Science of Watershed Health

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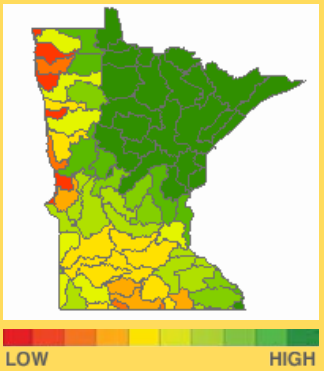
CONNECTIVITY Riparian Connectivity

How much undeveloped riparian area is there in each watershed?

Why is this important for connectivity?

Undeveloped land adjacent to streams, rivers and lakes (riparian land) helps reduce the delivery of runoff and pollutants to water bodies. If covered with trees, shrubs, and perennial grasses, the riparian area trap pollutants from overland flow, incorporate nitrogen from shallow groundwater, provide shade and reduce or mitigate stream temperature (Daniels and Gilliam, 1996, Lee et al. 2003, Mayer et al. 2005).

Land next to water bodies also provides important habitat corridors for plants and animals. The riparian zone is particularly important in areas of the state where the upland areas have been converted to development, agricultural or industrial uses, often providing the only remaining semi-intact mosaic of natural habitat.



Click map to enlarge and explore Watershed Health Assessments.

In addition to habitat value, an accessible floodplain allows streams and waterbodies to move laterally during times of high flows. An episodic exchange between the stream or lake and its floodplain replenishes the system and dissipates energy from high water events.

CREATING THE INDEX	INDEX RESULTS	SUPPORTING SCIENCE	NEXT STEPS
Input Data Calculating the index Ranking and scoring	Overview of results Interpreting the results Relationship to other health components	Scientific literature support Confidence in index	Future enhancements

Why is this important for connectivity (more detail)?

Perennial riparian vegetation increases allochthonous inputs (external sources, such as leaves, plants and soil), aquatic productivity, and aquatic organism abundance and diversity. Water bodies are more likely to serve as population source areas rather than sinks when bordered by perennial vegetation (Naiman et al., 1993). Riparian vegetation provides important habitat for aquatic, amphibian, and terrestrial organisms, and provides migration corridors for terrestrial organisms.

Many landscapes have been fragmented by agricultural and urban land uses and timber harvesting. Riparian areas associated with streams and lakes often provide important narrow, linear linkages between remaining terrestrial habitats. These riparian networks form corridors, which connect otherwise isolated patches of suitable habitat. The amount of human use in riparian areas varies greatly and may be limited by flooding, wet soils and steep terrain. These corridors have been shown to harbor a wider range of species (Sabo et al., 2005), aid dispersal (Naiman et al., 1993) and facilitate gene flow among otherwise isolated populations (Vignieri, 2005). This index represents the amount and connectivity of non-developed land cover in riparian areas.

Calculating the index

A 200-meter (660 ft) buffer was created around perennial ditches and streams using 1:24,000 scale MN DNR Streams data. The 200-meter buffer was combined with 100 and 500-year Federal Emergency Management Agency (FEMA) designated floodplain and the maximum extent of the combined data layers was designated as “riparian area”. Land cover within the riparian area was calculated using the National Agricultural Statistical Service (NASS) land cover data.

Watershed Scale

The percent agricultural and developed land relative to the total riparian area was calculated and scored. Scores range from 0 (all lands within 200 meters of streams or in floodplains are in annual cropland or urban cover) to 100 (all lands are neither urban nor annual agriculture). This value was created for the riparian land within each major watershed.

Catchment Scale

The same approach was applied to calculate a value for the amount of undeveloped riparian land within each DNR Catchment.

Ranking and scoring

The combined value for the percent of riparian land in agricultural or developed land use was scored in equal intervals from 0-100.

Overview of results

The inputs were combined before scoring; therefore, the range of results from 11 to 100 reflects a riparian zone that was 0 to 89% in agricultural or developed land uses.

Interpretation of results

Scores ranged from 11 to 100 for watersheds across the state, with lowest scores in the agricultural south central and northwest. The highly developed Twin Cities metropolitan area had moderate scores. The highest scores were found in the northern and eastern portions of the state. Values in southeastern and southwestern watersheds reflect forest, woodlots, or grasslands associated with perennial vegetation on steeper slopes.

The catchment level results reveal important patterns within major watersheds, particularly those watersheds with mid-range health scores. In almost all cases, mid-range scores result from averaging a range of conditions from high scores, often ranging from very to very low. The pattern of intact to intensely used of riparian land is very important for identifying areas that provide biologic and hydrologic access to important habitats and land area. Unimpeded access to riparian lands provide services such as land for seasonal flooding, habitat replenishment and refugia for many species.

Relationship to other health components

Water quality

Riparian connectivity is directly related to water quality over much of the state, as sediment, nutrients, pollutants, and temperature are reduced by perennial riparian vegetation and wetlands.

Hydrology

The access of water bodies to an undeveloped vegetated riparian area allows for flooding to occur without damaging structures or eroding exposed soils. A well connected riparian area could provide more balance and stability of the hydrologic system, which would reduce high and low discharge extremes.

Geomorphology

Riparian connectivity can influence geomorphology by altering runoff and sediment delivery. Streambanks are stabilized by grass, shrubs, and trees, although with different effectiveness depending on the history, type, and duration of these vegetation types. Streams with forest riparian areas are characterized by higher frequencies of large coarse woody debris, such as trees or logs, which alter flow paths, the configuration of riffles and pools in smaller streams, and the sinuosity (a measure of the “curviness” of streams; ditches have a sinuosity of 1).

Biology

Intact riparian areas are the foundation of diverse, productive aquatic ecosystems. Riparian areas moderate chemical and physical changes, which affect aquatic organisms. For example, sediment inputs are reduced by riparian vegetation, thus the streambed can support a greater diversity of fish and macroinvertebrates. In addition, allochthonous inputs are higher at high levels of riparian connectivity, which contributes to diverse food webs.

Scientific literature support

There is an extensive scientific literature indicating the importance of vegetated riparian buffers relative the hydrological, geomorphic, biological function of streams. Studies have documented the extent, mechanism, and variation in impacts of riparian vegetation globally, in the U.S., and within

Minnesota and adjacent states (e.g., Johnston et al., 1997; Sovell et al., 2000; Blann et al., 2002; Bharati et al., 2002). A connected riparian buffer has been documented as beneficial to stream quality (e.g., Jones et al., 1999), and facilitates migration and maintenance of sustained populations in the face of disturbance for both aquatic and terrestrial biota.

When agricultural land is compared with areas of perennial vegetation, surface runoff from tilled land may produce 100 times more sediment than from vegetation-covered land (Verry 1986), and nitrate and other nutrient loadings, sediment delivery, bank erosion, increased in proportion to perennial vegetation in the perennial buffer (Jones et al., 2001; Staton et al., 2003; Townsend et al., 2004; Boody et al., 2005; Haase et al. 2008; Young and Briggs, 2008). Jones et al. (1999) have found that the length, or connectedness, of riparian buffer is important, in addition to the width, as fish diversity was greatest along longer stretches of intact riparian woody vegetation. In addition, deforestation, urbanization, and agriculture result in decreased dissolved oxygen (DO) levels from organic pollutant inputs and stormwater runoff (Annear et al. 2004). The reduction of DO significantly affects aquatic organisms, for example low DO can affect fish growth and may lead to an increase in tolerant species.

Confidence in index

The input data for the index were of generally high quality, which were recently produced landcover (NASS from 2008), the highest quality of generally available hydrography data, and recently updated floodplain information.

Future enhancements

These indices are based primarily on three data sets – landcover, streams, and floodplains. Landcover data are updated regularly, and are accurate for annual crops via the NASS program. However, urban land uses are based on the almost decade-old National Land Cover Data (NLCD) and the Multi-Resolution Land Cover Consortium (MRLC) with low resolution (56 meter or approximately 200-foot cell sizes). These NLCD/MRLC data could be substantially improved, particularly in a more recent, verified urban landcover classification, which includes small urban features.

Stream data are the best currently available, but do not include complete stream networks, with higher rates of omission for lower-order streams and ditches. Future indices should be re-computed as a more complete stream network data become available, but the results should be analyzed to isolate changes in riparian land use from changes due to an improved stream network data.

Not all counties have FEMA floodplain maps available, and those that do may not have up-to-date delineations. This inconsistency in floodplain mapping affects areas where unmapped floodplains would expand the total area considered “riparian” for this analysis. New FEMA floodplain maps should be added as they become available.

Finally, current floodplain maps are based on a combination of 10-meter digital elevation data, aerial photographs, and prior floodplain maps. Statewide LiDAR data, which should be available in the near future, should allow a more accurate delineation of floodplain zones.