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The Hydrological Functions of a Boreal Wetland

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Background

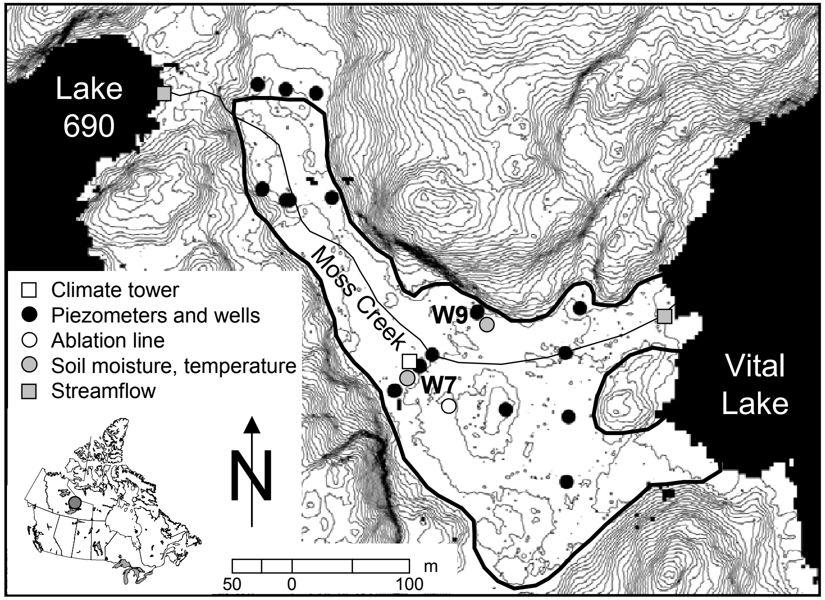
- The catchments that drain boreal stream networks exemplify heterogeneous conditions.
- Within this heterogeneity, wetlands are of critical importance to the catchment hydrology, because they are often situated at the outlet of headwater basins.
- While research has illuminated the runoff generation processes in these wetlands, an investigation seeking to understand the dynamic of hydrological function is absent.
- The questions addressed in this study were:
  - From where is the majority of water in a wetland collected, specifically one at the bottom of a headwater catchment?
  - Where and how does a wetland in such a landscape position tend to store the water it collects?
  - When discharging water, is a wetland in such a landscape position predominantly transmitting or contributing?

Study site and methods

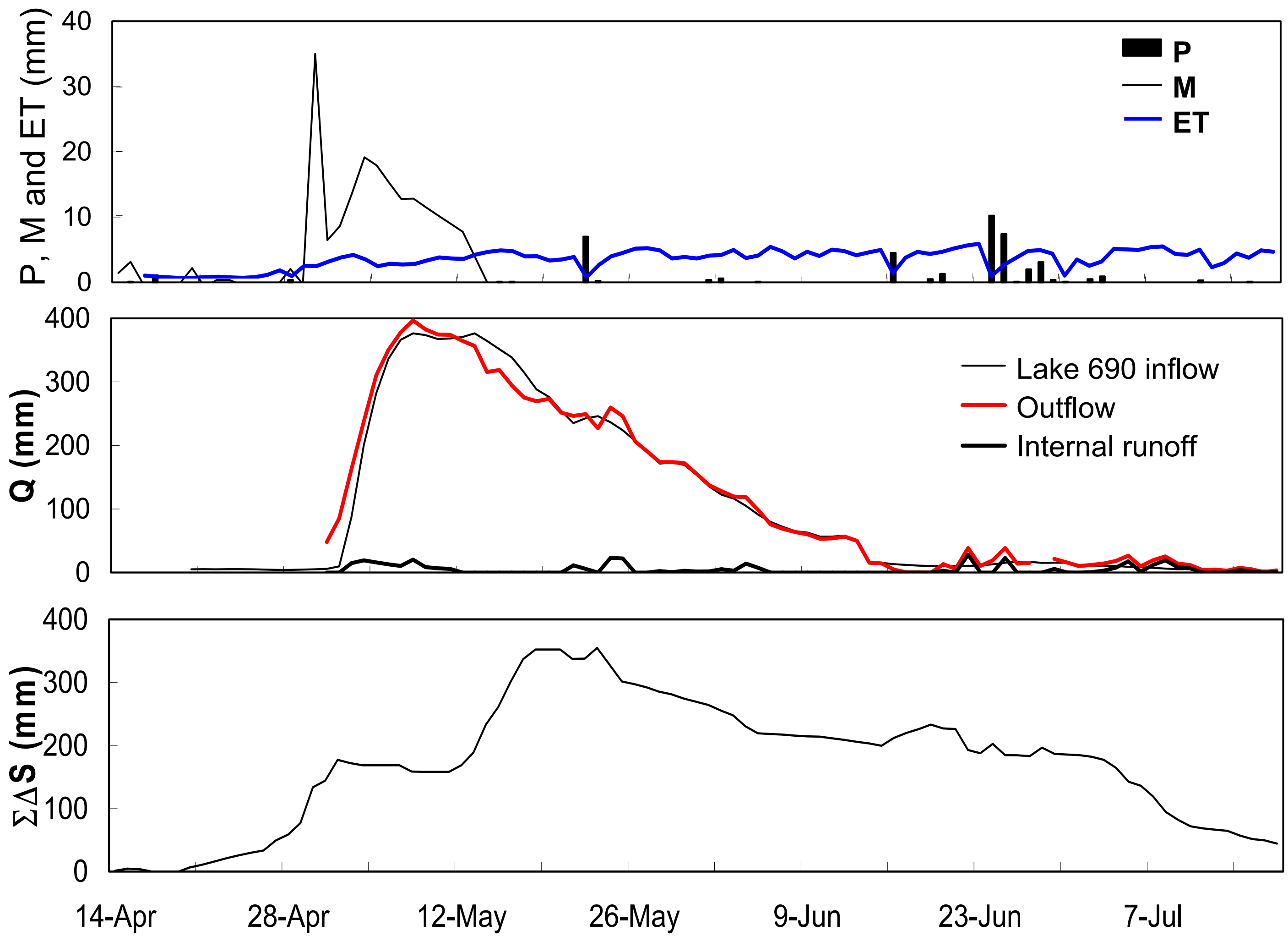
- The wetland under study was a 3.3 ha fen at the bottom of a 9.4 km^2 catchment draining Moss Creek, a tributary of Baker Creek.
- The water budget was estimated for the period from April 14 – July 16, 2008 following:

$$\Delta S = P + M + Q_i - Q_o - ET$$

- Piezometer nests were installed at locations to monitor intra-site groundwater hydraulic gradients.
- Precipitation, groundwater and surface waters were sampled for chemical analysis, including major ions, specific conductance, and the stable isotopes of ^{18}O and ^{2}H.
- If $\Delta S > Q_o$, storing; $\Delta S < Q_o$, discharging
- If $Q_i > Q_w$, transmitting; $Q_i < Q_w$, contributing

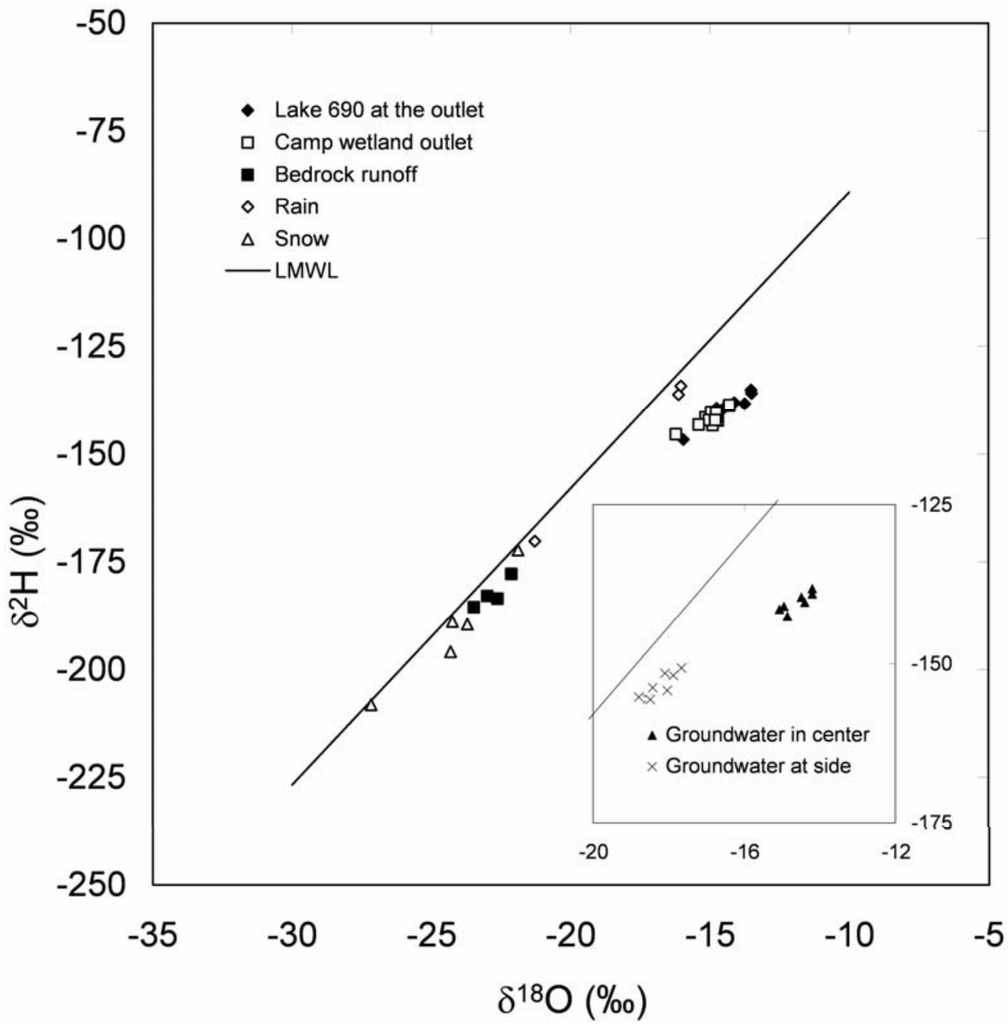


Water budget

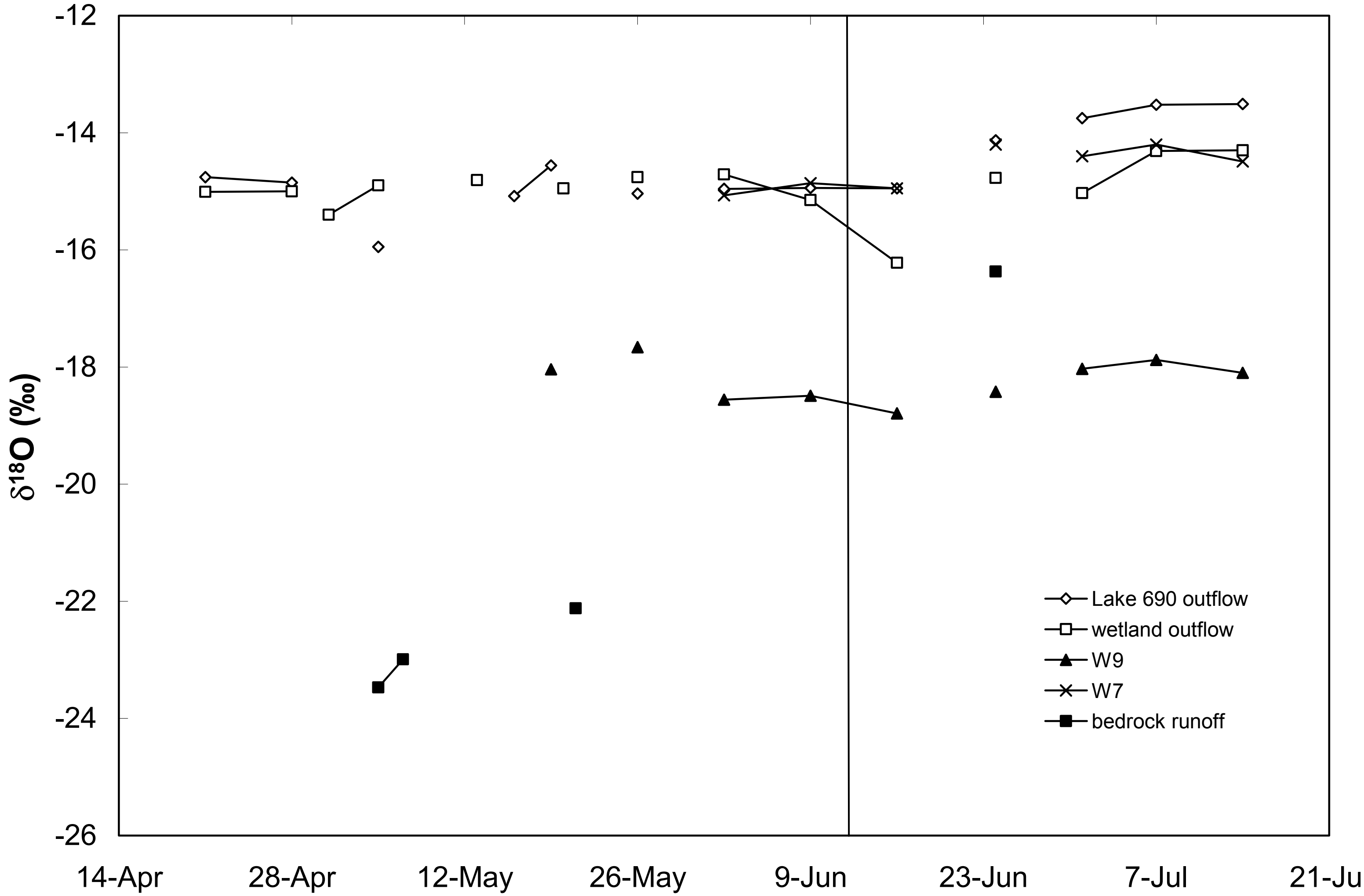


Intra-wetland groundwater flux

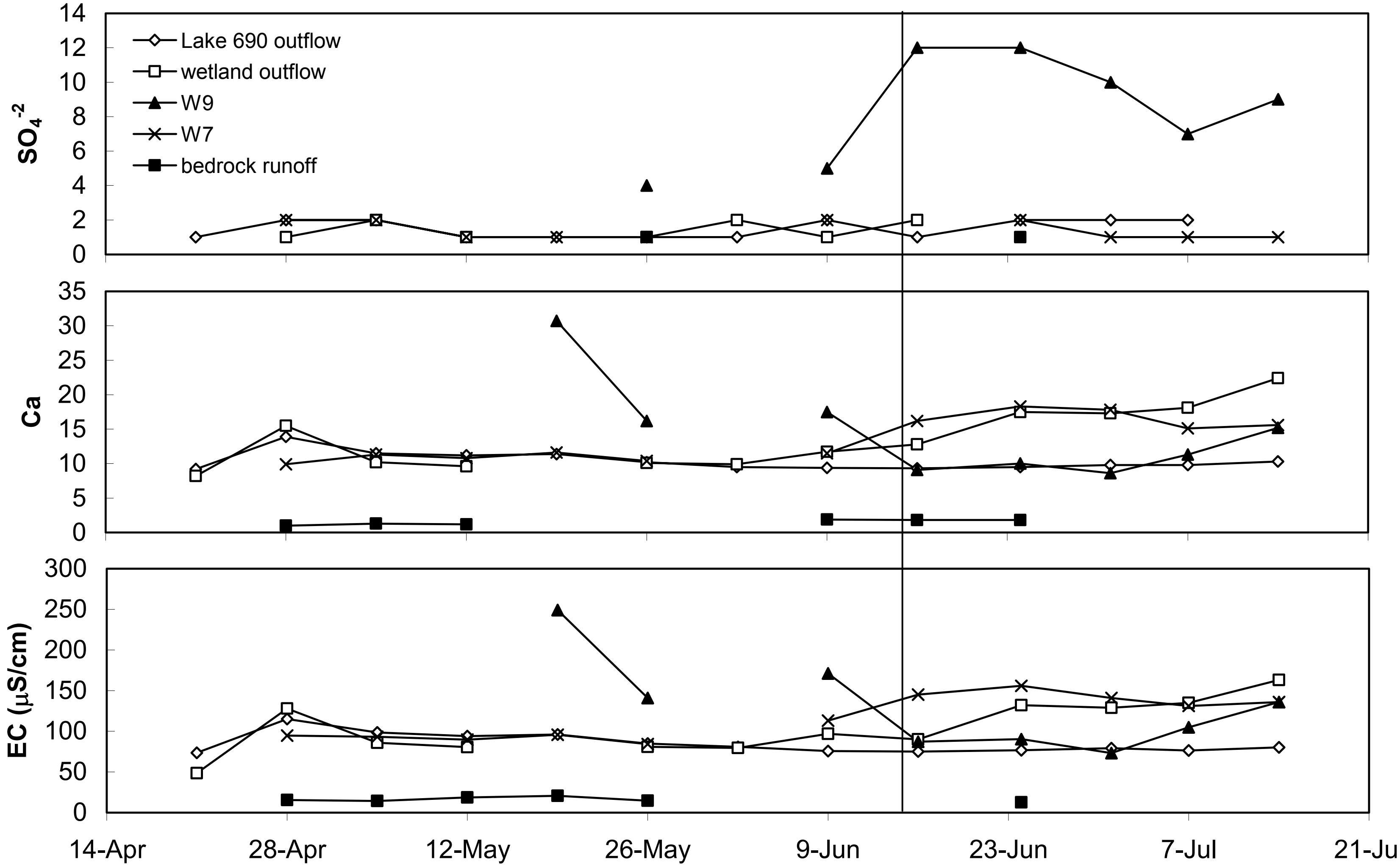
Stable isotopes



Stable isotopes



Ion chemistry



Streamflow separation

- The ion chemistry of rain, W7 groundwater and outflow permit the assumption that Q_o after June 14 was only a product of water stored in the wetland such that:

$$f_{gl} + f_{gw} = 1 \qquad f_{gl} = \frac{\delta^{18}O_o - \delta^{18}O_{gw}}{\delta^{18}O_{gl} - \delta^{18}O_{gw}}$$

- Where *f* is the fraction of water in Q_o, and the subscripts *gl*, *gw* and *o*, refer to isotopic signatures from groundwater from piezometer W7, ground from piezometer W9 and Q_o water.
- The value of f_{gl} averaged 91% of Q_o after June 14 implying Q_o is composed of water that is only transient in the wetland.

Collection

- The wetland collects the majority of its water from the upstream watershed; not the immediately adjacent hillslopes.
- Synchronicity may be important.
- Rain and bedrock runoff from adjacent hillslopes become important after inputs from the upper watershed decrease. Previous hydrological process studies suggest it is more likely to be the latter.

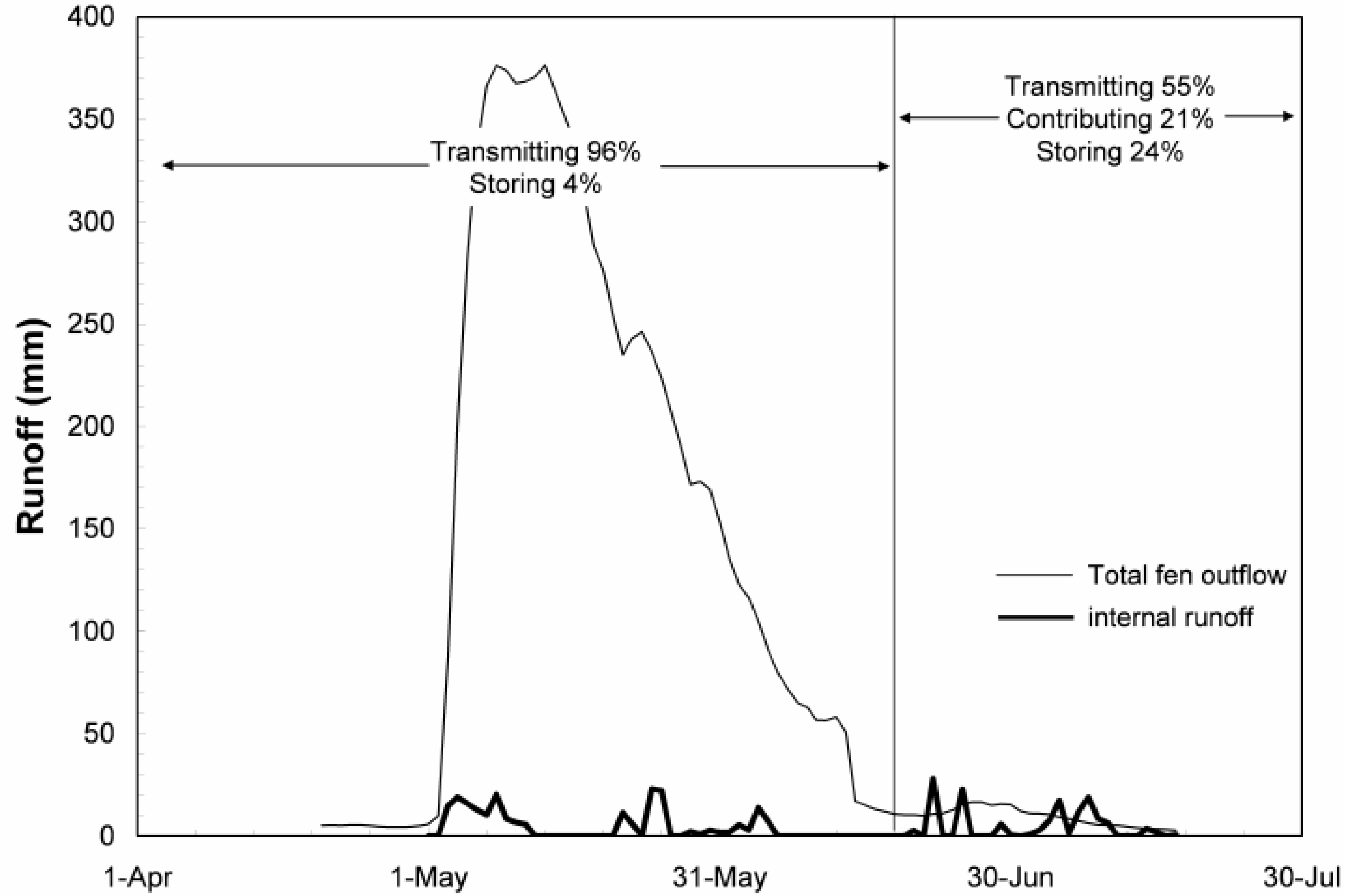
Storage

- The wetland tends to store the water it collects in two separate zones; one near the bisecting stream and another on the fringes of the wetland.
- Piezometric gradients and hydrochemistry suggest there is little exchange between the two.
- Water stored in the central zone appears to be only transient in the wetland.

Discharge

- The wetland is predominantly a transmitter of water.
- It is predominantly a contributor only after upstream sources are reduced.

Two phase functioning



Conclusions

- This wetland is primarily a transmitter of water and what water it did supply was altered little by intra-wetland geochemical processes.
- That only a fraction of the wetland contributed water to the outlet would suggest that it is very important for source areas to be properly simulated for coupled hydrology-biogeochemical models to be successful.
- Landscape position influenced the hydrological function of this wetland and should therefore be considered in hydrological model parameterization.

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