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Assessment of wetland ecosystem services associated with changing climate and agricultural wetland drainage in a major food producing region

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Agricultural regions worldwide face the dual challenge of producing food for a growing world population while simultaneously reducing the industry's environmental footprint. The prairie region of western Canada, where more than 40 million ha are used as cropland or pasture, is one of the world's major food producing regions. This complex landscape provides agroecosystem services associated with these agricultural lands and their millions of depressional wetlands. As a cold region, and one with a highly variable climate which is undergoing strong climate change, agricultural practices continue to evolve. One widely used tool for adaptation to wet periods and to maximize arable land area is to drain wetlands; however, a tradeoff exists between draining wetlands to support expansion of cropland, and conserving wetlands to maintain their valuable ecosystem services. Wetland drainage decisions are often made without identifying impacts to the services these systems provide.

We address this gap using a novel assessment to quantify impacts to ecosystem services via wetland drainage in the Canadian prairie landscape, and explore how wetland ecosystem services may be impacted by future climate. Quantifying response of a suite of indicators (median annual flows, total phosphorus export, riparian habitat, dabbling ducks, wetland-associated birds, carbon sequestration) to wetland drainage demonstrated that all respond strongly to the loss of depressional wetlands, but sensitivity varies among the indicators. Median annual flows and phosphorus export respond more strongly than longer return period flows, potentially tripling in magnitude with high levels of wetland loss. Dabbling ducks and wetland-associated bird abundances are even more sensitive, with abundances predicted to decrease by half with loss of as little as 20% of wetland area. As a relatively unique region, where inundated wetland area is highly dynamic both interannually as the system alternates between dry and wet phases, and intra-annually (across seasons), wetland ecosystem services response to climate change is more nuanced. In the Canadian prairie, there appears to be a delicate balance between future warming and changes in precipitation amount that could yield either increases or decreases in wetland area, with wetland ecosystem services anticipated to change accordingly. Our results illustrate the

sensitivity of wetland ecosystem services to agroecosystem management and climate change in a major food producing region, highlighting the need to consider the tradeoff between loss of these services and benefits of agricultural expansion. Under a drier future climate, fewer remaining wetlands may both enhance the value of wetland-associated ecosystem services, and temper the demand for wetland drainage.