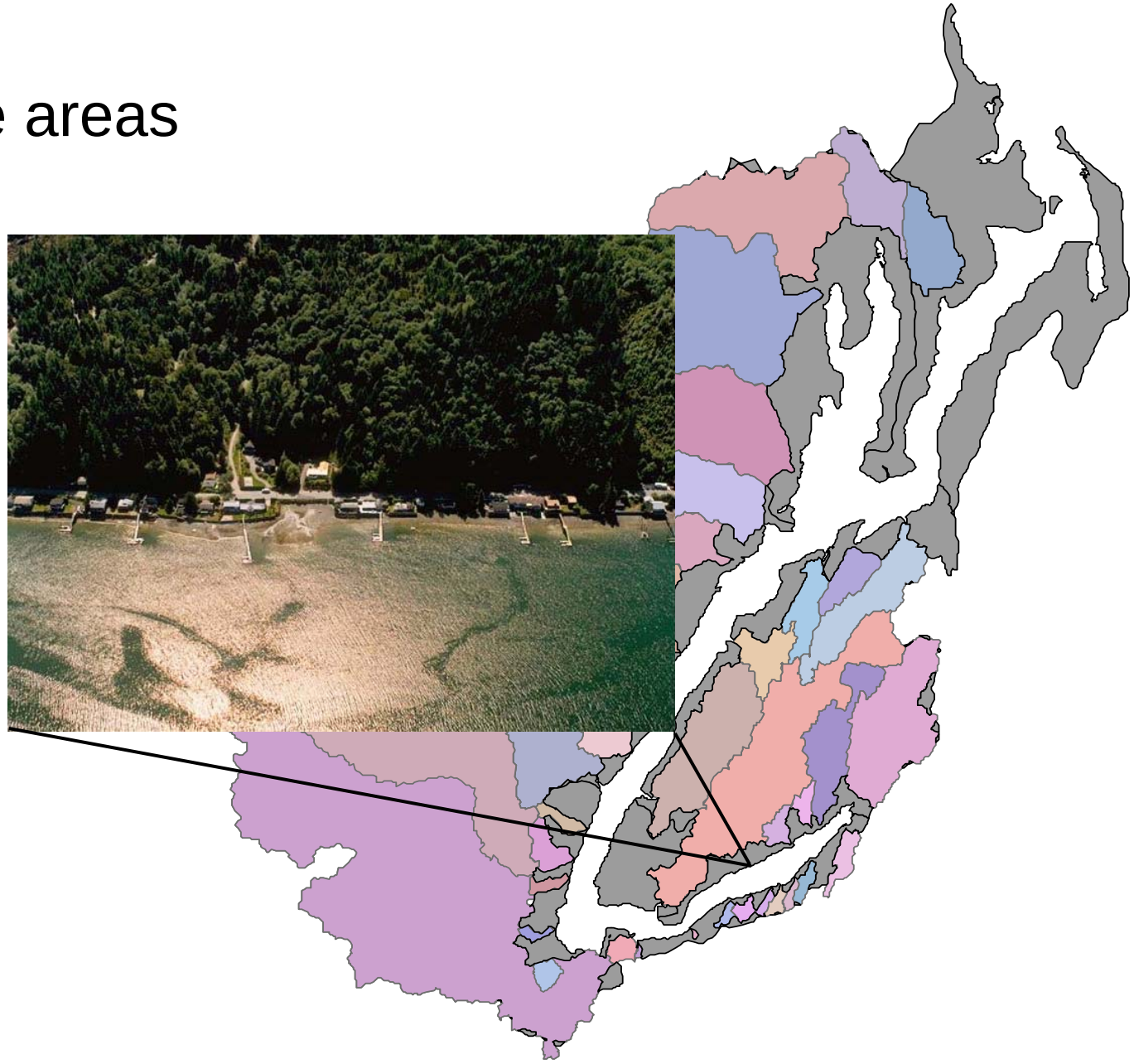
Surface water from major watersheds



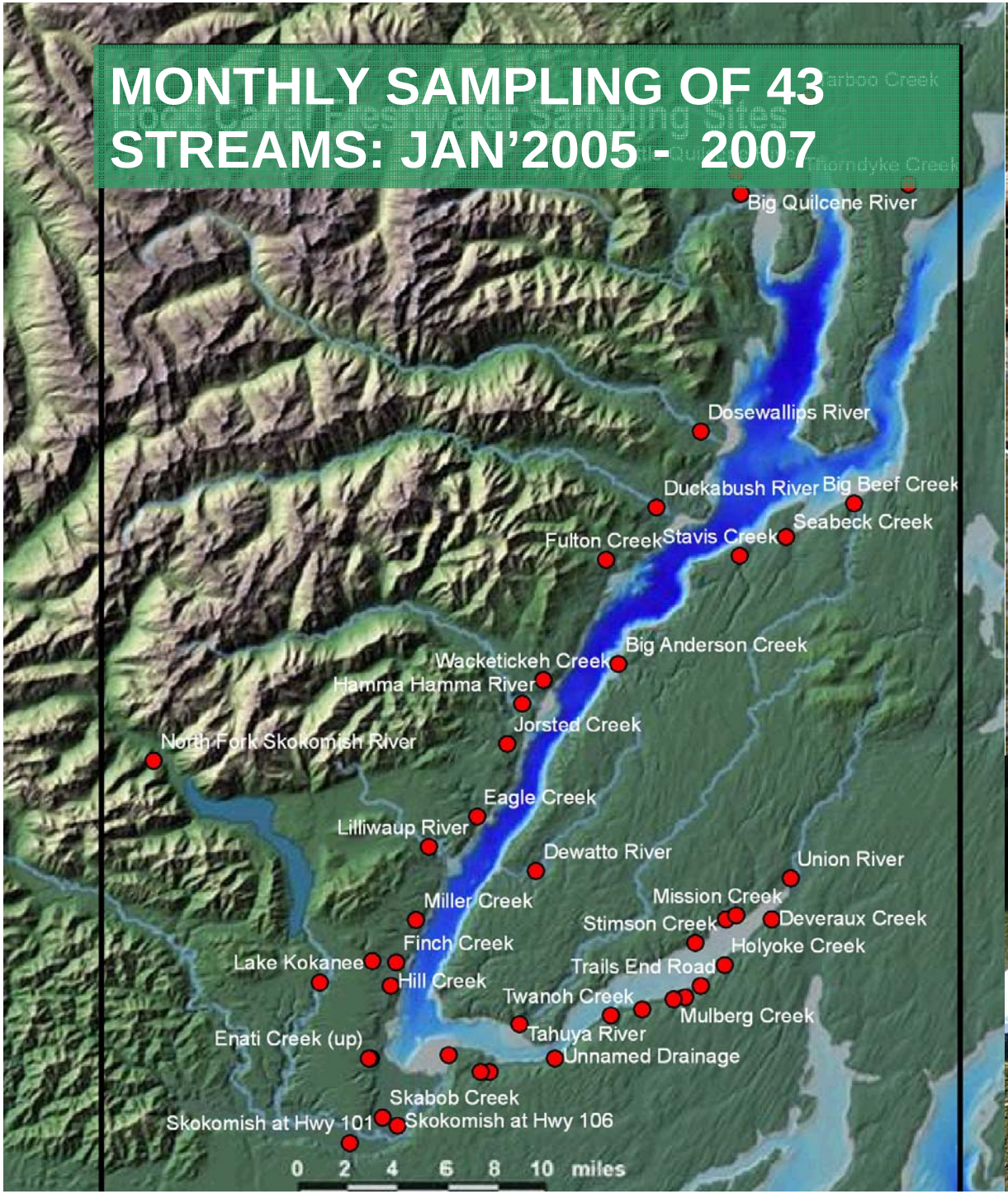
Surface runoff and groundwater from unchanneled areas



Shoreline areas

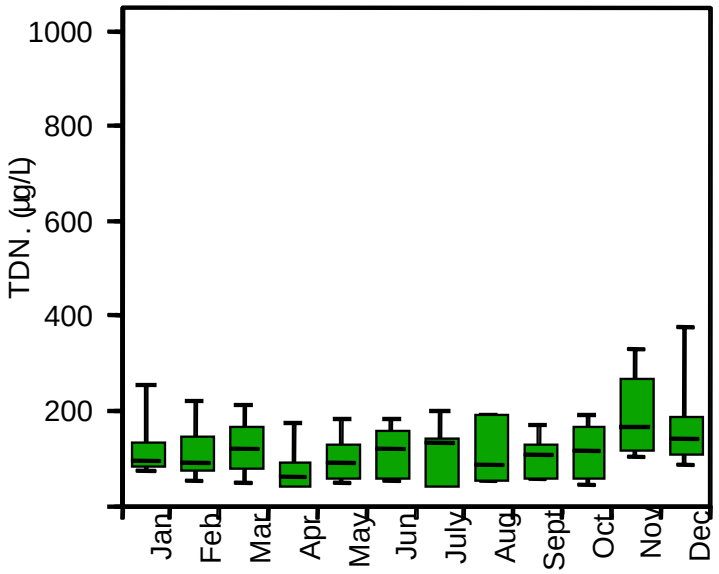


MONTHLY SAMPLING OF 43 STREAMS: JAN'2005 - 2007

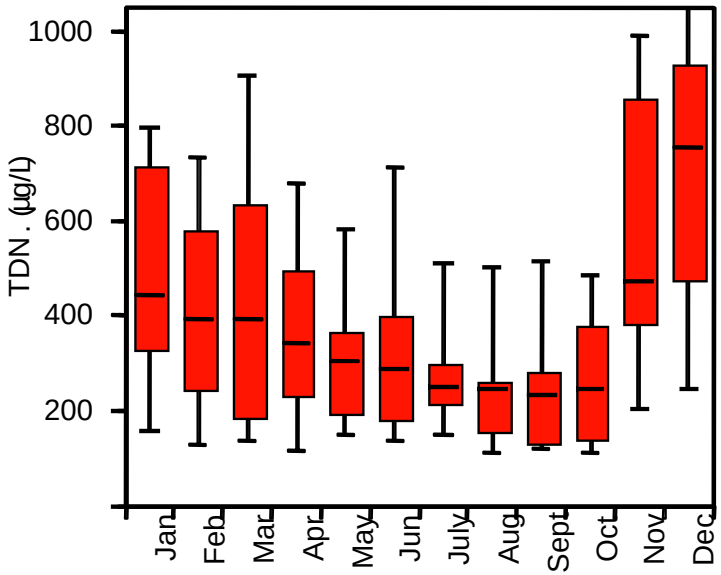


AVERAGE MONTHLY TDN IN TEN MOST…

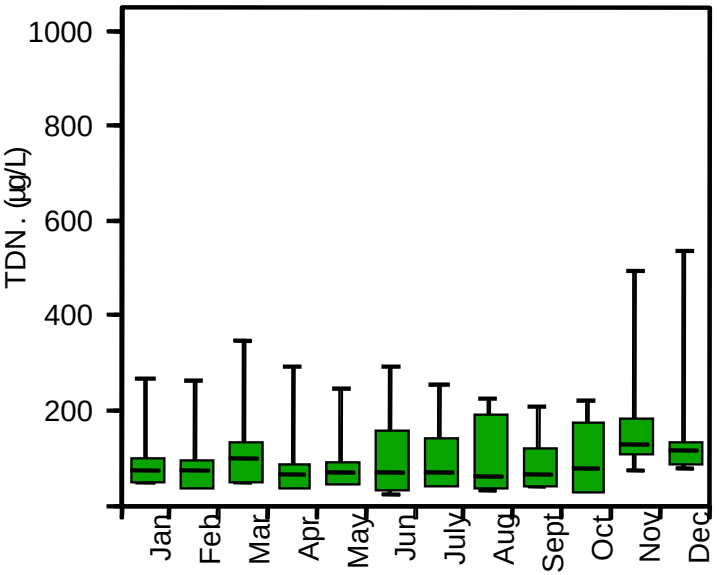
mature coniferous forest



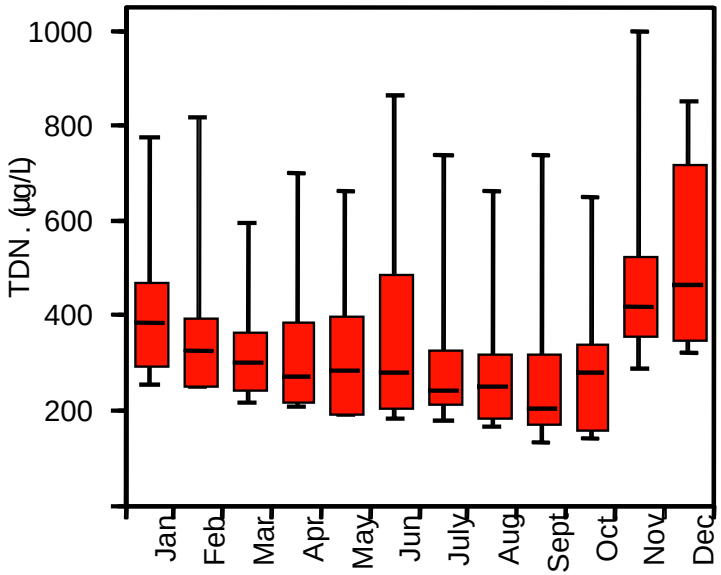
mixed deciduous forest



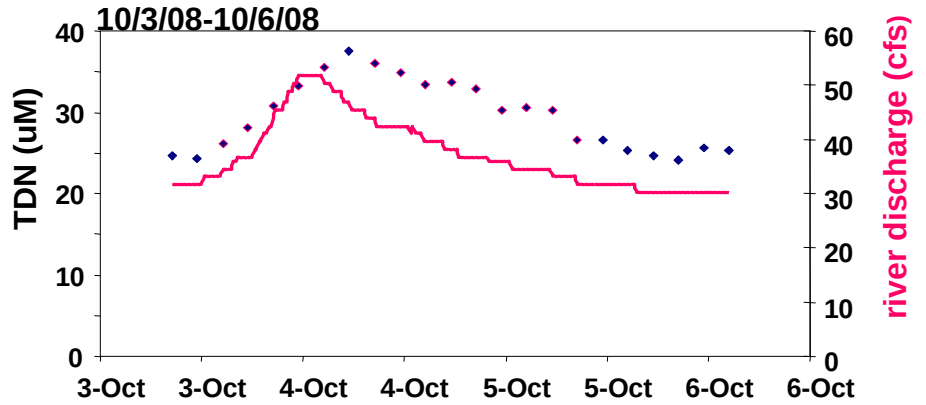
least densely populated watersheds



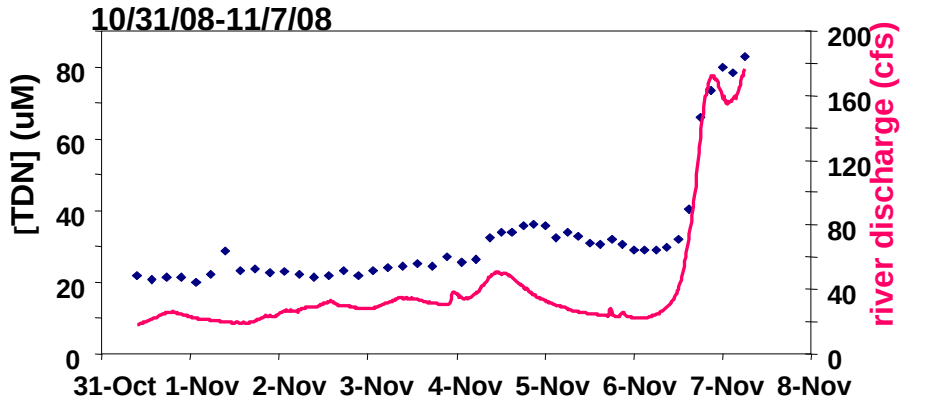
most densely populated watersheds



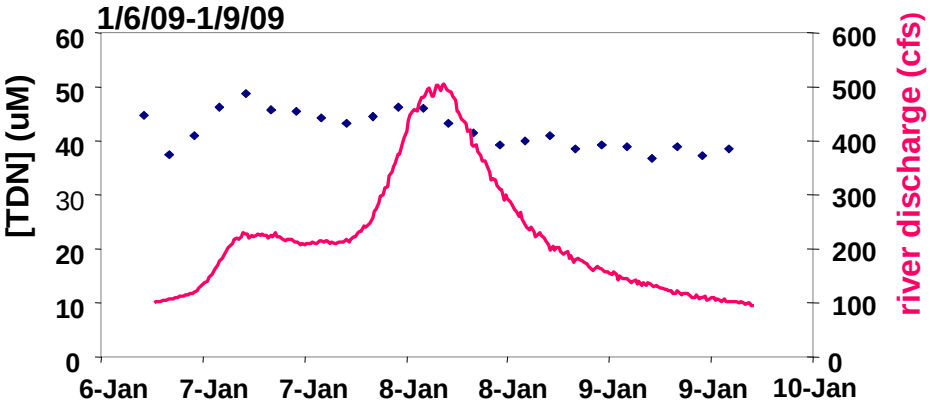
STORM RESPONSE: UNION RIVER [TDN]



First major storm of autumn displays near-doubling of TDN, then slow decline after peak flow.



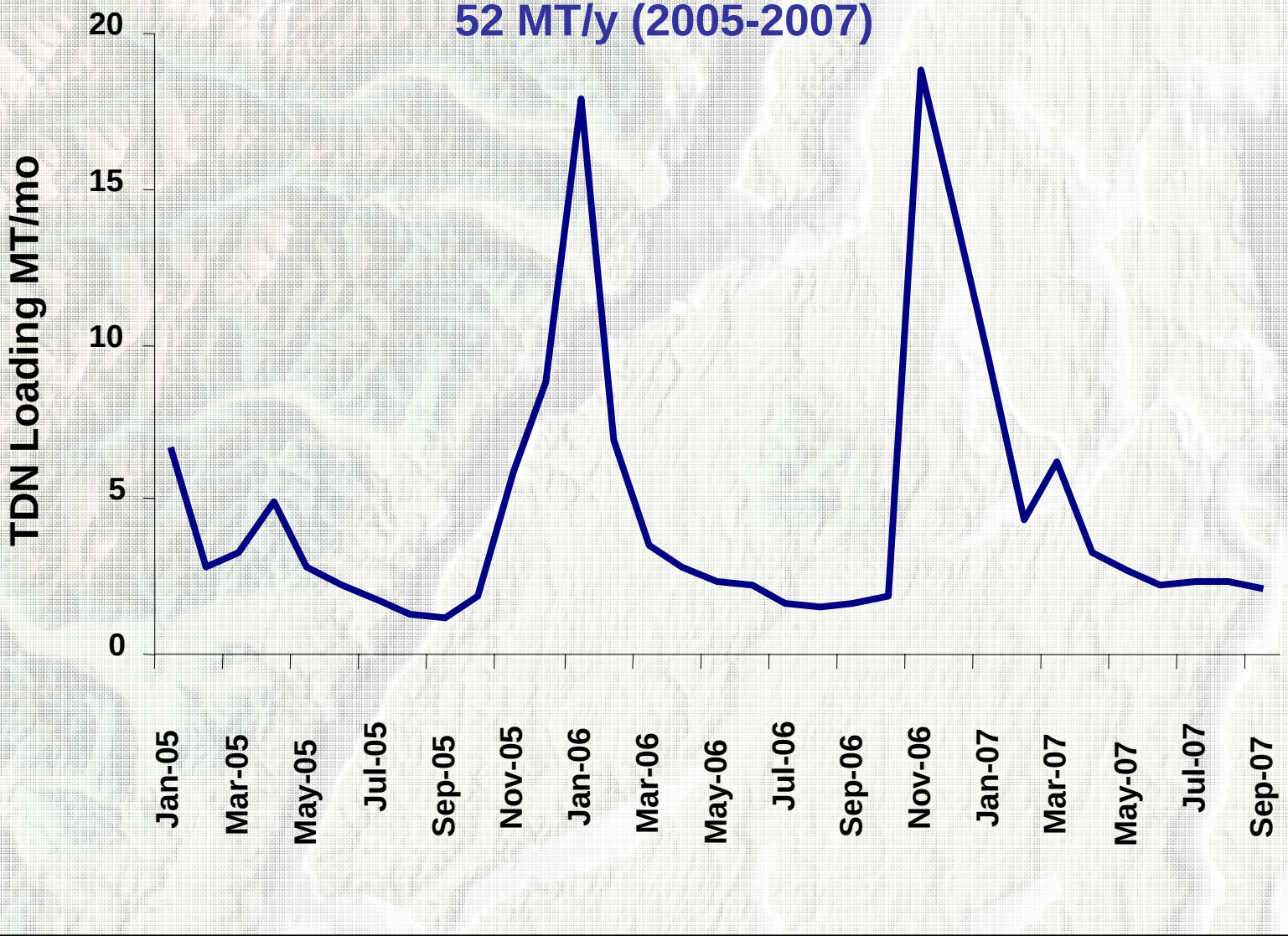
TDN concentrations continue to respond to large storm events in November. At peak river flow, concentrations are nearly 4x greater than just several days earlier



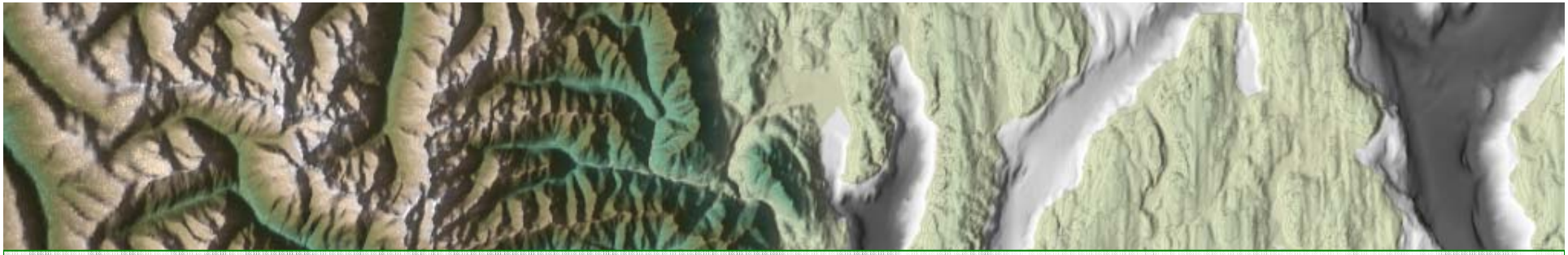
By January, TDN response to heavy river discharge is not as marked. Perhaps supply of excess nutrients stored in soils is depleted after numerous large storms.

Nick Ward UW Oceanography, unpubl data

LYNCH COVE TDN LOADING (DSEM*)



*Bechtold, Constans

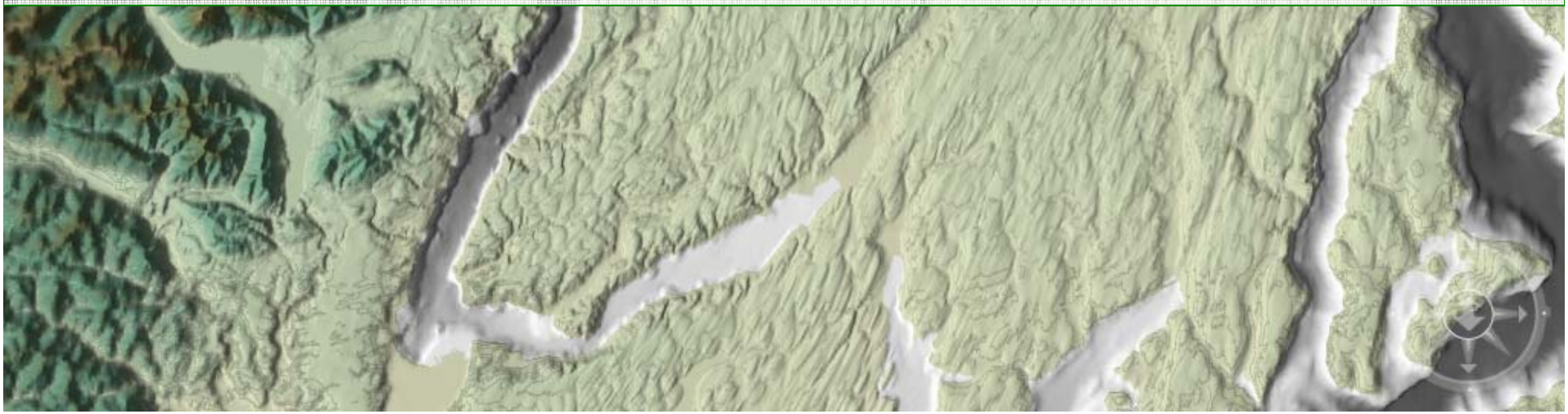


Distributed Hydrology Soil Vegetation Model (DHSVM)

-*Lettenmaier laboratory*

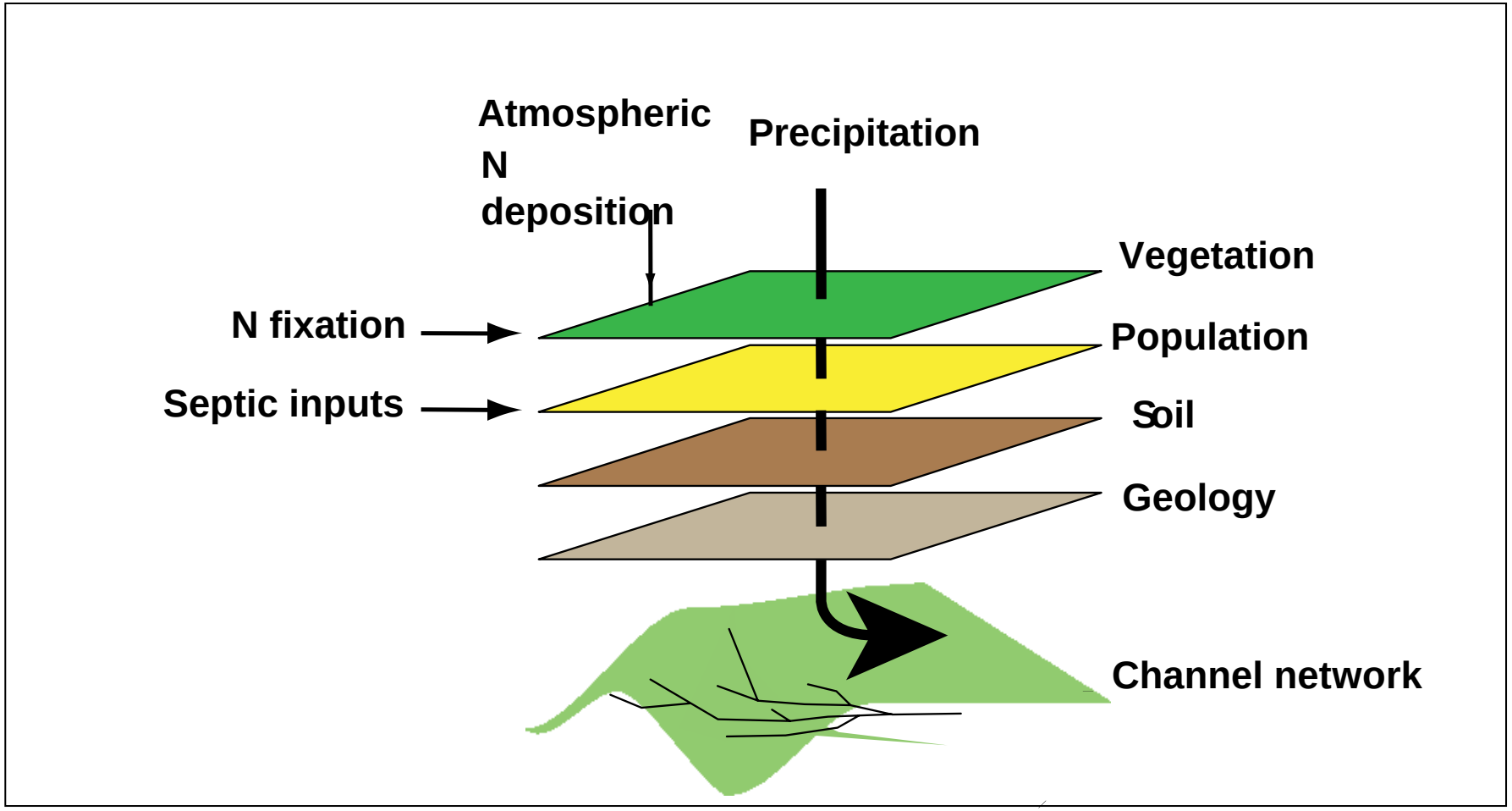
Solute Export Model (D-SEM)

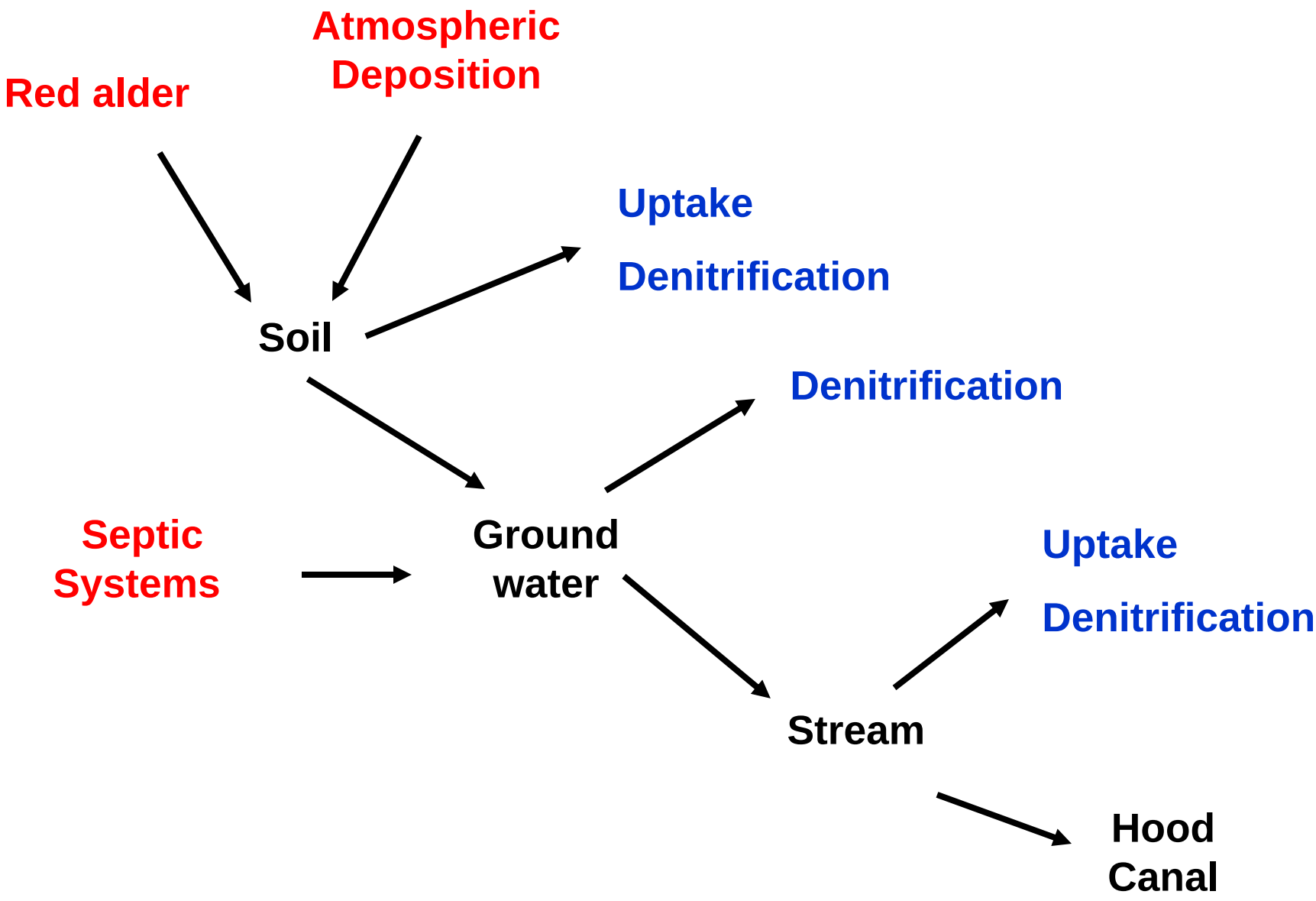
-*Porranee Thanapakpawin*

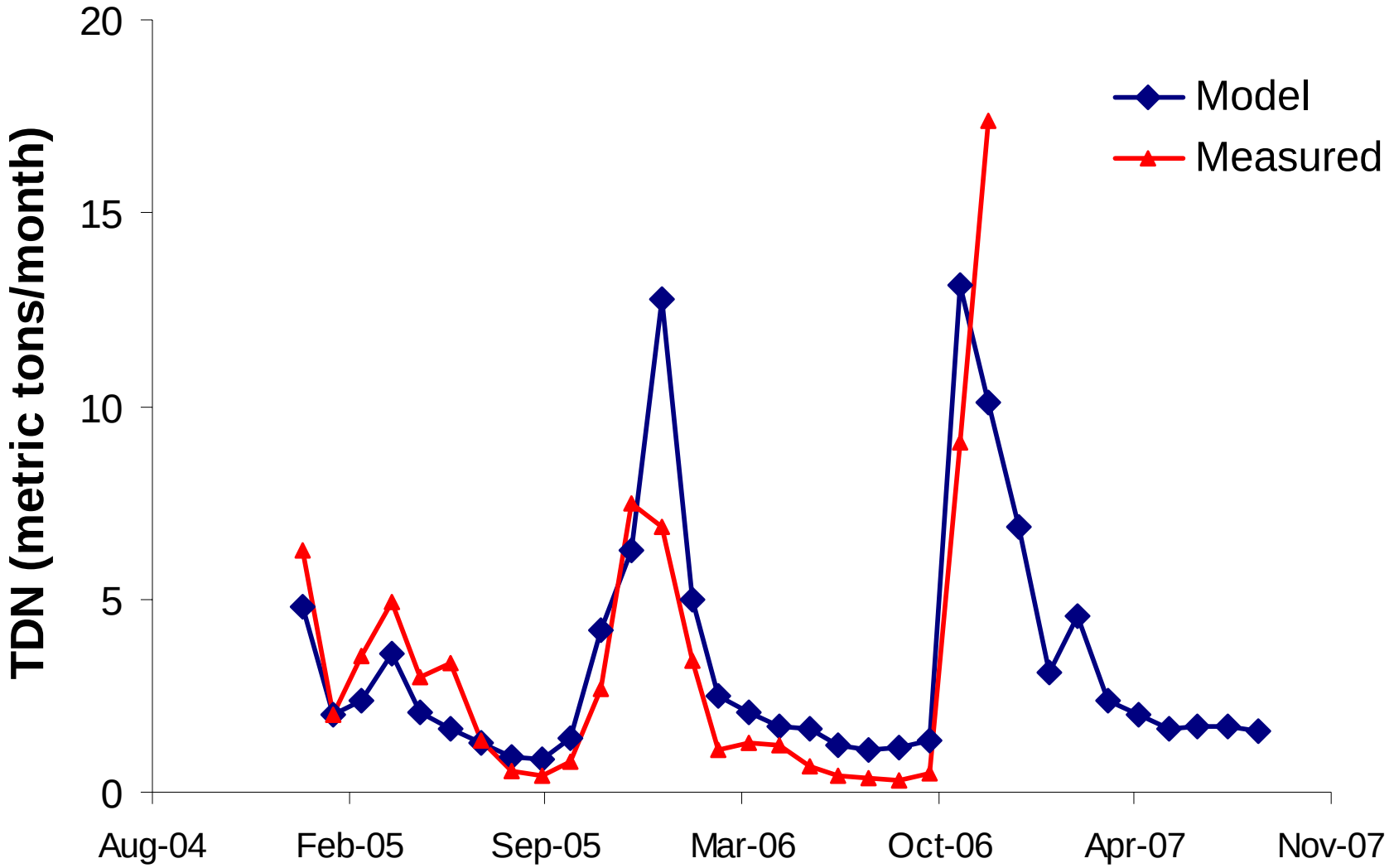


“MECHANISTIC” WATERSHED MODEL: *D-SEM*

Interpolation, process ID, future scenarios

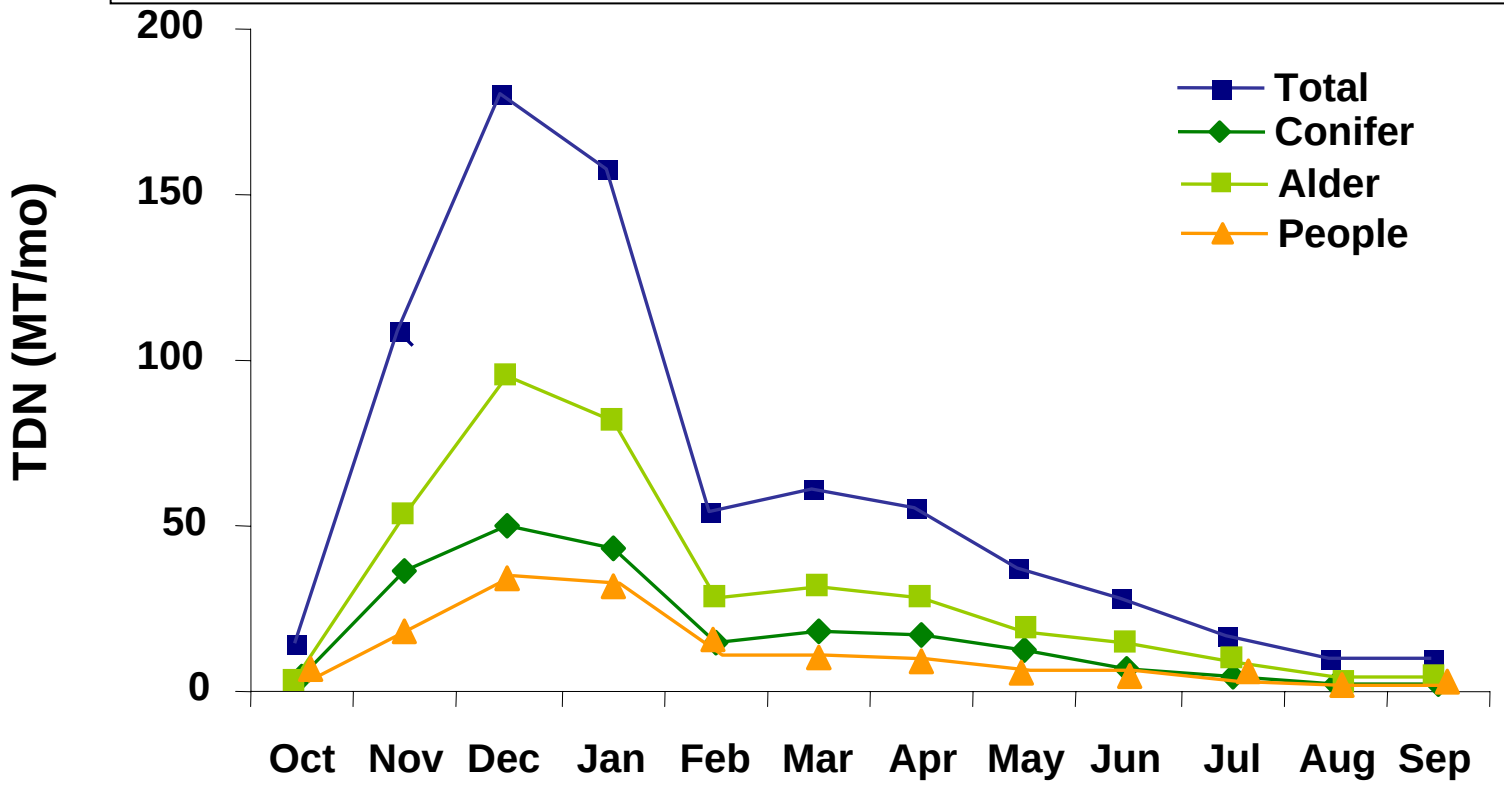



Red alder
Atmospheric Deposition
Uptake
Denitrification
Soil
Denitrification
Septic Systems
Ground water
Uptake
Denitrification
Stream
Hood Canal


TDN (metric tons/month)
20
15
10
5
0
Aug-04
Feb-05
Sep-05
Mar-06
Oct-06
Apr-07
Nov-07
Model
Measured

HOOD CANAL TOTAL TDN LOADING

2007, OVERALL UPDATES – *IN PROGRESS*

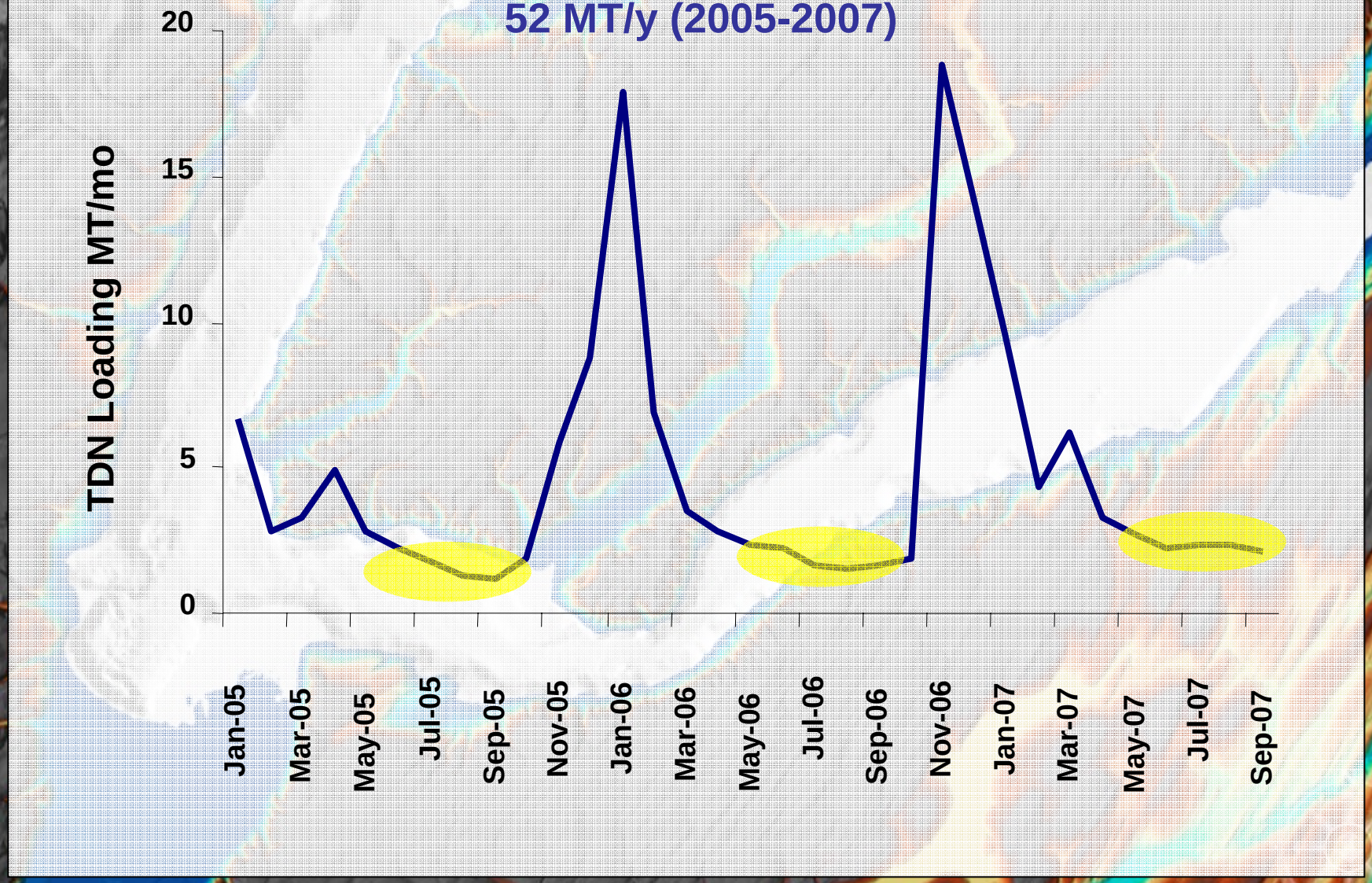


How do watershed inputs compare with marine inputs?

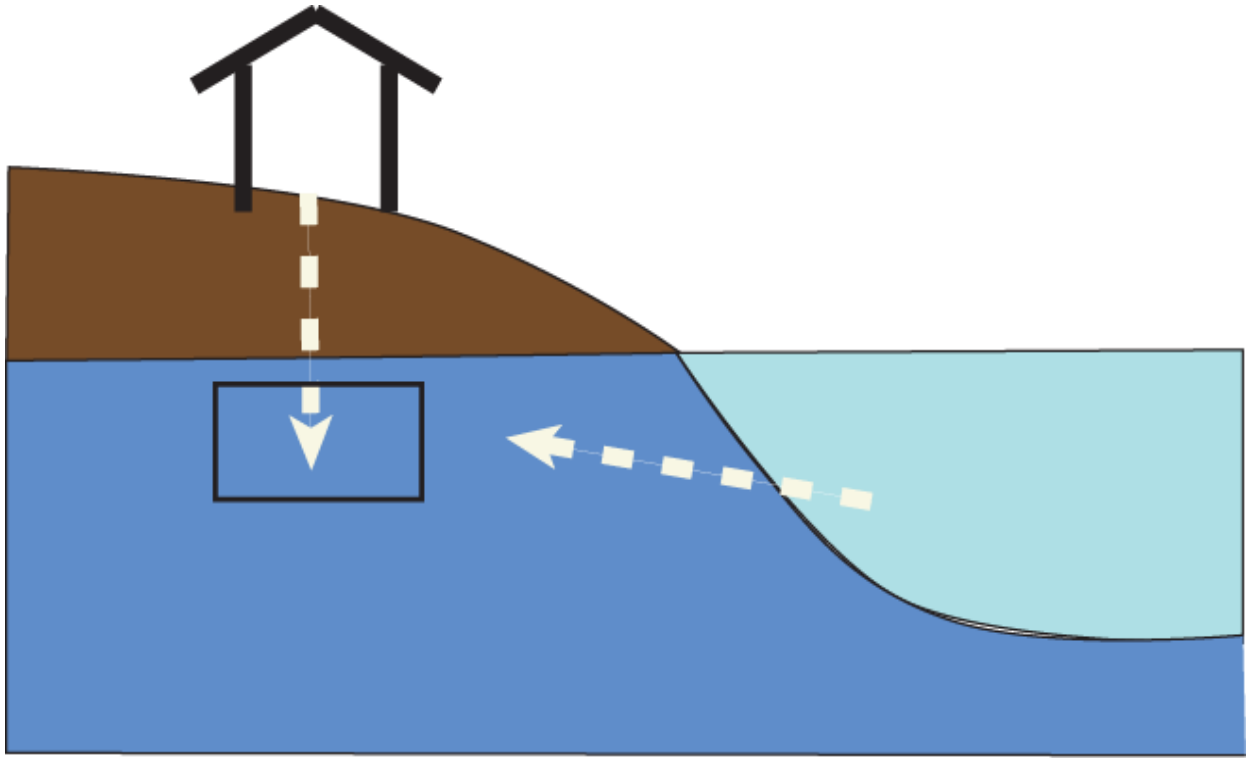
- watersheds only contribute about
  2-4 % of Hood Canal N
  10-15% of Lynch Cove N

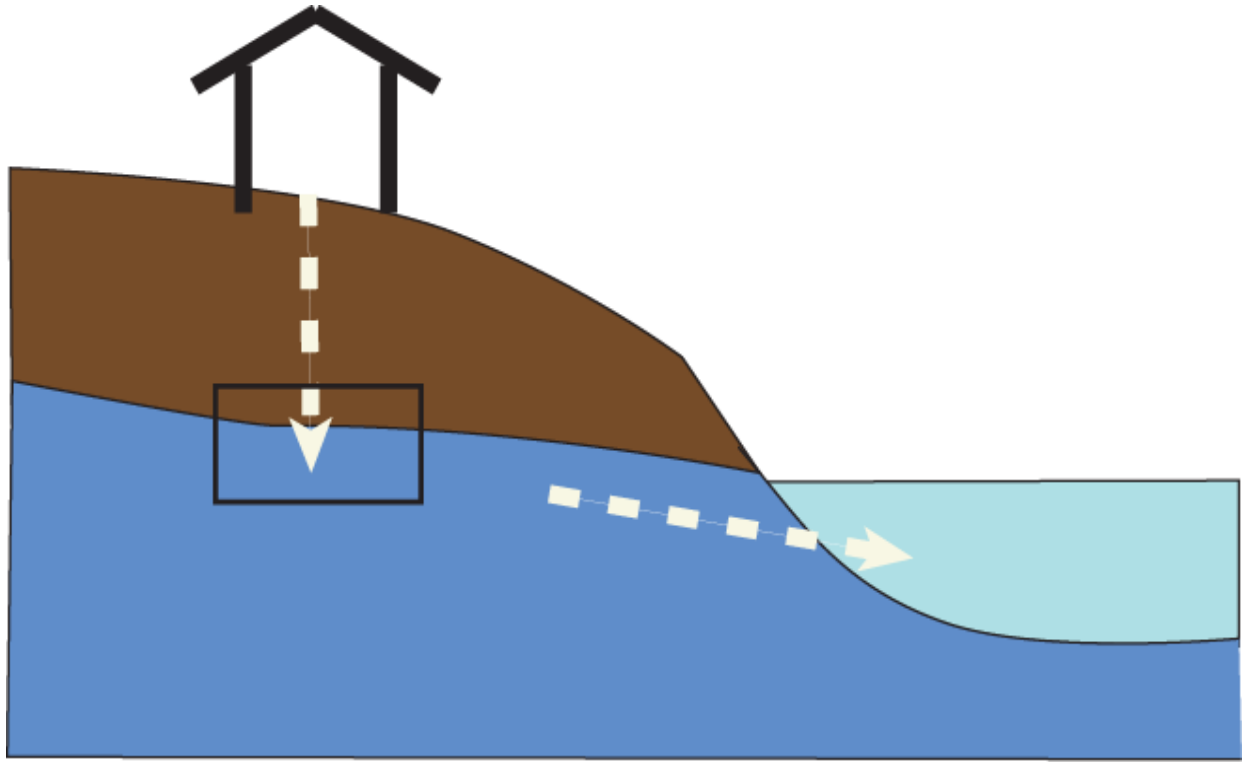
- winter river inputs are flushed out of Hood Canal by spring

LYNCH COVE TDN LOADING (DSEM*)

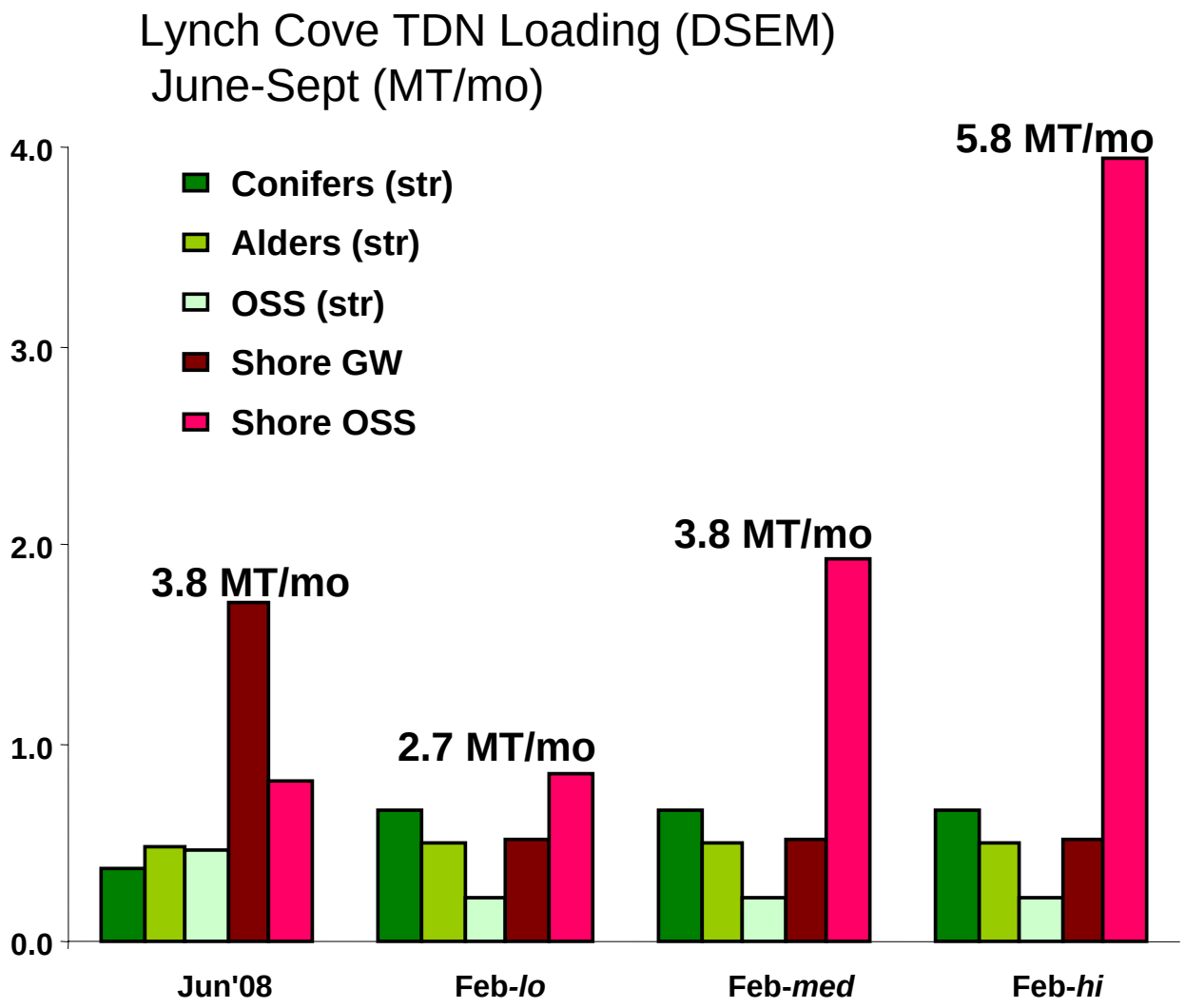


*Bechtold, Constans






Groundwater/Seepage inputs to Lower Hood Canal,
August September (USGS)


Lynch Cove TDN Loading (DSEM)
June-Sept (MT/mo)
4.0
3.0
2.0
1.0
0.0
Conifers (str)
Alders (str)
OSS (str)
Shore GW
Shore OSS
3.8 MT/mo
2.7 MT/mo
3.8 MT/mo
5.8 MT/mo
Jun'08
Feb-lo
Feb-med
Feb-hi

Next steps:

Shoreline modeling of Hood Canal

Puget Sound – N and toxics

Skagit Futures

- -agriculture
- -conservation
- -residential