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North Central Climate Adaptation Science Center
NORTHWEST Climate Adaptation Science Center

Development of a Surface-Water Index of Permanence to Assess Surface-Water Availability for Ecohydrological Refugia

Surface-water availability has major implications for the environment and society in the 21st century. With climate change, increased drought severity, and altered water and land use, future water availability is predicted to continue to decline in many areas, including much of the western United States (Seager and others, 2013). An understanding of where and when water will be available at multiple scales is crucial for the planning and management of wildlife health, recreation, and energy development.

Currently, indices describing water presence and permanence exist for specific surface-water components (for example, streams and wetlands); however, a general surface-water permanence index that includes all major surface-water components is lacking. Developing a Surface-Water Index of Permanence (SWIPe) can provide a reliable metric to understand future river reach- to region-scale surface-water permanence and availability and inform land management and policy decisions.

SWIPe is designed to cover the upper Missouri River Basin and combines three existing datasets: (1) the U.S. Geological Survey Dynamic Surface Water Extent (DSWE; Jones, 2019), (2) the U.S. Geological Survey Probability of Streamflow Permanence-Upper Missouri ($PROSPER_{UM}$; Sando and others, 2022a), and (3) seasonal vegetation characteristics (Sando and others, 2022b) to identify likely groundwater/surface-water interaction locations.

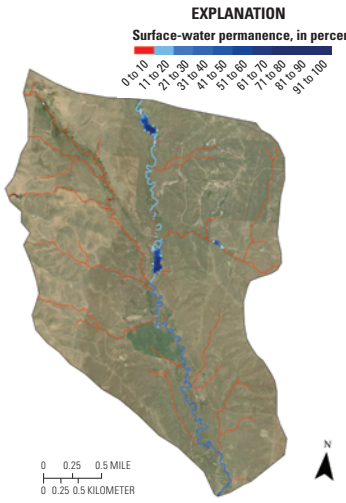
SWIPe Development

SWIPe Datasets

Develop index from existing datasets:

- DSWE (Jones, 2019),
- $PROSPER_{UM}$ (Sando and others, 2022a), and
- Seasonal vegetation characteristics to identify potential groundwater/surface-water interaction (Sando and others, 2022b).

Example SWIPe Output



SWIPe Tool

An interactive, web-based tool that is planned to be created for use by stakeholders will include the following abilities:

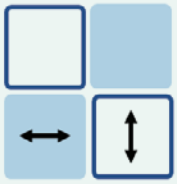
- Develop situational maps (for example, dry versus wet year simulations),
- Analyze predictions using a customizable spatiotemporal focus and,
- Overlay gridded climate data for visual comparison of historical climate conditions with surface-water conditions.

Links to Explore

- Projects—Climate Adaptation Science Centers (https://cascprojects.org/#/ and https://cascprojects.org/#/project/4f83509de4b0e84f60868124/624f510ed34e21f8276a0649).
- Explore DSWE science products (https://www.usgs.gov/landsat-missions/landsat-dynamic-surface-water-extent-science-products).
- Explore the $PROSPER_{UM}$ application (https://webapps.usgs.gov/prosperum/).

SWIPe

SWIPe Highlights

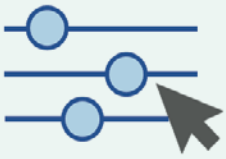


10-meter resolution

Flexible temporal scale

Missouri River Basin geographic extent

Contrast wet and dry periods



User-friendly interface

Ecological Application of SWIPe—Northern Leopard Frog Case Study

Historically, the *Lithobates pipiens* (Schreber, 1782; northern leopard frog; NLF) population is distributed across north-central North America (fig. 1), and populations east of the 100th meridian are considered stable. However, populations to the west of the 100th meridian are considered less stable based on genetic assessment (Stockwell and others, 2016), and the Rocky Mountain populations of NLF are listed as endangered under the Canadian Species at Risk Act. Historical population declines are largely attributed to overharvest of NLFs in the 1960s and 1970s for educational and research purposes (Gibbs and others, 1971), but recovery of NLFs in some regions is limited by climate change, invasive species, disease, and habitat loss and degradation (Stockwell and others, 2016). This species uses permanent and seasonal water sources for overwintering and breeding, respectively. Seasonal waterbodies are particularly important for recruitment and early life stages of the NLF, and permanently ponded waterbodies are essential for metapopulation connectivity. SWIPe and its associated products are planned to provide crucial information regarding availability of suitable habitat and the presence of permanent surface-water refugia for the NLF population across its northwestern distribution.

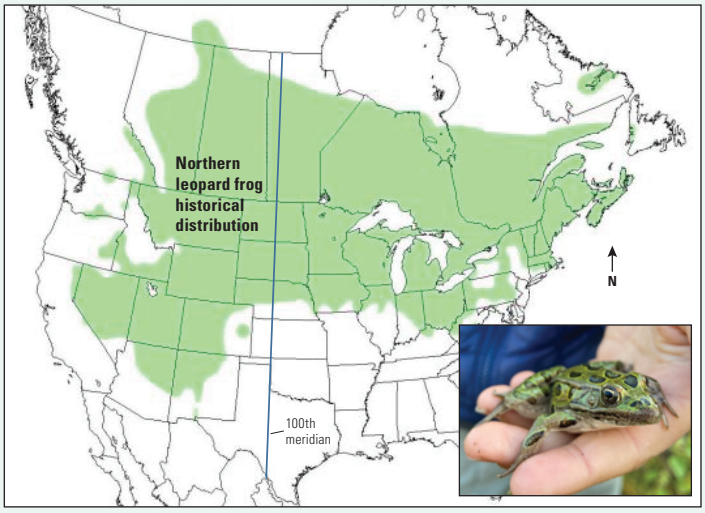


Figure 1. Probable historical distribution of *Lithobates pipiens* (Schreber, 1782; northern leopard frog; modified from Smith and Keinath [2007]). Inset photograph of adult northern leopard frog (photograph by Roy Sando, U.S. Geological Survey).

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