Category: Water Quality
Indicator: Vulnerability to Ecological Impacts From Land Uses

Methodology

Vulnerability to Ecological Impacts From Land Uses is an indicator of the potential for impacts by land uses such as agriculture and urbanization on water quality, hydrology and other aquatic ecosystem attributes.

We calculated this indicator by assessing the amount of different types of land cover in the watersheds and riparian buffers of Texas rivers and streams. This indicator evaluates three types of land use changes: general conversion of natural vegetation in watersheds and riparian buffers, urban and suburban development and conversion of lands to row crop agriculture. These land use changes have been documented to affect many attributes of aquatic ecosystems and water resources including water quality, hydrologic regime, aquatic and riparian habitat quality, invasive species introductions and stream network intactness. We structured this indicator to provide a picture of the overall degree of risk of changes to ecosystem attributes from these land use changes.

This indicator has 3 sub-indicators: Land Conversion (in both watershed and riparian buffers), Urban Growth and Agriculture.

Land Conversion

Land Conversion is an assessment of the degree to which natural vegetation has been converted into anthropogenic land uses. We assessed this in both the upstream watershed and riparian buffer for every stream in Texas.

Watershed

To derive the measure of natural land uses in the upstream watershed, we used the human impact data developed by the National Fish Habitat Partnership (NFHP). The NFHP calculated the percent of local and upstream network watershed area in each of the land use classes in the 2001 National Land Cover Database. To assess Land Conversion in the watershed we summed the percent of all "natural" NLCD land cover classes as an estimate of the percent of unconverted lands. This included 2001 NLCD classes 11, 12, 41, 42, 43, 52, 71, 90 and 95. To map this metric we divided the range of values into five equal sized bins of 0-20, 20-40, 40-60, 60-80, and >80% natural cover.

Riparian

To evaluate the degree of land conversion in the riparian zone of Texas rivers, we first developed a GIS layer of riparian buffers from medium resolution NHDPlus. The width of buffers differed according to five size classes of rivers as described in Table 1.

Table 1. Stream size classes and corresponding buffer widths to be used in analyses.

Size class	Watershed area	Buffer width
Headwater	<200 km^2	30m
Creek	200-700 km^2	60m
Small river	700-3,000 km^2	60m
Medium river	3,000-10,000 km^2	90m
Large river	>10,000 km^2	90m

We used Tabulate Areas in ArcGIS to determine amount of each 2001 NLCD land use category in each river buffer and then calculated the percent of the buffers in the same "natural" land cover classes as listed above in the watershed analysis. In the maps, we display the buffers according to the same bins as the watershed metric.

Urban Growth

To derive the measure of Urban Growth, we also used the human impact data on land uses in the upstream watershed developed by NFHP. To assess Urban Growth in the watershed we derived an estimate of the percent of impervious land in the watershed. This was done using the estimates of the percent of impervious land in each of the urban and suburban development NLCD land cover classes. We multiplies this proportion times the percent of each of these land use classes in the watershed and then summed them as an overall estimate of the percent of impervious surface. This included 2001 NLCD classes 21, 22, 23, 24 and 31. To map this metric we divided the range of values into five bins of 0-1.5, 1.5-3, 3-10, 10-30, and >30% natural cover. These breaks were based on general literature consensus on thresholds in conversion of land to impervious surfaces that correspond to increasing impacts on biological integrity and water quality.

Agriculture

To derive the measure of Agriculture, we also used the human impact data on land uses in the upstream watershed developed by NFHP. To assess Agriculture in the watershed we used the percent the upstream watershed in 2001 NLCD class 82 (Cultivated Crops). We did not use class 81 (Pasture/Hay) because this class tends to not be accurately differentiated in all places from natural classes such as 71 (Grassland/Herbaceous). To map this metric we divided the range of values into five bins of 0, 0-5, 5-15, 15-50, and >50% natural cover. These breaks were based on general literature consensus on thresholds in conversion of land to impervious surfaces that correspond to increasing impacts on biological integrity and water quality.

Data Sources

National Fish Habitat Board. 2010. Through a Fish's Eye: The Status of Fish Habitats in the United States 2010. NFHAP. Association of Fish and Wildlife Agencies. Washington, DC. 68p.
http://assessment.fishhabitat.org/
HCI Scores and Human Disturbance Data (linked to NHDPLUSV1) for Texas.
http://ecosystems.usgs.gov/fishhabitat/

National Hydrography Dataset Plus (NHDPlus) Version 1. Medium-resolution 1:100,000.
http://www.horizon-systems.com/NHDPlus/NHDPlusV1_data.php

The Nature Conservancy. Riparian buffers developed from NHDPlus.

Multi-Resolution Land Characteristics Consortium. 2001 National Land Cover Database.
Scale/Resolution: 30 meter; Time Period: 2001.
http://www.mrlc.gov