**Ecosystem Type: LAKES AND PONDS**

**Category: Food, Fuel, and Materials**

1. **Materials**

***Supplier*** – Lakes and ponds are ecosystems that provide materials used for food and fuel. For example, they are a habitat that is dominated by fish species (Lynch et al, 2016), and contribute to 40% of the world’s reported fisheries. Lakes also provide about 87% of the world’s surface freshwater for consumption (Gleick, 1996). Agriculture has the largest use of freshwater resources for food production (Calzadilla, Rehdanz, and Tol, 2010). In addition, a study in 2005 indicated that thermoelectric-power generation had the second highest use of water—about 201 billion gallons per day (Kenny et al, 2009).

**Addenda Layer:**

Maximum bat species richness - southeast

Maximum bat species richness - southwest

Maximum big game species richness - southeast

Maximum big game species richness - southwest

Mean bat species richness - southeast

Mean bat species richness - southwest

Mean big game species richness - southeast

Mean big game species richness - southwest

NIB bat species richness - southeast

NIB bat species richness - southwest

NIB big game species richness - southeast

NIB big game species richness - southwest

**Layer without Citation:**

Cotton yields

Grain yields

Hectares of cotton crops

Hectares of grain crops

Maximum fur bearer species richness - southeast

Maximum fur bearer species richness - southwest

Maximum small game species richness - southeast

Maximum small game species richness - southwest

Maximum total harvestable species richness: southeast

Maximum total harvestable species richness: southwest

Maximum waterfowl species richness: southeast

Maximum waterfowl species richness: southwest

Mean fur bearer species richness - southeast

Mean fur bearer species richness - southwest

Mean small game species richness - southeast

Mean small game species richness - southwest

Mean total harvestable species richness: southeast

Mean total harvestable species richness: southwest

Mean waterfowl species richness: southeast

Mean waterfowl species richness: southwest

NIB fur bearer species richness - southeast

NIB fur bearer species richness - southwest

NIB small game species richness - southeast

NIB small game species richness - southwest

NIB total harvestable species richness - southeast

NIB total harvestable species richness - southwest

NIB waterfowl species richness - southeast

NIB waterfowl species richness - southwest

***Driver*** – A decrease in water supply within lakes due to excessive human consumption or droughts can lead to changes in the availability of these reservoirs to support materials used in food and fuel production. These ecosystems are particularly sensitive to climate (Hayes et al., 2017), and experience a great flux in volume of water depending on the weather conditions and adjacent landscapes.

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

1. **Nutrition**

***Supplier*** – Lakes are filled with animals and plants that can be consumed by humans (Bolen, Smith, and Schramm, 1989). They also supply 87% of the world’s surface freshwater for consumption (Gleick, 1996). In fact, agriculture has the largest use of freshwater resources for food production (Calzadilla, Rehdanz, and Tol, 2010).

**Addenda Layer:** not applicable

**Layer without Citation:**

Fruit yields

Grain yields

Hectares of fruit crops

Hectares of grain crops

Hectares of vegetable crops

Maximum fur bearer species richness - southeast

Maximum fur bearer species richness - southwest

Maximum small game species richness - southeast

Maximum small game species richness - southwest

Maximum total harvestable species richness: southeast

Maximum total harvestable species richness: southwest

Maximum waterfowl species richness: southeast

Maximum waterfowl species richness: southwest

Mean fur bearer species richness - southeast

Mean fur bearer species richness - southwest

Mean small game species richness - southeast

Mean small game species richness - southwest

Mean total harvestable species richness: southeast

Mean total harvestable species richness: southwest

Mean waterfowl species richness: southeast

Mean waterfowl species richness: southwest

NIB fur bearer species richness - southeast

NIB fur bearer species richness - southwest

NIB small game species richness - southeast

NIB small game species richness - southwest

NIB total harvestable species richness - southeast

NIB total harvestable species richness - southwest

NIB waterfowl species richness - southeast

NIB waterfowl species richness – southwest

Vegetable yields

***Driver*** - The ability for lakes and ponds to retain water and to capture nutrients that have an impact on consumables provided by these ecosystems is affected by changes in water use and adjacent land cover. For example, impervious surfaces can create higher discharge into lakes, which reduces the effectiveness these ecosystems have for capturing nutrients. One study found that intensified discharge may lead to a decrease in the overall residence time for sediments flowing into the reservoir (Verstraeten and Poesen, 2000). The ability of lakes to capture nutrients can be beneficial for aquatic plants that rely on these sources for productivity (Thiebaut, 2008).

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** - not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

1. **Energy**

***Supplier*** – There is a demand for inland reservoirs such as lakes to supply energy, particularly for thermoelectric power generation. In 2005, thermoelectric power accounted for almost 41 percent of all freshwater withdrawals (Kenny et al, 2009). Further, the Great Lakes region identified in 2007 that 75 percent of water used for thermoelectric production came from the surface waters of the Great Lakes (Tidwell and Moreland, 2011). This equates to a withdrawal of 25.8 billion gallons per day from these major freshwater resources, which also accounted for 81 percent of total withdrawals from the Great Lakes (Tidwell and Moreland, 2011).

**Addenda Layer:** not applicable

**Layer without Citation:**

Grain yields

Hectares of grain crops

***Driver*** – A decrease in water supply within lakes due to excessive human consumption or droughts can lead to changes in the availability of these reservoirs to support energy production. These ecosystems are particularly sensitive to climate (Hayes et al., 2017), and experience a great flux in volume of water depending on the weather conditions and adjacent landscapes.

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:**

1. **Mediation of Waste, Toxics, and Other Nuisances**

***Supplier*** –

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

***Driver*** – Impervious surfaces can increase the amount of runoff flowing into a lake or pond, which may reduce the benefits that these ecosystems provide. For example, intensified discharge can stimulate a greater number of combined sewer overflows (Patz et al., 2008), increasing the amount of contaminated water flowing into these ecosystems. This reduces the cleanliness and availability of the drinking water supply that these ecosystems provide.

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

1. **Mediation of Flows**

***Supplier*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

***Driver*** – The supply of water that lakes and ponds provide are impacted by adjacent landscapes, water use, and climate change. For example, impervious surfaces can have a negative impact on the lake’s overall water quality. Higher discharge that carries with it greater nutrients, bacteria, and other wastes degrades the habitat that provides beneficial food resources for consumption (Leibold, 1999). Decreasing precipitation rates minimizes the amount of water being trapped in the reservoirs (MacDonald, 2010). Further, overuse of water for different uses other than food depletes the resources available to support the life cycle of aquatic species that are consumed (MacDonald, 2010).

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

1. **Maintenance of Physical, Chemical, and Biological Indicators**

***Supplier*** –

**Addenda Layer:** not applicable

**Layer without Citation:**

***Driver*** – The physical supply of water that lakes and ponds provide for food and fuel are impacted by adjacent landscapes, water use, and climate change. For example, impervious surfaces can have a negative impact on the lake’s overall water quality, which can have an effect on the life cycle of aquatic species that are consumed (MacDonald, 2010). These surfaces plus intensified rainfall produce runoff that may contain excess fertilizer and manure. These fertilizers can cause toxic algal blooms, which leads to a loss of oxygen resulting in the death of fish and other aquatic species (Carpenter et al., 1998).

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

1. **Spiritual, Symbolic, Religious, and Social Experiences**

***Supplier*** – Lakes are filled with animals and plants that can be consumed socially (Bolen, Smith, and Schramm, 1989). They also supply 87% of the world’s surface freshwater for consumption (Gleick, 1996). Food security provided by these resources has become an important spiritual and social experience for some cultures (Tobin, 2007).

**Addenda Layer:**

Maximum bat species richness - southeast

Maximum bat species richness - southwest

Maximum big game species richness - southeast

Maximum big game species richness - southwest

Mean bat species richness - southeast

Mean bat species richness - southwest

Mean big game species richness - southeast

Mean big game species richness - southwest

NIB bat species richness - southeast

NIB bat species richness - southwest

NIB big game species richness - southeast

NIB big game species richness - southwest

**Layer without Citation:**

Cotton yields

Fruit yields

Grain yields

Hectares of cotton crops

Hectares of fruit crops

Hectares of grain crops

Hectares of vegetable crops

Maximum fur bearer species richness - southeast

Maximum fur bearer species richness - southwest

Maximum small game species richness - southeast

Maximum small game species richness - southwest

Maximum total harvestable species richness: southeast

Maximum total harvestable species richness: southwest

Maximum waterfowl species richness: southeast

Maximum waterfowl species richness: southwest

Mean fur bearer species richness - southeast

Mean fur bearer species richness - southwest

Mean small game species richness - southeast

Mean small game species richness - southwest

Mean total harvestable species richness: southeast

Mean total harvestable species richness: southwest

Mean waterfowl species richness: southeast

Mean waterfowl species richness: southwest

NIB fur bearer species richness - southeast

NIB fur bearer species richness - southwest

NIB small game species richness - southeast

NIB small game species richness - southwest

NIB total harvestable species richness - southeast

NIB total harvestable species richness - southwest

NIB waterfowl species richness - southeast

NIB waterfowl species richness - southwest

***Driver*** – The physical supply of water that lakes and ponds provide for food and fuel to support social and spiritual experiences are impacted by adjacent landscapes, water use, and climate change. For example, impervious surfaces can have a negative impact on the lake’s overall water quality, which can have an effect on the life cycle of aquatic species that are consumed (MacDonald, 2010). These surfaces plus intensified rainfall produce runoff that may contain excess fertilizer and manure. These fertilizers can cause toxic algal blooms, which leads to a loss of oxygen resulting in the death of fish and other aquatic species (Carpenter et al., 1998).

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** – not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

1. **Physical and Intellectual Interactions w/ Biota, Ecosystems, and Land/Seascapes**

***Supplier*** – One sector that has for generations been utilizing water from lakes to support and advance their food business is agriculture. In fact, agriculture has the largest use of freshwater resources for food production (Calzadilla, Rehdanz, and Tol, 2010).

**Addenda Layer:**

Maximum bat species richness - southeast

Maximum bat species richness - southwest

Maximum big game species richness - southeast

Maximum big game species richness - southwest

Mean bat species richness - southeast

Mean bat species richness - southwest

Mean big game species richness - southeast

Mean big game species richness - southwest

NIB bat species richness - southeast

NIB bat species richness - southwest

NIB big game species richness - southeast

NIB big game species richness - southwest

**Layer without Citation:**

Cotton yields

Fruit yields

Grain yields

Hectares of cotton crops

Hectares of fruit crops

Hectares of grain crops

Hectares of vegetable crops

Maximum fur bearer species richness - southeast

Maximum fur bearer species richness - southwest

Maximum small game species richness - southeast

Maximum small game species richness - southwest

Maximum total harvestable species richness: southeast

Maximum total harvestable species richness: southwest

Maximum waterfowl species richness: southeast

Maximum waterfowl species richness: southwest

Mean fur bearer species richness - southeast

Mean fur bearer species richness - southwest

Mean small game species richness - southeast

Mean small game species richness - southwest

Mean total harvestable species richness: southeast

Mean total harvestable species richness: southwest

Mean waterfowl species richness: southeast

Mean waterfowl species richness: southwest

NIB fur bearer species richness - southeast

NIB fur bearer species richness - southwest

NIB small game species richness - southeast

NIB small game species richness - southwest

NIB total harvestable species richness - southeast

NIB total harvestable species richness - southwest

NIB waterfowl species richness - southeast

NIB waterfowl species richness - southwest

***Driver*** – The physical supply of water that lakes and ponds provide for food and fuel to support physical experiences are impacted by adjacent landscapes, water use, and climate change. For example, impervious surfaces can have a negative impact on the lake’s overall water quality because intensified rainfall produces runoff that may contain excess fertilizer and manure. These fertilizers can cause toxic algal blooms, which makes water from the reservoirs undesirable to use (Carpenter et al., 1998).

**Addenda Layer:**

**Layer without Citation:**

Percent impervious area

Value of cotton crops

Value of grain crops

***Demander*** - not applicable

**Addenda Layer:** not applicable

**Layer without Citation:** not applicable

**Sources:**

Bolen, E.G., Smith, L.M., and Schramm, H.L. Jr. (1989) Playa Lakes: Prairie Wetlands of the Southern High Plains. *BioScience, 39*(9), 615-623. DOI: 10.2307/1311091. [abstract only]

Carpenter, S.R. et al. (1998) Nonpoint Pollution of Surface Waters With Phosphorous and Nitrogen. *Ecological Applications, 8*(3), 559-568. DOI: 10.1890/1051-0761(1998)008[0559:NPOSWW]2.0.CO;2.

Hayes, N.M. et al. (2017) Key differences between lakes and reservoirs modify climate signals: A case for a new conceptual model. *Limnology and Oceanography Letters, 2*(2), 47-62. DOI: 10.1002/lol2.10036.

Leibold, M.A. (1999) Biodiversity and nutrient enrichment in pond plankton communities. *Evolutionary Ecology Research, 1*, 73-95. DOI: 10.1038/srep02835.

Lynch, A.J. et al. (2016) The social, economic, and environmental importance of inland fish and fisheries. Environmental Reviews, 24(2), 115-121. <https://doi.org/10.1139/er-2015-0064>.

MacDonald, G.M. (2010) Water, climate change, and sustainability in the southwest. *PNAS, 107*(50), 21256-21262.

Patz, J.A. et al. (2008) Climate Change and Waterborne Disease Risk in the Great Lakes Region of the U.S. *American Journal of Preventive Medicine, 35*(5), 451-458. DOI: <https://doi.org/10.1016/j.amepre.2008.08.026>.

Thiebaut, G. (2008) Phosphorous and aquatic plants. In: White, P.J., Hammond, J.P. (Eds) The Ecophysiology of Plant-Phosphorous Interactions. Plant Ecophysiology, vol 7. (31-49) <https://doi.org/10.1007/978-1-4020-8435-5_3>. [abstract only]

Tidwell, V. and Moreland, B. (2011) *Energy and Water in the Great Lakes.* Prepared for the Great Lakes Commission by Sandia National Laboratories. Albuquerque, New Mexico.

Tobin, P. (2007) The social and cultural experiences of food security in the Takla Lake First Nation: Informing public health. [Unpublished dissertation] University of Northern British Columbia. DOI: https://doi.org/10.24124/2007/bpgub489.