NATURAL RESOURCE NAVIGATOR

Charting a Smart Future for a Changing Climate

DATA DOCUMENTATION

V 1.3

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CONTENTS

INTRODUCTION

This document contains the metadata and documentation for data included as part of the Natural Resource Navigator Map Tool, an on-line, interactive decision support and mapping tool designed to help natural resource managers make climate smart decisions to sustain natural resources. The metadata are organized by sections and map layer name to match the structure of the Map Tool. Complete methods are provided for original data generated or processed for use in the Map Tool. These data will be made available for download from the Natural Resource Navigator (www.naturalresourcenavigator.org). Third-party data, whether displayed without alteration or used as source data in analyses, are cited in the relevant sections below. Sources for documentation and acquisition of third-party data are provided whenever possible.

Standard Restrictions

Unless otherwise specified for a particular dataset, the following standard restrictions and limitations apply to all data provided as part of the Navigator Map Tool:

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Use limitations

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Data Set Credit

The following citation may be used for all uses of data downloaded or accessed from the Natural Resource Navigator. The database may be referenced as a whole, or individual datasets may be specified by inserting the layer name

The Nature Conservancy. 2016. ["*Layer Name*"]. Natural Resource Navigator Map Tool. www.naturalresourcenavigator.org. Albany, NY. Accessed [*Date*].

BOUNDARIES & REFERENCE

NY Boundaries-State, Counties, Cities and Towns

Summary

New York State boundary, county boundaries, and city and town boundaries. Accessed in 2015 from http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=927.

Description

Vector polygon GIS files of the state boundary, county boundaries, and all city and town boundaries in New York State. The file was originally a compilation of U.S. Geological Survey 1:100,000-scale digital vector files and NYS Department of Transportation 1:24,000-scale and 1:75,000-scale digital vector files. Boundaries were revised to 1:24,000-scale positional accuracy and selectively updated based on municipal boundary reviews, court decisions and NYS Department of State Local Law filings for annexations, dissolutions, or incorporations. Currently, boundary changes are made based on NYS Department of State Local Law filings (http://locallaws.dos.ny.gov/). Additional updates and corrections are made as needed in partnership with municipalities.

Credits

NYS Office of Information Technology Services GIS Program Office (GPO). http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=927

Use limitations

GIS DATA IS PROVIDED AS IS AND WITHOUT ANY WARRANTY, EXPRESS OR IMPLIED, AS TO THEIR PERFORMANCE, MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE. The GPO, NYS Department of State, and municipalities do NOT represent or warrant that the GIS data or the data documentation provided are error-free, complete, current, or accurate.

Extended Freshwater Study Region

Summary

This project boundary was used to define the extent of our freshwater analyses, and is the same as the study area used for the NY Natural Heritage Program's Freshwater Blueprint, which included the entire area of all Ecological Drainage Units that intersect New York State. For complete methodology see the report from the NY Natural Heritage Program's Freshwater Blueprint (http://nynhp.org/FBP).

Citation

White, E.L., J.J. Schmid, T.G. Howard, M.D. Schlesinger, and A.L. Feldmann. 2011. New York State freshwater conservation blueprint project, phases I and II: Freshwater systems, species, and viability metrics. New York Natural Heritage Program, The Nature Conservancy. Albany, NY.

Hydrologic Units

Summary

USGS Hydrologic Units (12-digit). The United States is divided and sub-divided into successively smaller hydrologic units which are classified into four levels: regions, sub-regions, accounting units, and cataloging units. A cataloging unit is a geographic area representing part of all of a surface drainage basin, a combination of drainage basins, or a distinct hydrologic feature. Cataloging Units sometimes are called watersheds. For complete methodology and to download the original data, see https://water.usgs.gov/GIS/huc.html

Attributes

The following attributes were added to allow for easier raster zonal calculations and also are used in the stream crosswalk data:

HUC_12d: HUC12 as an 11 digit number (dropping leading zero).

Hzone: short unique 4-digit ID number for each HUC12.

allpix: count of 30 x 30 m. pixels that make up the HUC12 (grid aligned and snapped to hybrid LULC raster).

rast_area_km2: area in sq. km. of the rasterized version of the HUC12.

Citation

Coordinated effort between the United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS), the United States Geological Survey (USGS), and the Environmental Protection Agency (EPA). The Watershed Boundary Dataset (WBD) was created from a variety of sources from each state and aggregated into a standard national layer for use in strategic planning and accountability. Watershed Boundary Dataset for NY, URL: "http://datagateway.nrcs.usda.gov"

Catchments

Summary

Catchments (NHDPlusV2). A catchment is the surface area contributing drainage directly to a given reach. See metadata at http://www.horizon-systems.com/NHDPlus/NHDPlusV2_documentation.php. Download from: http://www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php

Attributes

The following attributes were added to allow for easier raster zonal calculations and also are used in the stream crosswalk data:

Region: NHD hydrologic region: NE (New England, HUC2 = 01), MA (Mid Atlantic, HUC2 = 02), GL (Great Lakes, HUC2 = 04), MS (Mississippi, HUC2 = 05).

Hzone: short unique 4-digit ID number for each HUC12.

Catone: short unique 4-digit ID number for each catchment.

Citation

McKay, L., Bondelid, T., Dewald, T., Johnston, J., Moore, R., and Rea, A., "NHDPlus Version 2: User Guide", 2012. ftp://ec2-54-227-241-43.compute-1.amazonaws.com/NHDplus/NHDPlusV21/Documentation/NHDPlusV2_User_Guide.pdf

Terrestrial Hexagon Grid

Summary

Space-filling hexagonal grid used for summarizing some terrestrial and species data layers. Each hexagon is 216.5 sq. km. (54,500 acre). Each hexagon has a unique ID ("hexzone").

Methods

The hexagon grid was created using the Create Hexagon Tesselation Geoprocessing Package in ArcGIS 10.2, which was created by Tim Whiteaker at The University of Texas at Austin.

Lakes

Summary

Lakes include those lakes, ponds, and reservoirs within the extended freshwater study region, for reference use. It is a composite dataset that includes the lakes and ponds that were classified as part of the Northeast Lake and Pond Classification (NLPC) as revised by The Nature Conservancy in January of 2016, plus those waterbodies coded as lakes, ponds, or reservoirs in the USGS NHDPlusV2 datasets but not included in the NLPC data, as well as Lakes Erie, Ontario, and Champlain.

Methods

The Northeast Lake and Pond Classification (NLPC) dataset was clipped to the study area, the "LakePond" and "Reservoir" feature types were extracted from the NHDPlusV2 dataset and manually selected and added if they did not overlap with the NLPC data, as were the Great Lakes and the Canadian portion of Lake Champlain. All NLPC class attributes were set to null for features that were not a part of that analysis, and the lake/pond class and a new binary NEassess[ment] attribute were coded so as to easily distinguish the NLPC data from that which was added. A visual comparison of the added features with the latest aerial imagery showed that while some of these "not included" features may have been falsely classified in the NHDPlusV2 as "LakePond" instead of wetlands, many did in fact coincide with visible areas of open water.

Attributes

GNIS_NAME: name of lake, pond, or reservoir

CL_4_TYPE: full four-variable classification for the water body. "unclassifiable" if included in the NLPC data but not classified; <null> if not included in the NLPC data.

LK_PD_CL: “Lake” or “Pond” as classified in the NLPC; “LkPd”, “Rsrv”, or “GrLk” if not.

NEassess: 1 if in the source NLPC dataset, 0 if not included.

Other original NLPC attributes are described in the NLPC report: https://easterndivision.s3.amazonaws.com/Freshwater/Lakes/Northeast%20Lake%20and%20Pond%20Classification.pdf.

Citation

Olivero-Sheldon, A. and M.G. Anderson. 2016. Northeast Lake and Pond Classification. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

Rivers and Streams

Summary

Rivers and streams include the stream centerlines of all river and streams from the USGS NHDPlus V2 Hydrography/NHDFlowline dataset within our freshwater study region boundary that were coded as “StreamRiver”, “ArtificialPath” (for wider rivers, estuaries, and flow through lakes and reservoirs), “CanalDitch”, or “Connector” (assumed connection between upstream and downstream sections of a stream network). Coastlines, pipelines, and underground conduits are not included.

Methods

USGS NHDPlus V2 Hydrography/NHDFlowlines were clipped to the freshwater study region and all features coded as coastlines, pipelines, and underground conduits were dropped.

The NEAHC size class of the stream reach and its description were added to the reach as described in the NHDPlus V1 to V2 crosswalk methodology (see “NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk” described in the “Additional Facilitating Layers” section at the end of this document). For V2 streams not assigned a V1 COMID by the crosswalk, typically new added stream segments where no V1 streams were before, Thiessen polygons surrounding areas of each catchment closest to each V1 stream were used to assign the V1 NEAHC size class to the landscape. Non-stream raster cells (30 m.) were set to nodata, and the majority size class value of the stream cells within each V2 catchment was assigned to the V2 catchment and then to the V2 stream reaches within the catchment. The result was visually inspected and corrected if the assigned size class was inconsistent with those of surrounding streams with similar stream orders.

NESZCL: The NEAHC size class	Drainage area
Size 1 Headwaters and Creeks	<38.61 sq. mi
1a Headwaters	<3.861 sq. mi
1b Creeks	>= 3.861, <38.61 sq. mi.
Size 2 Small Rivers	>= 38.61, < 200 sq. mi.
Size 3 Medium Rivers	>= 200, < 3861 sq. mi.
3a Medium Tributary Rivers	>= 200, <1000 sq. mi.
3b Medium Main Stem Rivers	>=1000, <3861 sq. mi.
Size 4 Large Rivers	>=3861, <9653 sq. mi.
Size 5 Great Rivers	>= 9653 sq. mi.

Attributes

V2COMID: the NHDPlus Version2 COMID unique identifier for each stream reach (segment).

BATNETID: the functional network ID from the Anderson et al. (2013) Northeast Freshwater Resilience Analysis report giving the ID of the network to which each sub-reach segment belongs. Negative BATNETIDs represent new networks not included in the original Anderson et al. analysis (in drainages below their threshold drainage area size or for stream reaches new to the NHDPlus V2 dataset that do not connect to existing networks or only do so where a dam crossing is required).

LAKE_FLAG: a binary flag (1=yes, 0=no) for if the reach or subreach represents an artificial flowline through a freshwater lake, pond, or reservoir as opposed to representing the centerline of a moving stream, river, or estuary. Data from the Northeast Freshwater Resilience Analysis report (Anderson et al. 2013).

FCN_V1COMID: the matching NHDPlus Version1 COMID unique identifier, derived from the COMID of reaches in the the Northeast Freshwater Resilience Analysis report (Anderson et al. 2013).

V2FCN_ID: the new unique ID for each stream reach or subreach segment assigned after all splitting of V2 segments at dam points has occurred and subsequently COMID is no longer unique. This is the new unique Identifier for the dataset.

V2CATZONE: the unique ID for the V2 catchment within which the reach falls, as described in the "NRN_Catchments" data layer.

NAHCS_V1COMID: the matching NHDPlus Version1 COMID from the Northeast Aquatic Habitat Condition Assessment (NEAHC) dataset. -9999 for V2 reaches with no matching V1 segments.

GNIS_NAME: USGS GNIS name of the water feature, from the NHDPlus Version2 data.

NESZCL: The Northeast Aquatic Habitat Condition Assessment (NEAHC) size class of the stream reach, as described in the NHDPlus V1 to V2 crosswalk methodology in the final NRN Metadata document and "Reference\Rivers and Streams" layer. Stream size is based on the stream's drainage area. Only the primary five main size classes are recorded, not the 1ab and 3ab subdivisions.

NESZCL_neahc: The original Northeast Aquatic Habitat Condition Assessment (NEAHC) size class of the stream reach including ab subdivisions.

D_NESZCL: Descriptive label from the original Northeast Aquatic Habitat Condition Assessment (NEAHC) size class of the stream reach. Value is blank or null when there was not a 1:1 crosswalk equivalent, as the ab subdivisions were not used.

Citation

Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/GeoCondition

PROTECTION

Protected Lands

Summary

Protected Lands include public land ownership or voluntarily provided private conservation lands that offer a degree of permanent protection and are managed, at least in part, to preserve biological diversity and to other natural, recreational and cultural uses. Only protected lands of GAP Status 1-3 are included; not included are lands of GAP Status 4 (lands with unknown management intents or without mandates or legal structures in place that would prevent conversion of natural habitat types to anthropogenic habitat types).

Methods

The protected land database composite was created in 2013 for this project. The protected lands were identified using a combination of public and internal data on lands under federal, state, or other public ownership, lands owned in fee by conservation organizations, and private lands under conservation easement. To create this database we enhanced the publicly available TNC Secured Land Database with the New York Protected Areas Database (NYPAD). This dataset divides secure lands to 5 GAP statuses. GAP 1 and 2 land was mostly designated as state land or nature reserve. GAP 3 lands have more land designated state forest, or conservation easements on private land. Gap 4 lands are holdings that do not meet the IUCN (International Union for Conservation of Nature) definition of protected lands and GAP 39 refer to Agricultural Easements.

Description of GAP status Codes (Source: USGS and TNC):

GAP Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, intensity, and legacy) are allowed to proceed without interference or are mimicked through management.

GAP Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities, including suppression of natural disturbance.

GAP Status 3: Area having permanent protection from conversion of natural land cover for the majority of area. Subject to extractive uses of either broad, low-intensity type (eg. Logging) or localized intense type (eg. Mining). Confers protection to federally listed endangered and threatened species throughout the area.

GAP Status 4: No known public/private institutional manadates/legally recognized easements. Holdings that do not meet the IUCN definition of a protected area or are not GAP Status 1 or 2.

Gap Status 39: Agricultural Easement

Restrictions

While the protected lands layer used is the most comprehensive known to exist for NYS, there may be protected lands not included if the fee owner or easement holder is not known to DEC or TNC, or has chosen to withhold data. Protected land boundaries are based on parcel data provided by municipalities and may not have been verified by field survey. GAP status assignments are based on the best available knowledge and general principles, and may not reflect the specific management practices or legal constraints on a given parcel.

Citation

TNC Secured Land Database: The Nature Conservancy. 2009. Eastern U.S. Secured Lands. Various scales. Compiled from multiple sources. http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/secured/Pages/default.aspx

New York Protected Areas Database: New York State Department of Conservation. 2013. New York Protected Areas Database (NYPAD) version 1.0. http://nypad.org/Download

Matrix Forest Block Protection

Summary

For this analysis we examined the levels of protection for Matrix Forest Blocks (MFB). These matrix occurrences represent the viable matrix forest occurrences in NY. Matrix sites are large contiguous areas whose size and natural condition allow for the maintenance of ecological processes, viable occurrences of matrix forest communities, embedded large and small patch communities, and embedded species populations. The goal of the matrix forest selection was to identify viable examples of the dominant forest types that, if protected and allowed to regain their natural condition, would serve as critical source areas for all species requiring interior forest conditions or associated with the dominant forest types. Only forest blocks falling at least partially in NY are shown.

Methods

This analysis is based on matrix forest blocks as defined by The Nature Conservancy. Regional forest blocks may be downloaded from http://easterndivision.s3.amazonaws.com/Terrestrial/distribute_matrix.zip

Matrix occurrences are bounded by features from the 1:100k US Census Bureau's TIGER line dataset such as roads, railroads, major utility lines, and major shorelines. The bounding block feature types were chosen due to their ecological impact on biodiversity in terms of fragmentation, dispersion, edge-effects, and invasion of alien species. Minimum size thresholds for block size vary by ecoregion from 10,000-25,000 acres.

Background on the principles used for defining matrix forest blocks can be found here:
Anderson M.G. 2008. Conserving Forest Ecosystems: Guidelines for Size, Condition and Landscape Requirements. In Askins, R.A. (ed) Saving Biological Diversity: Balancing Protection of Endangered Species and Ecosystems. Springer-Verlag. Pp 119 - 136.
http://books.google.com/books?hl=en&lr=&id=UThZO4TUf44C&oi=fnd&pg=PA1&dq=Saving+Biological+Diversity:+Balancing+Protection+of+Endangered+Species+and+Ecosystems&ots=Xvdz_TVLpa&sig=GARddsdNfK46VELDNHaBuSza4BQ#v=onepage&q=anderson&f=false

The protection analysis was restricted to those blocks occurring partly or wholly within NYS. We calculated proportion of the block in protected lands (GAP Status 1-4 and 39) using Tabulate intersection, based on our 2013 protected lands composite data (see above).

Attributes

NAME name of matrix block

ECOREG ecoregion block is primarily within

ELU_GRP ELU stratification group within ecoregion

ELUGRP_TXT description of ELU group

Percent_Protected: the area of GAP Status Protection 1-4 +39 divided by Matrix Area

Shape_Area: Area of forest block in square meters

Limitations

Block boundaries are defined based on assumptions about the fragmenting effects of road features and so may not reflect true ecological boundaries. The interior of blocks may be fragmented by features not included in the roads dataset used. Thresholds for minimum block size are based on theoretical thresholds of ecological function, habitat requirements, and disturbance regimes. Large unfragmented blocks not included in this dataset may still provide valuable wildlife habitat and functions.

Riparian Percent Protected

Summary

Percent of the 100m riparian buffer that is protected (in GAP 1, 2, or 3 land), based on The Nature Conservancy's 2011 Protected Lands Dataset. This may underestimate the current level of protection--examine the Protected Lands dataset for a more up-to-date picture of protected lands. Note that only perennial streams and rivers with catchments of one square mile or larger as mapped in the NHD Plus 1:100,000 Version 1 dataset were included in this analysis because smaller streams were too inconsistently mapped, and the analysis was conducted before the release of NHD Plus Version 2.

This dataset is provided by a third party and has been unaltered for this project. For complete methodology and to download the original data, please see: http://nature.ly/GeoCondition

Citation

Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

SYNTHESIS AND PRIORITIZATIONS

TNC Terrestrial Resilience Analysis Prioritized Network & Entire

Summary

These layers are from the Resilient & Connected Landscapes data set from The Nature Conservancy, Eastern Conservation Science, and the documentation below that follows is copied from the original metadata: The climate is changing, and nature is in flux. Plants and animals must relocate to survive. How do we ensure that the North American landscape will continue to support its iconic wildlife and vast botanical diversity? That nature will continue to provide the wealth of materials, food, medicines and clean water we depend on?

The Nature Conservancy's first-of-its-kind study maps climate-resilient sites, confirmed biodiversity locations, and species movement areas (zones and corridors) across Eastern North America. The study uses the information to prioritize a conservation portfolio that naturally aligns these features into a network of resilient sites integrated with the species movement zones, and thus a blueprint for conservation that represents all habitats while allowing nature to adapt and change.

Methods

Our method to identifying Resilient and Connected Landscapes sites had several steps:

First, we started with the map of resilient sites (see resilient sites website for more information, maps, and data https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/resilientland/Pages/default.aspx)

Next, we mapped areas that were critical flow zones and narrow climate corridors.

Next, we mapped areas resilient areas that had confirmed rare species, exemplary natural communities, and representative geophysical settings.

Finally, we combined these datasets to prioritize a subset of resilient sites using criteria based on flow and diversity, and then to identify critical between-site linkages that both connected essential features and corresponded to areas of concentrated flow.

The results of this assessment may inform a variety of conservation strategies aimed at influencing decisions or maximizing the natural benefits and services provided by nature while simultaneously sustaining its diversity and resilience.

If you have questions the full report is at "Resilient and Connected Landscapes for Terrestrial Conservation" http://nature.ly/TNCResilience

Attributes

Simple Legend 5 Classes: The field for the simplest of the legends. Resilient Area: places buffered from climate change because they contain many connected micro-climates that create climate options for Species. Flow: the movement of species populations over time in response to climate. Flow tends to concentrate in the zones and corridors described below. Climate Corridor: narrow zone of highly concentrated flow, often riparian corridors or ridgelines. Climate Flow Zone: broad areas of high flow that is less concentrated than in the corridors. Typically intact forested regions. Confirmed Diversity: known locations of rare species or unique communities based on ground inventory. Unconfirmed areas may contain the same species.

Simple Legend 6: The field for the legend that adds Climate Corridors with Confirmed Diversity. Resilient Area: places buffered from climate change because they contain many connected micro-climates that create climate options for species. Flow: the movement of species populations over time in response to climate. Flow tends to concentrate in the zones and corridors described below. Climate Corridor: narrow zone of highly concentrated flow, often riparian corridors or ridgelines. Climate Flow Zone: broad areas of high flow that is less concentrated than in the corridors. Typically intact forested regions. Confirmed Diversity: known locations of rare species or unique communities based on ground inventory. Unconfirmed areas may contain the same species.

Prioritized Network: The Prioritized Network is a subset of the resilient and connected networks. It includes resilient only areas that are secured, resilient areas with confirmed biodiversity, climate flow zones, climate flow zones with diversity, climate corridors, and climate corridors with diversity.

Full Description: This is the legend that has all of the detail of the different rows. This field is mainly for Eastern Division Staff to keep track of processing components, but it may be helpful for other external uses as well.

Credits

Eastern Conservation Science, The Nature Conservancy. December 2016

Use limitations

There are no access and use limitations for this item.

TNC Terrestrial Resilience Analysis (Entire)

STREAMS

Streams: Current Condition\Streams Condition Score

Summary

Stream Condition is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for stream condition were flow alteration, floodplain connectivity, functioning floodplain, impervious cover, road-stream crossings, and water quality impairment. Input data were generated at multiple scales, including stream networks, catchments, and floodplains, but were all applied to reaches in the NHD v2+ stream lines. Summary scores were calculated by reach, and are best interpreted as general trends across a project area. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of stream condition, based on available evidence and expert opinion. Input indicators used for stream condition were flow alteration, floodplain connectivity, functioning floodplain, impervious cover, road-stream crossings, and water quality impairment. These indicators directly or indirectly measure the degree of human modification of the system, which alters conditions beyond a range of naturally occurring variation. Natural systems with high condition are expected to be more diverse and productive, with greater ability to sustain function over time without intervention. Indicators were also selected to be spatially uncorrelated, in order to avoid biasing the final index by 'double-counting' multiple indicators that are driven by common factors.

The selected indicators were each scored on a range of 0-100, where 100 indicates a natural or unaltered state, and 0 indicates complete loss of the system or its functional or structural attributes. In some cases, absolute thresholds for acceptable variation are not well-documented, so even breaks or quantiles were used for scoring, with an underlying assumption that the full range of conditions exists within the project area, and that the trait varies linearly with condition without critical thresholds. In all cases, higher scores indicate higher condition, not necessarily higher values of the indicator.

Each scored indicator was spatially attributed to the same base habitat dataset. For streams, the NHD+V2 stream segments were used as the unit of analysis. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each unit. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. Since some of the input variables are scored on a relative basis, and the data have varying spatial resolutions, the resulting score should only be used as a guide for planning and does not replace direct assessment of conditions on the ground. We encourage users to supplement or substitute this information with additional data and their own knowledge as appropriate.

Attributes

CSTR_Cscore_all: overall stream current condition score (0-100). 100 is good condition, 0 is poor condition.

Streams: Current Condition\SCORED Flow Alteration from Upstream Dam Water Storage

Summary

The data used in this analysis are from "Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set" (Anderson et al. 2013); text from these metadata are taken from that report:

In this dataset, the risk of flow alteration from dam water storage is expressed as the ratio of the volume of water capable of being stored behind dams upstream to the mean annual flow volume expected in a reach expressed as a percent. The authors created an index to measure the relative risk of flow alteration by dams for each connected stream network, by calculating how much of each river's (size 2 or greater) mean annual flow was potentially stored by upstream impoundments (Fitzhugh and Vogel 2010, Zimmerman 2006). This value, the total cumulative storage potential of all upstream impoundments, was simplified to place all river reaches into one of five risk classes: very low <2%, low 2-10%, moderate 10-30%, high 30-50%, severe 50%+ (derived from Zimmerman 2006).

Flow alteration is among the most serious threats to freshwater ecosystems. Natural, seasonal patterns of rising and falling water levels shape aquatic and riparian habitats, provide cues for migration and spawning, distribute seeds and foster their growth, and enable rivers, lakes, wetlands, and estuaries to function properly (Bunn and Arthington 2002, Poff et al. 1997). The need to allocate a portion of water to meet society's needs for water supply, crop production, energy generation, and flood management requires careful evaluation and integration of competing uses to ensure rivers and streams have hydrologic regimes adequate to support native fish and wildlife.

Although flows can be altered a variety of irrigation, interbasin transfer, and other management practices, dams are often responsible for a disproportionately large portion of all flow alteration in a basin. In particular, the storage capacity of dams has been found to be highly correlated with measures of overall hydrologic alteration (Graf 1999, Zimmerman 2006 a, b, c; Fitzhugh and Vogel 2010). Dams that can retain larger amounts of water are noted as agents of greater hydrologic alteration in the system. The ratio of dam water storage upstream of a reach to the mean annual flow volume expected in a reach has been used as a standardized metric to compare and classify rivers into categories of risk of hydrologic alteration in the absence of more detailed available site-specific flow measurements (Zimmerman 2006 a, b, c; Fitzhugh and Vogel 2010). Because different rivers can vary in the exact form of the relationship between dam storage and ecological condition (Figure 30), and because the inter- and intra-year timing of alteration in flows has an effect on ecological condition (Figure 31) the most appropriate use of this upstream dam water volume storage metric is as an indicator of the maximum potential level of alteration of flood flows, and by inference ecological condition, and also the range of possible levels of alteration (Fitzhugh and Vogel 2010).

Methods

From Anderson et al. (2013):

The maximum volume of water capable of being stored behind all dams upstream of a given reach was accumulated using the National Inventory of Dams (ACE 2010) and compared to the mean annual flow from the NHD Plus (USGS 2006).

The categories of maximum "Potential Risk of Flow Alteration from Upstream Dam Water Storage" used in this report are as follows (Zimmerman 2006) based on upstream storage volume of dams as a percent of mean annual flow volume:

Class 1: <2% Very low risk
Class 2: >= 2 < 10% Low risk
Class 3: >= 10 < 30% Moderate risk
Class 4: >= 30 < 50% High risk
Class 5: >= 50% Severe risk

Only perennial streams and rivers with catchments of one square mile or larger as mapped in the NHD Plus 1:100,000 Version 1 dataset were included in this analysis because smaller streams were too inconsistently mapped. Dam data for the Northeastern United States compiled from multiple state and federal sources by The Nature Conservancy and edited for use in the Northeast Aquatic Connectivity project (Martin and Apse 2011). This dataset was the result of a project to compile a dataset of dam barriers in the northeast states (ME, NH, VT, MA, CT, RI, NY, PA, NJ, DE, MD, VA, WV, DC) and spatially link the dams to the correct stream flowline in the USGS National Hydrography Plus (NHD-Plus) 1:100,000 stream dataset. A standardized method of dam snapping was used to updgrade the data (Marin and Apse 2011). Thirteen dams that were slated to be removed within the next 3 years were removed from the regional dam dataset to incorporate these upcoming changes. The Barrier Assessment Tool (TNC 2010) was used in ArcGIS 9.3 on the dams and 1:100,000 NHD Plus centerline dataset to facilitate creation of networks and several network metric calculations. One of the metric calculations was an accumulation of the dam storage attribute from the National Inventory of Dams (NID) dams that were in the regional dam database. Only National Inventory of Dams were used in the dam storage accumulation because of inconsistencies in how other smaller dams from state or other sources did or did not track the storage volume. The NID maximum dam storage attributes was chosen for accumulation, rather than the normal storage attribute, to better reflect the maximum potential for water storage in the system (Fitzhugh per comm.). For example, many flood control dams had a normal storage of zero but a very large maximum potential storage which would be used to hold back water during floods and we wanted to account for this potential to alter flow in the system. When a maximum dam storage value was not listed in the NID database, the normal storage or NID storage was substituted (whichever was larger). This accumulation of the dam storage upstream of every NHD Plus 1:100,000 reach was then divided by the mean annual flow volume for that reach (NHD Plus 2006) and this ratio converted to a percent. The mean annual flow was converted from cfs to acre-feet per with the conversion factor 723.97 before the division and percent calculations to ensure the same units were being compared.

Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/GeoCondition

For our analysis we used the field PMAFSTOR from the above dataset:

“PMAFSTOR: Percent of mean annual flow volume capable of being stored behind dams upstream. Based on accumulated maximum storage values (and/or when max was blank we used the largest of listed normal storage or NID storage value) for all dams above a given reach and the mean annual flow volume at the reach from the NHD Plus V1 unit runoff mean annual flow value.”

To facilitate the combining of indicators into a single condition metric, we crosswalked these data, developed on NHD Plus version 1, to NHD Plus version 2. See the detailed crosswalk methods associated with the “NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk” layer described in the “Additional Facilitating Layers” section at the end of this document. Version 1 segments were assigned a score based on the PMAFSTOR value in the original dataset. Small watersheds (<1 sq mi) left out of the original analysis and other segments new in NHDPlusV2 were mostly headwaters; the likelihood that there was a dam above these segments was low, so we gave them the maximum score of 100.

For use in the Habitat Explorer composite condition score, each stream segment was assigned a value between 0-100, according to the following chart. High score values indicate better condition. Thresholds used for symbolization and condition scoring are based on Zimmerman (2006).

Dam Storage (% mean annual flow volume potentially stored behind dams)	Score
Unassessed; small watersheds	100*
Unassessed; segments new in NHDPlusV2	100**
>50	0
30-50	20
10-30	50
2-10	80
<2	100

*Unassessed; small watersheds (<1 sq mi) left out of the original Anderson et al. 2013 analysis because they were inconsistently mapped across the region. Since these were mostly headwaters, the likelihood that there was a dam above the segments was low, so we gave it the maximum score.
**Stream segments that did not exist in the original dataset because it was based on NHD Plus Version 1. Since these were mostly headwaters, the likelihood that there was a dam above the segments was low, so we gave it the maximum score.

Attributes

SRC_COMID: COMID from the source data (Anderson et al. 2013), which was matched to the V2 stream reaches based on the crosswalked NAHCS_V1COMID atribute.

PMAFSTOR: Percent of mean annual flow volume capable of being stored behind dams upstream. Based on accumulated maximum storage values (and/or when max was blank we used the largest of listed normal storage or NID storage value) for all dams above a given reach and the mean annual flow volume at the reach from the NHD Plus V1 unit runoff mean annual flow value.

CSTR_DAMSTOR_score: Flow alteration by upstream dam water storage score, based on PMAFSTOR.

CSTR_DAMSTOR_label: Descriptive label for the dam storage.

Streams: Current Condition\SCORED Floodplain Connectivity

Summary

This indicator is a measure of the percentage of the Active River Area with contiguous natural land cover that is adjacent to the stream channel. In size 2 and larger rivers, these areas could provide for connectivity between overbank flows and floodplains therefore providing flood attenuation benefits. For headwater streams and larger, these could also represent forested, shrub or otherwise vegetated riparian buffers which could offer water purification benefits.

Methods

This analysis uses the Active River Area, which is based upon dominant processes and disturbance regimes to identify areas within which important physical and ecological processes of the river or stream occur. The framework identifies five key subcomponents of the active river area: 1) material contribution zones, 2) meander belts, 3) riparian wetlands, 4) floodplains, and 5) terraces (Smith et al. 2008). See more at: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/floodplains/Pages/default.aspx#sthash.wpDofAnH.dpuf

We assessed, by catchment, the percentage of the Active River Area with contiguous natural land cover that is adjacent to the stream channel. For size 2 and larger rivers, only the areas of lateral connectivity within the terrestrial floodplain portions of the ARA were considered (base zone riparian wetlands and non-wetland areas, excluding the upland material contribution zones and input water cells). For size 1 headwater streams the full terrestrial ARA (excluding input water cells) was considered. For more detail on the analysis of contiguous adjacent natural cover, see the methods for “Streams\Lateral Connectivity” below.

The area of each NHD Plus V2 reach-based catchment containing the floodplain-only or full terrestrial portion of the ARA was calculated, as was the area within this that was identified as being laterally connected. The percentage of the ARA in natural land cover contiguous with water input cells by catchment was then calculated as the ratio of the observed to potential amount of ARA area that could be laterally connected.

For use in the Habitat Explorer composite condition score, each stream segment was assigned a value between 0-100, according to the following chart. High score values indicate better condition. Value breaks were assigned by quantile.

Percent of ARA in natural land cover contiguous with water input cells by catchment	Value	Score
95.46-100	1st quantile	100
82.05-95.45	2nd quantile	80
66.20-82.04	3rd quantile	60
46.75-66.19	4th quantile	40
23.07-46.74	5th quantile	20
0-23.06	6th quantile	0

Attributes

ReachLength_KM: reach length in kilometers (prior to any splitting by dams or other features in separate analyses that use functionally-connected network (FCN) data).

NESZCL: The Northeast Aquatic Habitat Condition Assessment (NEAHC) size class.

latcon_cat_basepix: the size of the ARA within the stream reach catchment (# of pixels). Either the full terrestrial ARA excluding water cells (for headwater size class 1 streams) or just the ARA baseflow zones (additionally excluding upland contributing areas, for size class 2 and above) were used to determine the max possible extent within each catchment.

STR_LATCON11: current (2011) percent (%) of the ARA (base pixels) that is in natural landcover and contiguous with stream and river input water cells in the ARA within each stream reach catchment based on current (2011) landuse/landcover (LULC).

CSTR_LAT_CON_score: Scored current (2011) percent of ARA with natural lands adjacent/contiguous to the stream by stream reach catchment. Used as a Condition indicator.

CSTR_LAT_CON_label: Value ranges for scoring classes and map symbology for CSTR_LAT_CON_score. Classes based on 6 quantiles.

Streams: Current Condition\SCORED Functioning Floodplain

Summary

This indicator measures the percent of the Active River Area (ARA) that lies within a floodplain complex for each HUC12 watershed. Floodplain complexes represent undeveloped areas that are large enough to allow for natural floodplain processes like movement of water and sediment, storage of flood waters, recharge of groundwater, treatment of pollutants, and habitat diversity.

Methods

This analysis uses the Active River Area, which is based upon dominant processes and disturbance regimes to identify areas within which important physical and ecological processes of the river or stream occur. The framework identifies five key subcomponents of the active river area: 1) material contribution zones, 2) meander belts, 3) riparian wetlands, 4) floodplains, and 5) terraces (Smith et al. 2008). See more at: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/floodplains/Pages/default.aspx#sthash.wpDofAnH.dpuf

Floodplain complexes are identified as areas within the Active River Area that consist of a core which is at least 150 acres of natural land cover, and corridors which are lands adjacent to cores that have undeveloped land cover. Delineating Floodplain Complexes was limited to rivers of NEAHCS size class 2 or greater. For this scoring exercise, headwater catchments with streams of size class 1, the percent of the size 1 catchments in natural habitat cover for each HUC12 watershed was used. The percentage of the ARA within floodplain complexes relative to the full area of the ARA, or the percentage of all size 1 catchments in natural cover relative to the full area of all size 1 catchments, was calculated for each HUC12. For more about the delineation of floodplain complexes, please see the methods for “Streams\Floodplain Complexes” below.

For use in the Habitat Explorer composite condition score, each stream segment was assigned a value between 0-100, according to the following chart. High score values indicate better condition. Value breaks were assigned by quantile.

Percent of ARA that is in a floodplain complex by HUC 12	Value	Score
90.06-100.00	1st quantile	100
78.36-90.05	2nd quantile	80
66.90-78.35	3rd quantile	60
55.66-66.89	4th quantile	40
38.40-55.65	5th quantile	20
0-38.40	6th quantile	0

Attributes

huc12sz1terr11allpix: amount of the HUC12 that is within size 1 headwater catchments and is not water (# 30m pixels).

huc12sz1terr11natpix: amount of the HUC12 that is within size 1 headwater catchments, is in natural landcover (not in developed or agriculture), and is not water (# 30m pixels).

ARA_GT40LK_PIX: amount Active River Area (ARA) within the stream reach catchment (# pixels), excluding ARA associated with size class 1 headwater streams. Note that the ARA for larger size class streams may extend partway up smaller size class tributaries, so this may be non-zero even if the stream itself is a size 1 stream.

FPC11_GT40_PK: amount of the Active River Area (ARA) within the stream reach catchment that is also within a Floodplain Complex (# pixels). Floodplain Complexes (FPCs) were only defined within floodplains of size 2 or larger streams and rivers but may extend partway up smaller size class tributaries, so this may be non-zero even if the stream itself is a size 1 stream.

STR_FPCNAT_METH: code as to which methodology was used to calculate the “Functioning Floodplain” (STR_FPCNAT11) percentage: (1) if a headwater size 1 stream using amount of natural cover within the size 1 terrestrial portion of the HUC12, and (2) is a larger stream or river using the amount of FPC within the ARA.

STR_FPCNAT11: current (2011) percent (%) of ARA within Floodplain Complexes for larger streams and rivers, or percent (%) of the terrestrial portion of size class1 catchments of a HUC12 watershed that is in natural cover.

CSTR_ARA_FPC_score: Scored percent of catchment's ARA within floodplain complexes/percent of HUC12's headwater catchments in natural cover. Used as a Condition indicator.

CSTR_ARA_FPC_label: Value ranges for scoring classes and map symbology for CSTR_ARA_FPC_score. Classes based on 6 quantiles.

Streams: Current Condition\SCORED Percent Impervious Cover

Summary

This indicator presents the current percent impervious cover of the full upstream drainage area of each stream reach combined with a local weighting factor as a proxy for local water quality. Impervious cover represents those areas covered by impenetrable materials such as roads, parking lots, and buildings that prevent water from leaching directly into the soil. Impervious cover has been shown to be negatively correlated with water quality.

The calculation of impervious cover used here in the subsequent condition and threat scoring represents a tradeoff between the amount of impervious cover within the full upstream drainage of a stream reach and that observed in closer proximity to the reach in question. For headwater streams (NEAHCS size class 1) with total drainage areas typically smaller than the area of the HUC12 unit they are within, the percent impervious cover of the smaller total upstream drainage was used. For rivers draining larger watersheds (>38.6 square miles, NEAHC size class 2+) which may extend through 20 or more HUC12s for the main stem river alone, the percent impervious cover of the full upstream drainage area of a given reach was averaged with the percent impervious cover of the local HUC12 unit containing the reach.

Impervious cover was then scored using the same thresholds used in previous studies covering New York State (Anderson and Olivero Sheldon 2011, White et al. 2011).

Methods

Current estimates of the percent of impervious cover are based on the 2011 National Land Cover Dataset. Future (2050) estimates of percent impervious cover for predicted new development are based on either the 2011 statewide average % impervious for each of the four development intensity classes of the current (2011) hybrid habitat model (for more details, please see methods for future 2050 base habitat map in this document) or the current % impervious, whichever is greater.

LULC class	NLCD description	2011 average % impervious
21	Open space (<20 % impervious)	8 %
22	Low Intensity (20-49 %)	26 %
23	Med. Intensity (50-79 %)	61 %
24	High Intensity (80-100 %)	88 %

For areas beyond NYS, future impervious always equals current impervious. In order to use the NHD Plus accumulation tool, all raster data was shifted to align with the national grid for NLCD and NHD catchment data.

Impervious cover was calculated for each catchment and for the total upstream drainage of each reach using the CA3T NHDPlus accumulation tool from USGS and Horizon Systems (http://ftp.horizon-systems.com/NHDPlus/). Future percent impervious was converted to area impervious per cell in units of square kilometers. Maximum impervious (100%) equals 0.0009 sq. km. for a 30 x 30 m. grid cell. The CA3T tool was used to first allocate the summed impervious per catchment for all watersheds in each of the four "boundary unit" basins that cover NYS for the NHD Plus v2 data (Northeast 01, Mid-Atlantic 02, Great Lakes 04, and Mississippi 05). The output of the allocation step was then used as input to calculate the summed impervious for each reach for the accumulation step. As a check and correction for catchments with a lot of area in NoData regions of the input impervious data, particularly the Niagara and St. Lawrence Rivers plus streams along the NY-Canada land border, the allocation and accumulation of an "all-impervious" layer was also calculated and compared with the pre-calculated catchment and accumulation drainage areas that ships with the NHD Plus v2 datasets.

Flowlines classified as coastline or pipelines were removed from the dataset, as were other isolated flowlines disconnected from the NHD river networks and for which the CA3T tool could not calculated accumulated impervious. Some first- or zero- order streams that had no catchment of their own but represent a tiny spur branch of a larger stream were also removed as, again, the CA3T tool failed to calculate allocations and accumulations for them.

CA3T was run on the NHD Plus V2 datasets that were downloaded by Boundary Unit from USGS. The output data was joined to a copy of the NHD flowlines containing only those flowlines within the freshwater extended study area. The same was true of catchments.

The output allocation tables were joined to the catchment polygons (which already contained NHD-determined catchment area) and then merged into a single set of catchments for the full study area. The output accumulation tables were joined to the NHD flowlines and the NHD-determined cumulative area tables for each boundary unit and then merged into a single set of reaches (flowlines) for the full study area.

Catchments (with unique FEATUREID) were linked to HUCs and to reaches (with unique COMID) by converting catchment polygons to point features using points fixed inside each polygon (not centroids which could fall outside the polygon), spatially joining the catchment points to HUCs and keeping the HUC ID fields (text and long integer fields of the HUC id, plus a sequential integer id based on the ESRI object id), exporting the spatially-joined attribute table as a single table joined back to the catchment polygons, and then spatially joining the NHD flowlines to the catchment each is within.

The current and future percent impervious per catchment was calculated as the summed impervious for the catchment divided by the maximum possible impervious for the catchment (which is equal to the raster catchment area of all not-NoData areas within the catchment). Likewise, the accumulated current and future percent impervious per reach was calculated as the summed accumulated impervious for the reach divided by the maximum possible summed accumulated impervious for the reach. This avoided erroneous estimates for those reaches with significant NoData area mentioned earlier.

To qualitatively classify the predicted effect of upstream impervious cover (% imp) on water quality, we followed Anderson and Olivero Sheldon (2011) with the following thresholds: undisturbed areas as

0 < 0.5% imp, minimally impacted streams as 0.5 – 2%, moderately impacted as >2 – 10%, and highly impacted as >= 10% (Figure 19, 20). These thresholds were based on current research showing serious impacts to aquatic systems when impervious cover exceeds a threshold of 10%. In addition, studies show that declines in the number of stream taxa at a regional scale begin between 0.5 and 2% imp and declines of 40-45% at 2-3% imp (Anderson and Olivero Sheldon 2011).

For more information, please see pages 29 to 31 and the appendix of the full NY Freshwater Blueprint report that used the same thresholds: White, E.L., J.J. Schmid, T.G. Howard, M.D. Schlesinger, and A.L. Feldmann. 2011. New York State freshwater conservation blueprint project, phases I and II: Freshwater systems, species, and viability metrics. New York Natural Heritage Program, The Nature Conservancy. Albany, NY. 85 pp. plus appendix. http://nynhp.org/FBP

For use in the Habitat Explorer composite condition score, each stream segment was assigned a value between 0-100, according to the following chart:

Average of percent impervious cover in HUC12 and accumulation	Score
>40	0
20-40	20
10-20	40
5-10	60
2-5	80
0-2	100

Attributes

NESZCL: The Northeast Aquatic Habitat Condition Assessment (NEAHC) size class of the stream reach. See NRN_Flowlines_NHDFCN_nahcs_szcl dataset for more info.

up2011_pct_imp: 2011 % impervious upstream of the downstream end of the stream segment, including all catchments upstream.

up2050_pct_imp: 2050 % impervious upstream of the downstream end of the stream segment, including all catchments upstream.

cat2011_pct_imp: 2011 % impervious of just the catchment containing the stream segment.

cat2050_pct_imp: 2050 % impervious of just the catchment containing the stream segment.

imp2011_avg_huc12: 2011 % average impervious of all terrestrial pixels within the HUC12.

imp2050_avg_huc12: 2050 % average impervious of all terrestrial pixels within the HUC12.

STR_IMP_METH: method used for final impervious value: 1 for headwater streams using the CA3T-derived total upstream drainage percent impervious alone; 2 for size 2+ streams and rivers that use the average of the combined total upstream drainage + local HUC 12 average percent impervious.

STR_IMP11: final 2011 % impervious used to score as a stream condition indicator.

STR_IMP50: final 2050 % impervious.

STR_IMP_CHG: difference between the current and future estimate of % impervious.

CSTR_CURR_IMP_score: score assigned to the current % impervious stream condition indicator based on the listed threshold values.

CSTR_CURR_IMP_label: descriptive label describing the range of % impervious values covered by the given score.

Streams: Current Condition\SCORED Road-Stream Crossing Density

Summary

Road-stream crossings, when improperly designed or maintained, can significantly impede organism passage, undermine the ecological integrity of stream systems, and disrupt ecosystem processes such as hydrology, sediment transport and large woody debris transport. Only headwaters and creeks were assessed, as road-stream crossings of larger streams are usually bridges or other infrastructure that infrequently disrupt connectivity or hydrology. Also keep in mind that some segments in urban areas may show as having a low road-stream crossing density because they are underground or poorly mapped. Original data and description are from Anderson et al. (2013). We then crosswalked their analysis to the NHD Plus Version 2 in order to have all indicators on the same network.

Note that more detailed assessment and prioritization of some culverts within NY are available at http://nyanc-alt.org/gis/Champlain/, and the North Atlantic Connectivity Collaborative (https://www.streamcontinuity.org) has a database of on-the-ground culvert assessments (https://63.134.242.172/cdb2) as well as other resources.

Methods

We based our indicator on road-stream crossing density calculated by Anderson et al. (2013), and these methods are taken from that report:

"Because bridges are much less likely to pose a threat to stream connectivity, this analysis focused on road crossings of headwaters and creeks [Rivers size 2 and greater were assumed to have sufficient crossings]. Input data for streams were the 1:100,000 National Hydrography Dataset plus (2006), that had been modified for the 2008 Northeastern Aquatic Habitat Connectivity project by TNC, on headwaters and creeks only. Input data for roads were the North American Tele Atlas roads (2005). The Nature Conservancy then used Geospatial Modeling Environment to create points at all intersections of roads and streams."

Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/GeoCondition

For our analysis we used the "RDXSTM_DEN" field from the above dataset.

To facilitate combining indicators into a single condition metric, we crosswalked these data, developed on NHD Plus version 1, to NHD Plus version 2 (see "NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk" described in the "Additional Facilitating Layers" section at the end of this document). Version 1 segments were assigned a score based on the "RDXSTM_DEN" value in the original dataset. Unassessed segments, either new NHD+v2 headwater segments or small catchments originally left out of the analysis, were assigned a score of 100, which was the median score of the original dataset. Rivers size 2 and greater, which were not assessed in the original dataset, were assumed to have crossing sufficient for connectivity and assigned a score of 100 as well.

For use in the Habitat Explorer composite condition score, each stream segment was assigned a value between 0-100, according to the following chart. High score values indicate better condition. We based these thresholds roughly on thresholds used for indicating condition across macrogroup categories in the report for the original dataset.

Road-stream crossings per stream mile	Score
Unassessed, small catchments*	100
Unassessed, mostly new NHD+v2 headwater segments	100
River, crossings assumed sufficient for connectivity**	100
0	100
<0.25	80
0.25-0.50	60
0.50-1.00	40
1.00-1.50	20
>1.50***	0

*Unassessed in the original dataset. Mean score of that dataset was 75. Median was 100. So assigned 100 to Unassessed small catchments.
**Rivers size 2 and greater were not assessed in the original dataset—see citations in original report for evidence that crossings on these sizes are usually sufficient
***Note that there are some segments that have a crossing density almost two orders of magnitude more than this.

Attributes

LEN_MI: length of stream segment in miles.

RDXSTM_NUM: number of road-stream crossings that cross the stream segment.

RDXSTM_DEN: density of road-stream crossings along the stream segment (# per stream mile).

CSTR_RDXSTM_DEN_score: Road crossing density score, based on RDXSTM_DEN.

CSTR_RDXSTM_DEN_label: Descriptive label for the road crossing density score.

Streams: Current Condition\SCORED NY State Impaired Waters

Summary

This presents the current degree of impairment or threat to NYS waters (streams and rivers plus lake and estuary centerlines and some Great Lake shorelines) as of March 2015, based on both the maximum degree of impairment and the number of impaired uses, according to the Waterbody Inventory/Priority Waterbodies List (WI/PWL) dataset produced by the NYS Department of Environmental Conservation compiled in compliance with the federal Clean Water Act Section 303(d). The dataset provides a summary of general water quality conditions, tracks the degree to which a water body supports its designated uses, and monitors progress toward the identification and resolution of water quality problems, pollutants, and sources. The WI/PWL reports are produced for each of the 17 major drainage basins in the state on a schedule that allows each to be updated every 5 years. The review and updating of these reports include a public participation component. The data are available for four types of water bodies included on the WI/PWL: Shoreline, Rivers/Streams, Lakes/Reservoirs, and Estuary. For current updates to the original dataset, please see http://gis.ny.gov/gisdata/metadata/nysdec.PWL.xml.

Methods

Complete metadata for the original datasets, including the dbf files we used to create a database and reorganize and summarize the data, can be accessed here: http://gis.ny.gov/gisdata/metadata/nysdec.PWL.xml., and more information on how the level of impairment is determined for each type of use restriction is in the Assessment Methodology document (http://www.dec.ny.gov/docs/water_pdf/asmtmeth09.pdf; New York State Consolidated Assessment and Listing Methodology, May 2009).

The WI/PWL data were accessed in March 2015, so included the October 2014 revision, from: http://gis.ny.gov/gisdata/inventories/details.cfm?dsid=1117&nysgis=.

Using the information available from NYS DEC's website, we built a database based on the stream, lake, estuary, and shoreline segment IDs that enabled us to reorganize and summarize the data on impaired uses, pollutants, and sources for each segment. We calculated the number of uses with any level of impairment for each segment, as well as the greatest level of impairment of any single use. We also developed attribute fields for each use impairment, and completed them with the level of impairment (precluded, impaired, stressed, threatened, no impairment, or unassessed), so that the data could be symbolized by the level of impairment for each use.

Table 1 Relationships Between WI/PWL Severity/Documentation and Water Quality Assessment Categories

Severity of Problem	Level of Problem Documentation		
	Known	**Suspected**	**Possible**
Precluded	Impaired Water	N/A*	N/A*
Impaired		Impaired Water	N/A*
Stressed	Minor Impacts but Fully Supporting	Minor Impacts but Fully Supporting	Needs Verification (Considered Minor Impacts But Fully Supporting)
Threatened	Threatened, but Fully Supporting	Needs Verification (Considered Threatened)	Threatened (Poss) (But Fully Supporting)
None	No Known Impairment - Fully Supporting Uses		
???	UnAssessed Water		

* For more severe impacts (*Precluded, Impaired*) a greater level of documentation is needed.

Since both the severity of current water quality impairments as well as the number of uses impaired are relevant to species living within them and to people using the resource, and both might affect the water body's ability to adapt to climate change, we summed the number of impaired uses for every stream and shoreline segment as well as each estuary and lake.

Since the stream networks often intersect the shoreline segments and estuary and lake shapes, and water quality issues in each may affect the other, we wanted to code the stream catchments with the most prevalent condition impairment found within the catchment. Consequently, we turned the streams, shoreline, estuary, and lake files into 30m raster grids, then combined them such that the cells were assigned based on the following order of preference: (1, highest) streams > (2) shorelines > (3) lakes > (4) estuaries. The scored cells were then MAJORITY assigned to V2catchments (V2catzones) and joined to NHDPlusV2 stream reaches, relabeled and their final score assigned (see Indicator Thresholds below). We did this crosswalk to the NHD Plus Version 2 to be compatible with other datasets used within the Habitat Explorer in the Natural Resource Navigator.

For use in the Habitat Explorer composite condition score, each stream segment was assigned a value between 0-100, according to the following chart:

Value in DEC original	Water Quality Impairment Value —combination of level of impairment and # of Impaired uses:	Score
NoKnownImpct	No Impairments	100
Threatened(Poss)	Possibly Threatened, Needs Verification	80
Needs Verif	Stressed or Threatened, Needs Verification	80
Threatened	Threatened and <3 uses impaired	60
Threatened	Threatened and at least 3 uses impaired	40
Minor Impacts	Minor Impacts <3 uses affected	40
Minor Impacts	Minor Impacts 3 or more uses	20
Impaired	Any Use Impaired	0
Unassessed	Unassessed in original dataset	90
N/A	Unassessed; new NHDv2 segment	90

Note that the unassessed segments and segments new in the NHD Plus Version 2 were given a high condition score because most of them are headwaters. However, this is a large assumption, and we strongly advise users to consider the other condition indicators as well as what they know about water quality in these areas.

Attributes

CSTR_IMPAIR_SCORE: score assigned to the current water quality impairment indicator based on the listed threshold values above and then used in creation of Streams Overall Condition Score, which is used in the Habitat Explorer in the Natural Resource Navigator. 100 is high current condition, 0 is very poor current condition.

CSTR_IMPAIR_label: label used to describe the score, based on the level of impairment and the number of impaired uses identified in the Waterbody Inventory/Priority Waterbodies List dataset. See Water Quality Impairment Value in table above.

Restrictions

1. The NYSDEC asks to be credited in derived products.

2. Secondary distribution of the data is not allowed.

3. Any documentation provided is an integral part of the data set. Failure to use the documentation in conjunction with the digital data constitutes a misuse of the data.

4. Although every effort has been made to ensure the accuracy of information, errors may be reflected in data supplied. The user must be aware of data conditions and bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of data, and other condition.

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Other_Citation_Details: The Federal Clean Water Act Section 305(b) water quality reports and Section 303(d) impaired waters lists are highly visible ways for states to communicate to the public about the health of the nation's waters. Section 305(b) requires states to assess and periodically report on the quality of all the waters of their state. Section 303(d) further requires the states to identify from this assessment a list of Impaired Waters where specific designated uses are not fully supported, and where restoration and protection efforts beyond conventional technology-based controls are necessary to address water quality issues. NYSDEC's Division of Water has developed this Consolidated Assessment and Listing Methodology, which outlines in considerable detail the process the Department follows in monitoring and assessing the quality of New York State waters. The Methodology also improves the statewide consistency of assessment and listing decisions. The Methodology consists of three (3) separate parts: 1. The Monitoring Strategy provides an overview of the NYSDEC water quality monitoring program. 2. The Assessment Methodology details the evaluation of monitoring data and information to determine levels of water quality and use support. 3. The Listing Methodology outlines the identification and prioritization of waters that do not meet water quality standards or support designated uses. The corresponding documents are available in the same online page listed here.

Online_Linkage: http://www.dec.ny.gov/chemical/23852.html

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Streams: Current Condition\Biologically Based Water Quality Prediction

Summary

Predicted water quality impacts were developed by NY Natural Heritage for their Freshwater Blueprint report (2011) based on observed data from New York Department of Environmental Conservation's Stream Biomonitoring Unit's kicknet sampling of macroinvertebrates from 2000-2010. Biological Assessment Profiles, which are a means of plotting various biological index on a common scale of water quality impact, were calculated for each data point, and then regression modeling in random forests was used to model the relationship between a host of local and regional environmental variables and those data; the relationships were then used to predict values for stream segments in the state. Note that while there are instances of "severe impact" in the observed data, no stream segments are modeled as severe impact; this is likely due to local factors like point source pollution not captured in the environmental variables they were able to include.

Methods

The following is excerpted from White et al. (2011).

"The NYS DEC Stream Biomonitoring Unit's (SBU) database was the source of data for analyses of the diversity of aquatic macroinvertebrates. The SBU samples macroinvertebrates statewide in riffles of rivers and streams. In wadable streams, they use kicknets; in nonwadable streams, they use multiplates, which are artificial substrates that are left in situ and surveyed periodically for colonists. Generally speaking, wadable streams are smaller and nonwadable streams are larger, but this rule is not absolute. Kicknet sampling does not yield reliable abundance estimates, only richness estimates, but multiplate sampling yields abundance indices 62 as well as richness. The two datasets cannot be combined except when results are standardized (as in the Biological Assessment Profile [BAP] score, below).

We obtained a database with data up to and including the 2010 field season, a total of 7,132 samples. We used data from 2000 on, which left 2,756 samples from kicknet sampling at 1,749 sites, and 215 samples from multiplate sampling at 58 sites. Some sites were mapped outside of New York, which left 1,728 kicknet sites and 57 multiplate sites. When we had data for multiple samples at a site, we took the maximum value of the response variable in an effort to best represent the biological potential of the site. We then used the near function to grab the closest NEAHC reach, omitting kicknet points that were >100 m from a reach and multiplate points that were > 300 m from a reach (a larger distance for multiplates because they were in larger rivers, and therefore more likely to be farther from reaches). No kicknet points were within 100 m of more than one flowline.

For each of the two collection methods (kicknet, multiplate), we attributed the nearest stream segment with EPT richness (EPT), total species richness (SPP), percent model affinity (PMA), Shannon-Weiner diversity (DIV), and Biologic Assessment Profile (BAP). EPT richness is the total number of species of mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) found in an average 100-organism subsample. Species Richness is the total number of species or taxa found in a sample. Percent Model Affinity is a measure of similarity to a model, non-impacted community based on percent abundance in seven major macroinvertebrate groups. The Biological Assessment Profile (BAP) of index values is a method of plotting biological index values on a common scale of water quality impact. Values from five indices -- species richness (SPP), EPT richness (EPT), Hilsenhoff Biotic Index (HBI), Percent Model Affinity (PMA), and Nutrient Biotic Index (NBI) are converted to a common 0-10 scale (Smith et al. 2010).

If two or more collection points were closest to the same stream segment, we chose the maximum value. Thus, the observed datasets provided here have values labeled as "Max" (MaxEPT, MaxSPP, MaxPMA, MaxDIV, MaxBAP).

Because of the difference in collection methods, kicknet and multiplate data can only be combined with the BAP metric. Thus, we provide two observed datalayers in the "g_Insects" feature dataset of the geodatabase, one for each method, with these names: EPT_Kicknet_Observed and EPT_Mulitplate_Observed.

EPT Metric Modeling: For each of the five metrics, we used regression modeling in random forests to model the relationship between environmental variables and observed measures. We used the same 146 environmental variables as with the mussel modeling, with the single exception that we removed ecoregion as an attribute. We followed this procedure:

1. Attribute all stream segments in NYS with the environmental variables developed through the NEAHC effort conducted by TNC ECS.

2. Extract those segments with observed EPT data.

3. For BAP, merge the multiplate and kicknet data together; for the remainder (EPT, SPP, PMA, DIV), use only the kicknet samples.

4. Run the regression trees option within the randomForests package in R, using only the observed data. Model fits are described in Table X.

5. Use the relationship modeled in step 4 to predict the value for each metric throughout the rest of the state.

Because we could merge multiplate and kicknet data for BAP, we 63 modeled BAP for all stream segments in the state. Because we used only kicknet data for the remainder of the metrics, we removed segments with size classes 4 and 3b (large rivers and medium mainstems) from the model output. The modeled metrics are only applicable for the wadable riffles of the remainder of streams and can be found in "EPT_Predicted" of the geodatabase.

In general, many of the environmental variables that were important for characterizing each model were also important in the other models....Although BAP ranges from 0-10, predicted BAP was rarely below 3, suggesting that some of the unexplained variation in the BAP model might result from local factors that cause degradation, such as point-source pollution."

Attributes

COMID: NHD Plus V1 stream reach COMID from the NY Freshwater Blueprint.

BAP_PRED: Predicted Biological Assessment Profile (BAP) scores.

EPT_PRED: Predicted stream invertebrate (EPT: Ephemeroptera, Plecoptera, and Trichoptera) richness scores.

DIV_PRED: Predicted Shannon-Weiner Diversity Index (DIV).

PMA_PRED: Predicted stream percent model affinity (PMA)

SPP_PRED: Predicted total species richness (SPP).

Restrictions

These data are not to be distributed or made accessible to anyone other than staff of the New York State Chapters of The Nature Conservancy without written permission from The New York Natural Heritage Program.

Citation

White, E.L., J.J. Schmid, T.G. Howard, M.D. Schlesinger, and A.L. Feldmann. 2011. New York State freshwater conservation blueprint project, phases I and II: Freshwater systems, species, and viability metrics. New York Natural Heritage Program, The Nature Conservancy. Albany, NY. http://nynhp.org/FBP

Streams: Current Condition\Dam Density (per mile)

Summary

Dam density along each stream reach, from the Northeast Aquatic Habitat Assessment study (Anderson et al. 2013) and based on NHD Plus Version 1 streams but crosswalked to the Version 2 streams using the "NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk" described in the "Additional Facilitating Layers" section at the end of this document.

Attributes

GNIS NAME: reach name.

Stream Length (LEN_MI): length of stream segment in miles

DAMTOTAL: Total number of dams along the reach; upstream of the stream segment's outlet.

DAMDEN: density on that reach: total dams / miles of reach length.

Citation

Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/GeoCondition

Streams: Future Threats\Streams Threat Score

Summary

Stream Threat is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for stream threat were change in impervious cover, floodplain connectivity, fragmentation risk, flood pollution risk, and acid deposition sensitivity. Input data were generated at multiple scales, including stream networks, catchments, and floodplains, but were all applied to reaches in the NHD v2+ stream lines. Summary scores were calculated by reach, and are best interpreted as general trends across a project area. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of future stream condition, or threat, based on available evidence and expert opinion. Input indicators used for stream threat were change in impervious cover, floodplain connectivity, fragmentation risk, flood pollution risk, and acid deposition sensitivity. These indicators directly or indirectly measure future modification of the system, which could alter habitat conditions beyond a range of naturally occurring variation. Systems with high threat are expected to have eventual declines in diversity and productivity, and require intervention to maintain their current structure and function. Since it is not always possible to predict the location or degree of future habitat modifications, some threat indicators reflect the risk or likelihood of change, rather than an expected amount of change.

The selected indicators were each scored on a range of 0-100, where 0 indicates no meaningful level of alteration, and 100 indicates a level of threat that could lead to complete loss of the system or its functional or structural attributes. Scoring was based on the expected impact on habitat condition of the threat, not the change in the source of the threat itself. In some cases, thresholds for acceptable degree of modification were not well-documented, so even breaks, relative values, or number of changes in condition classes were used for scoring. In all cases, higher scores indicate a greater expectation of declines in future condition, not necessarily higher values of the indicator itself.

Each scored indicator was spatially attributed to the same base habitat dataset. For streams, the NHD+V2 stream segments were used as the unit of analysis. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each unit. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. Since some of the input variables are scored on a relative basis, and the underlying data have varying spatial resolutions, the resulting score should only be used as a guide for planning and does not replace local-scale information. We encourage users to supplement or substitute this information with additional data and their own knowledge as appropriate.

Attributes

TSTR_Tscore_all: overall stream future threat score (0-100). 0 is low threat, 100 is high threat.

Streams: Future Threats\SCORED Change in Percent Impervious

Summary

Degree of change in percent impervious cover from 2011 (current) to projected 2050 (future). These datasets characterize the proportion of area covered by impenetrable materials such as roads, parking lots, and buildings preventing water from leaching directly into the soil at two different spatial units relevant to stream condition: the local watershed (HUC12) containing each stream reach, and the full upstream drainage area of each stream reach or segment. For headwater streams, the full upstream drainage area is usually the smaller spatial unit; for size class 2+ rivers, the HUC12 unit is usually the smaller unit. Impervious surface has been negatively correlated with water quality.

Methods

Refer to the layer "Streams\Streams: Current Condition\SCORED Percent Impervious Cover" above for a full description of how the current and future percent impervious cover was assigned to individual stream reaches. In short, NEAHC size 1 headwater streams use the % impervious of their full upstream drainage area while size 2+ streams and rivers use the average of their upstream drainage area and the % impervious of the HUC12 that they are within.

As with the current impervious dataset, the average future impervious cover by HUC12 was classed according to the following table:

Average of percent impervious cover in HUC12 and accumulation	Class
>40	1
20-40	2
10-20	3
5-10	4
2-5	5
0-2	6

The changes in impervious class, as well as the raw changes in average impervious cover for those with no class change, were used to assign a value between 0-100 to each stream segment for use in the Habitat Explorer composite threat score. Higher values indicate a higher degree of threat to future conditions.

Change in % Impervious Cover	Score
No class change and <5% bin range raw change	0
No Class change and 5-50% bin range raw change	25
No class change and >50% bin range raw change	50
1 class change	75
2 class changes	100
3 class changes	100

Attributes

TSTR_CHG_IMP_score: score assigned to the future change in % impervious stream condition indicator based on the listed threshold values.

TSTR_CHG _IMP_label: descriptive label describing the magnitude of the future change covered by the given score.

Streams: Future Threats\SCORED Change in Floodplain Connectivity

Summary

Change in natural adjacent lands based on the jump in quantile class from 2011 to 2050 (or if no quantile class change, the amount of change) of percentage of the Active River Area with contiguous natural land cover that is adjacent to the stream channel. In size 2 and larger rivers, these areas could provide for connectivity between overbank flows and floodplains therefore providing flood attenuation benefits. For headwater streams and larger, these could also represent forested, shrub or otherwise vegetated riparian buffers which could offer water purification benefits. Reaches that are less connected may not be able to attenuate flood flows as well or provide water purification benefits.

Methods

As was similarly done for current conditions, we assessed, by catchment, the percentage of the Active River Area with contiguous natural land cover that is adjacent to the stream channel under future conditions based on the future hybrid LULC data layer. For size 2 and larger rivers, only the areas of lateral connectivity within the terrestrial floodplain portions of the ARA were considered (base zone riparian wetlands and non-wetland areas, excluding the upland material contribution zones and input water cells). For size 1 headwater streams the full terrestrial ARA (excluding input water cells) was considered. For more detail on the analysis of contiguous adjacent natural cover, see the methods for “Streams\Lateral Connectivity” below.

The area of each NHD Plus V2 reach-based catchment containing the floodplain-only or full terrestrial portion of the ARA was calculated, as was the area within this that was identified as being laterally connected. The future percentage of the ARA in natural land cover contiguous with water input cells by catchment was then calculated as the ratio of the observed to potential amount of ARA area that could be laterally connected.

The net change in area of adjacent natural lands ([future – current]/current) was used to assign a value between 0-100 to each stream segment for use in the Habitat Explorer composite threat score. Higher values indicate a higher degree of threat to future conditions.

Change in Adjacent Natural Lands	Score
Increase	0
No change	0
<10% lost	25
10-25% lost	50
25-50% lost	75
50-75 % lost	100
75-100% lost	100

Attributes

STR_LATCON50: future (2050) percent (%) of the ARA (base pixels) that is predicted to be in natural landcover and contiguous with stream and river input water cells in the ARA within each stream reach catchment, based on future (2050) LULC.

STR_LATCON_CHG: Change in the percent of ARA with natural lands adjacent/contiguous to the stream by stream reach catchment between current (2011) and future (2050) conditions (future minus current). Positive values equal additional losses in connectivity, negative values represent gains in connectivity. Values range from +100 to -100 with 0 representing no change.

TSTRLATCON_CHG_score: Scored change in the percent of ARA with natural lands adjacent/contiguous to the stream by stream reach catchment between current (2011) and future (2050) conditions. Used as a Threat indicator.

TSTRLATCON_CHG_label: Value ranges for scoring classes and map symbology for TSTRLATCON_CHG_score.

Streams: Future Threats\SCORED Connectivity Threat from Additional Road-Stream Crossings

Summary

Road-stream crossings, when improperly designed or maintained, can significantly impede organism passage, undermine the ecological integrity of stream systems, and disrupt ecosystem processes such as hydrology, sediment transport and large woody debris transport. New development in a watershed may lead to an increase in road-stream crossings. This dataset identifies streams within HUC12s that currently have a low road-stream crossing density (<1 crossing/mile) and are predicted by our statewide land use change model to have new development by 2050. This dataset also classifies streams within HUC12s that currently have a higher road-stream crossing density (>1 crossing/mile) that may be further degraded by additional new crossings but not exhibit as severe a change when going from many-to-more crossings as when going from few-to-many crossings.

Keep in mind that:

1. Not all road-stream crossings present problems.

2. CURRENT connectivity condition issues posed by improperly designed road-stream crossings will become even more of a problem with climate change, as species need to move to new suitable habitat, and flooding frequency and intensity increase. Streams currently in areas with a high density of road crossings may already have a connectivity problem.

3. Individual stream segments within the HUC 12 may have a road stream crossing density >1/mile, even though the sum of crossings/sum of stream miles is <1.

Methods

Data on current road-stream crossing density from Anderson et al. (2013) were used in this analysis. See "Streams\Road-Stream Crossing Density" above for more information. HUC12s were flagged for consideration of the risk for loss of aquatic connectivity if they had a current road-stream crossing density of less than 1 per stream mile (<100 in the huc12_rdx100 field of the original dataset). HUCs with 0 crossings or nodata (unknown) were lumped into the low current density class for the purposes of assigning a score based on the amount of new future development. The amount of new development in HUC12s with currently already high road crossing densities was also determined, and the same amount of new development thresholds applied as with the low current density class; however, the threat scores associated with penalties for new development in the high current density class were reduced in magnitude by half.

The classified HUCs were then converted to 30m raster format for further processing. It should be noted that this selection included HUCs with 0 crossings, which may include watersheds with truly no road-stream crossings other than presumed bridges; watersheds with a very low number of stream miles other than rivers, which were not evaluated, where there may be a few road-stream crossings of small streams but the density rounded down to 0; and streams in heavily urbanized areas where portions of the stream run underground. We were unable to reliably separate these scenarios in the data, so we categorized them as an unknown density class and scored and symbolized them all the same as the low density class.

These HUC12s were then evaluated for the amount of new development predicted to occur within the watershed according to the future land use model (see "Land Use\Future NYS LULC" below.) Lands under new development, not including areas predicted to become inundated, were extracted from the land use change analysis. New development pixels within the selected (current low crossing density) HUCs were summed by HUC (huc12_frag) and divided by the total number of 30 m pixels in the HUC. The proportion (0-1) of the watershed predicted to convert to development is used as a predictor of aquatic fragmentation risk. Values were re-joined with the HUC12 feature class and then those values were joined to the NHD v2 lines. All stream segments in a HUC12 were assigned the same value, with the exception of stream segments of NEAHC size class 2+ (and any segments belonging to the NYS Barge Canal system) for which current and future crossings were assumed to be bridge-like or otherwise not likely to impact aquatic connectivity.

The change in development in low-crossing density watersheds was used to assign a value between 0-100 to each stream segment for use in the Habitat Explorer composite threat score. Higher values indicate a higher degree of threat to future conditions.

Value	New Dev Class	Score
River (NEAHC size class 2+), road crossings assumed sufficient for connectivity (ex. bridge or large culvert)		0
No increase in development predicted in HUC12	1	0
New development, higher likelihood of future crossings or worsening impact (crossing density is currently LOW or UNKNOWN)		Scored according to amt of dev, as below
<1% HUC12 newly developed by 2050	2	25
1.01-10% HUC 12 newly developed by 2050	3	50
10.01-25% development	4	75
>25% of HUC12 predicted new development in 2050	5	100
New development, but low likelihood of future crossings or worsening impact (crossing density already HIGH)		Scored according to amt of dev, as below
<1% HUC12 newly developed by 2050	2	0
1.01-10% HUC 12 newly developed by 2050	3	25
10.01-25% development	4	38
>25% of HUC12 predicted new development in 2050	5	50

The labeling of the scores in the map is based on the severity of the expected future impact on the stream segment rather than the complex division by current development class and amount of new development detailed above.

Label	Score
River – future crossings no additional threat	0 and size class 2+
Lowest risk of further stream fragmentation	0
Low risk of further stream fragmentation	25
Medium-Low risk of further stream fragmentation	38
Medium risk of further stream fragmentation	50
High risk of further stream fragmentation	75
Highest risk of further stream fragmentation	100

The concatenated text string code for the future road crossing fragmentation risk class followes the following pattern:

Crossing density category	New Dev Class	Size class 2 or greater?
"LO", "UNK", or "HI"	1, 2, 3, 4, 5	"-Riv" or blank

Attributes

Pct_NewDev: percent (%) of the HUC12 with new future development based on the future landuse/landcover (LULC) data, excluding areas of new development within expected inundation zones related to sea level rise.

Hi_cur_rdx: current degree of road crossing density of the HUC12: 1 = High (HI) current road crossing density (>= 1 crossing per stream mile), 0 = Low (LO) current road crossing density (< 1 crossing per stream mile), and -9 = Undetermined/Unknown (UNK) current road crossing density.

NewDevClass: New Development Class. See table above for description.

size2plus: flag for if NESZCL size class is 1 (code 0) or size 2 or larger (code 1). Larger rivers have the "-Riv" modifier added to their class code.

Canal_flag: text flag for size class 1 stream segments that were otherwise unflagged but are part of the NYS Canal System, in Canada, or within large lakes. These also got the "-Riv" modifier added to their class code.

TSTR_RDXFRAGRSK_class: Concatenated text string code for the current road crossing density category + future new development category + whether a size class 2 or greater river (ex. "LOrdx4-Riv", "UNKrdx2", "HIrdx3", etc.).

TSTR_RDXFRAGRSK_score: score assigned to the TSTR_RDXFRAGRSK_class, used to indicate the magnitude of the future fragmentation risk threat. See table in full metadata documentation for full details and methods. 100 is high future threat, 0 is no or low future threat

TSTR_RDXFRAGRSK_label: Descriptive label for the future fragmentation risk based on the severity of the expected future impact on the stream segment rather than the complex division by current development class and amount of new development.

Pix_NewDev: number of 30m pixels of new future development in the HUC12 based on the future landuse/landcover (LULC) data, excluding areas of new development within expected inundation zones related to sea level rise.

Streams: Future Threats\SCORED Flood Pollution Risk

Summary

Infrastructure within the Active River Area (ARA) may be vulnerable to future flooding under climate change, and damage to that infrastructure could present a risk of pollutants entering streams and rivers. Although that risk certainly depends on the location within the ARA, elevation, local flood mitigation measures, and site-specific conditions of holding tanks or storage areas, we thought it was important to identify this infrastructure to raise awareness of a possible increased risk with climate change if materials are not well secured against possible flood impacts. We focused on potential sources of nutrients, as the impacts of nutrients may be more severe with warming temperatures (greater algal growth and associated toxicity, greater anoxia), and potential toxins, as even a single release could have severe local impacts, and also because many chemicals may linger for long periods even if they are only released in a single event. In many instances, state datasets were more current and consistent, better attributed, or more usable than those available through HAZUS or EPA, so we selected those over federal datasets even though that limits the utility of our subsequent summaries to within NY's boundary.

Methods

Point data were gathered from the following datasets, re-projected to NAD Contiguous Albers 1983, clipped to the base zones of the Active River Area, and associated with USGS NHD catchments through a spatial join. Only points deemed moderate or higher pollution risk with flooding and climate change (see tables below) were extracted by selection. Risk ratings in parentheses (VH=Very High, H=High, M=Moderate):

NY Bulk Storage Facilities: Data are from the New York State Department of Environmental Conservation via the NY GIS Clearinghouse https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1253.

SITETYPEN=Only points for Chemical Distributor (H), Chemical Manufacturing (H), Manufacturing (Other than Chemical) Processing (M), Retail Gasoline Sales (M), Storage Terminal/Petroleum Distributor (H) were included.

Note that some sites may have had two points, because they had a point for a chemical permit and a point for a peteroleum product. Since those were two pollutants and likely stored in different locations, and screening them out by location or attribute was difficult because the point names and locations did not often match well, and the number of cases seemed limited, we allowed all points to remain.

EPA CERCLIS Superfund sites, selected from Facility Registry System geodatabase: http://www.epa.gov/envirofw/geo_data.html

INTEREST_T: Sites on the National Priorities List were rated Very High risk (VH) , and all other sites were rated High risk (H)

NY Remedial Action Sites: Data are from the New York State Department of Environmental Conservation via the NY GIS Clearinghouse https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1097

This dataset combines points in the following programs: State Superfund, Brownfield Cleanup, Environmental Restoration, and Voluntary Cleanup.

SITECLASS: Only "1 Causing or presenting an imminent danger of causing irreversible or irreparable harm to public health or environment" (VH), "2 Significant threat to the public health or environment" (H), and A "Remediation ongoing or needed" (M) points were included.

Note: Points within close proximity to CERCLIS Superfund site dataset points and sharing nearly identical point names were removed from the dataset to avoid double counting.

NY Combined Sewer Stormwater Overflows: Data are from the New York State Department of Environmental Conservation. http://www.dec.ny.gov/chemical/88736.html

All of these were rated Very High Risk (VH).

HAZUS Nuclear Facilities: https://msc.fema.gov/portal/resources/hazus

All of these were rated Very High Risk (VH).

HAZUS Wastewater Treatment Facilities: https://msc.fema.gov/portal/resources/hazus

All of these were rated High Risk (H).

Summary tables of the total number of points of each risk category that fell within each catchment were generated. Rows for catchments that contained no point of any type were appended. The same summaries were generated for each HUC12 in the study region.

Indicator Thresholds:

The number of points by risk category was used to assign a value between 0-100 to each stream segment for use in the Habitat Explorer composite threat score, according to the table below. Higher score values indicate a higher degree of threat to future conditions.

Label	Value	Score
Extremely High Risk	More than 10 VH points or more than 20 points overall	100
Very High Risk	1-10 VH risk points in floodplain (nuclear, top tier superfund, CSO)*	100
High Risk	11-20 regardless of severity but no VH	100
Moderate-High Risk	Some combo of High and Medium, 6-10	67
Moderate Risk	Some combo of High and Medium, 2-5	50
Moderate-Low Risk	Only Medium, 2-10	33
Low Risk	1 High Threat	33
Lowest Risk	1 Medium Threat	10
No reported pollution hazard infrastructure in floodplain	No reported pollution hazard infrastructure in floodplain	0

These scores were based on our professional judgment and an examination of the distribution of the dataset.

Attributes

TSTR_FldPollRsk_score: flood pollution risk score based on the total number of points in each risk category that fell within the Active River Area (ARA) inside each stream reach's catchment. 100 is high future threat, 0 is no or low future threat.

TSTR_FldPollRsk_label: display label for the flood pollution risk score (risk level).

Sum_FIPrsk_M: total count of infrastructure points assigned to the Medium Risk category found within the ARA inside the reach catchment.

Sum_FIPrsk_H: total count of infrastructure points assigned to the High Risk category found within the ARA inside the reach catchment.

Sum_FIPrsk_VH: total count of infrastructure points assigned to the Very High Risk category found within the ARA inside the reach catchment.

Sum_FIPrsk_any: total count of infrastructure points assigned to any Risk category found within the ARA inside the reach catchment.

FldPollRsk_Label2: additional label for the flood pollution risk score (summary of counts).

Restrictions

Only the Wastewater Treatment facility dataset contained points outside of NYS, so summaries for catchments in surrounding states likely underestimate the number of polluting risks and should only be used with caution.

See metadata for individual point components using links above and their accompanying restrictions. For data from NYS DEC (Bulk Storage Sites, Remedial Action Sites, and Combined Sewer-Stormwater Outfalls), please note:

1. The NYSDEC asks to be credited in derived products.

2. Secondary distribution of the data is not allowed.

3. Any documentation provided is an integral part of the data set. Failure to use the documentation in conjuction with the digital data constitutes a misuse of the data.

4. Although every effort has been made to ensure the accuracy of information, errors may be reflected in data supplied. The user must be aware of data conditions and bear responsibility for the appropriate use of the information with respect to possible errors, original map scale, collection methodology, currency of data, and other condition.

Streams: Future Threats\SCORED Streams Acid Deposition Sensitivity

Summary

This map shows the sensitivity of streams and lakes in NY to acid deposition, based on the sensitivity of their underlying geology. Although impacts from acid deposition have already affected stream condition, we include sensitivity to deposition as a future and ongoing threat because even if deposition is severely curtailed, the effects will linger in aquatic systems and potentially be worsened by warming water temperatures. Note that this is just sensitivity, and actual future impacts will depend on past deposition and future deposition, as well as other factors on the ground that will affect aquatic system sensitivity. Impacts on aquatic systems may be exacerbated by warming stream temperatures and increased precipitation.

Sensitivity to acid deposition was created by overlaying EPA alkalinity data and the reclassified Acidic Deposition effects on terrestrial ecosystems dataset developed by the Southern Appalachian Mountains Initiative. A sensitivity index was calculated based on the highest sensitive value from both data sets. Note that some areas on Long Island and at the periphery of the state were not evaluated. Since these areas largely fell near or between Not Sensitive or Marginally Sensitive areas, and the underlying geology suggested that was appropriate, we scored them between those values.

Methods

Sensitivity to acid deposition was created by overlaying EPA alkalinity data and the reclassified Acidic Deposition effects on terrestrial ecosystems dataset developed by the Southern Appalachian Mountains Initiative. The EPA and the Southern Appalachian Mountains Initiative dataset were combined using the ArcGIS union tool. Then a sensitivity index was calculated based on the highest sensitive value from both data sets. The “unioned” data set was then dissolved by the new sensitivity value to create the final data set with 4 classes: Class 1- Most Sensitive, Class 2 - Sensitive, Class 3 - Marginally Sensitive, Class 4 - Not Sensitive. This work was done by B.J. Cosby and C.T. Driscoll in a report to TNC, and the resultant map was eventually published with other work in Lovett et al. (2009).

The Lake Sensitivity to Deposition and the Stream Sensitivity to Deposition datasets were developed based on the Sensitivity to acid deposition version 2 dataset. NHD Plus version 2 stream segments were assigned values using a Majority rule for the stream catchment (V2catzone). Lake features were also assigned values using a Majority rule. There were a few locations with no data/not evaluated in the original dataset. Rather than spatially interpolate, which did not seem entirely justified based on an examination of the heterogeneity in underlying geology in the evaluated and unevaluated areas on Long Island in the original dataset, we noted these streams as unassigned in the original dataset, and scored them in between the values for Marginally Sensitive and Not Sensitive.

The acid deposition sensitivity class was used to assign a value between 0-100 to each stream segment for use in the Habitat Explorer composite threat score. Higher values indicate a higher degree of threat to future conditions.

Sensitivity Class Label	Sensitivity Class	Score
Most Sensitive	1	75
Sensitive	2	50
Marginally Sensitive	3	25
Unassessed in original data source	0	12.5*
Not Sensitive	4	0

*not evaluated in data we had but most fall on edges of class 3-4, so we used the midpoint of those scores

Attributes

TSTR_AcidDeposSens_class: stream's acid deposition sensitivity class.

TSTR_AcidDeposSens_score: threat score associated with the stream's acid deposition sensitivity class.

TSTR_AcidDeposSens_label: display label for the stream's acid deposition sensitivity class threat score.

Citation

Please cite these data as being derived from: Lovett, G. M., Tear, T. H., Evers, D. C., Findlay, S. E., Cosby, B. J., Dunscomb, J. K., Driscoll, C. T., & Weathers, K. C. (2009). Effects of air pollution on ecosystems and biological diversity in the eastern United States. *Annals of the New York Academy of Sciences*, *1162*(1), 99-135.

Streams: Climate Sensitivity\Streams Sensitivity Score

Summary

Climate sensitivity for freshwater streams is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for climate sensitivity were connected network length, stream size variety, slope variety, and temperature variety. Scores were applied to reaches in the NHD+v2 network. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of climate change sensitivity, based on available evidence and expert opinion. Input indicators used for climate sensitivity were connected network length, stream size variety, slope variety, and temperature variety. These indicators directly or indirectly measure the degree to which an ecosystem is likely to be affected by the changing climate. Systems with high sensitivity to climate change are expected to experience greater changes in habitat structure and function, and be less likely to return to their previous state, in response to changes in climate. Since there is limited documentation of observed climate change response across a range of habitat conditions, sensitivity indicators largely measure attributes of diversity and connection that are expected to confer an increased ability to resist or recover from change.

The selected indicators were each scored on a range of 0-100, where 0 indicates the lowest degree and 100 indicates the greatest degree of climate change sensitivity within the study area. Scoring was largely based on the number of condition classes found within a connected stream network. In all cases, higher scores indicate a relatively greater degree of sensitivity to climate change, as compared to other locations in the study area.

Each scored indicator was spatially attributed to the same base habitat dataset. For streams, the NHD+V2 stream segments were used as the unit of analysis. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each unit. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. The resulting score should only be used as a guide for planning, since it is unknown what levels of sensitivity result in significant differences in climate change response. We encourage users to monitor for climate change impacts and supplement or substitute this information with additional observed or modeled data as appropriate.

Attributes

SSTR_Sscore_all: overall stream sensitivity to climate change score (0-100). 0 is low, 100 is high.

Streams: Climate Sensitivity\SCORED Connected Network Length

Summary

This dataset shows the length (miles) of the functionally connected stream network. These networks are bounded by fragmenting features (dams) and/or the topmost extent of the mapped headwaters. Resilient stream systems are those that will support a full spectrum of biodiversity and maintain their functional integrity even as species compositions and hydrologic properties change in response to shifts in ambient conditions due to climate change. We examined all connected stream networks in the freshwater project boundary for New York State, excluding only segments with drainage areas < 1 mi^2 due to inconsistencies in how these small headwaters were mapped across quads in the source NHD Plus. We looked at four physical properties correlated with resilience: network length, network complexity (number of size classes), number of gradient classes and number of temperature classes. We counted the number of each class type within a connected network. A network was defined as a continuous system of connected streams bounded by dams or upper headwaters. Our analysis uses the products that under laid the NE Freshwater Resilience Analysis, and we used their methods to determine the complexity metrics for small headwater and creek networks that were excluded from the NE Freshwater Resilience analysis due to thresholds and cutoffs they applied because of the regional scale of their analysis.

Methods

Methods followed those used by the Northeast Freshwater Resilience Analysis report at https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/fwresilience/Pages/default.aspx but expanded the geographic scope of that analysis to include smaller networks left out of that dataset, but still greater than > 1 mi^2 drainage area that were included in the Northeast Connectivity Analysis (Martin and Apse 2011) and thus had dams snapped and qced around them. (Note comids/arcs with drainage areas < 1 mi^2 were not included due to inconsistencies in how these small headwaters were mapped across quads and across states in the northeast in the source NHD Plus). We also then crosswalked these results to the NHD Plus Version 2 dataset to be compatible with others in our analyses.

Length of Connected Network:

We obtained the length of each functionally connected network, including those not originally included in the data distribution for the regional analysis, from The Nature Conservancy's Eastern Division Science office, and joined it a file containing all of the individual stream segment classifications, that they also provided, clipped to our NY freshwater project boundary, on BATNETID, or the unique functionally connected network ID.

We then crosswalked these results to the NHD Plus version 2 stream reaches (and subreaches where broken by dams within a reach and separating multiple networks). See the detailed crosswalk methods associated with the "NHD Plus Version 2 to FW Resilience FCN BATNET IDs Crosswalk" layer described in the "Additional Facilitating Layers" section at the end of this document. New NHD+V2 segments that had not been previously evaluated were given a value of 100.

The length of the connected network was used to assign a value between 0 - 100 to each stream segment for use in the Habitat Explorer composite climate sensitivity score, according to the table below. Higher score values indicate a higher degree of sensitivity to climate change.

Connected network length in miles	Score
Stream network not evaluated—reaches new in NHD Plus V2	100
0.00 - 25.00	100
25.01 - 100.00	75
100.01 - 500.00	50
500.01 - 1000.00	25
1000.01 - 4029.49	0

See the original freshwater resilience analysis for justification of these thresholds, as well as references therein, and the Network Length section of Anderson et al. (2013):
Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/GeoCondition

Attributes

BATNETID: the functional network ID from the Anderson et al. (2013) Northeast Freshwater Resilience Analysis report giving the ID of the network to which each sub-reach segment belongs. Negative BATNETIDs represent new networks not included in the original Anderson et al. analysis (in drainages below their threshold drainage area size or for stream reaches new to the NHDPlus V2 dataset that do not connect to existing networks or only do so where a dam crossing is required).

BATNET_MI_V2NI: original length (in miles) of the FCN network. This was not recalculated if the network was extended by new reaches or if the network was wholly new in the NHDPlus version 2 dataset (new NHDPlus version 2 reaches not included in the tabulation). Likewise, the count of size, slope, and temperature classes was not reevaluated due to lack of data associated with the new reaches.

SSTR_networklength_score: the sensitivity score assigned based on the total length of all stream reach segments found within the FCN network.

SSTR_networklength_label: description of the SSTR_networklength_score used for the legend.

Streams: Climate Sensitivity\SCORED Size Variety

Summary

Resilient stream systems are those that will support a full spectrum of biodiversity and maintain their functional integrity even as species compositions and hydrologic properties change in response to shifts in ambient conditions due to climate change. We examined all connected stream networks in the freshwater project boundary for New York State, excluding only segments with drainage areas < 1 mi^2 due to inconsistencies in how these small headwaters were mapped across quads in the source NHD Plus. We looked at four physical properties correlated with resilience: network length, network complexity (number of size classes), number of gradient classes and number of temperature classes. We counted the number of each class type within a connected network. A network was defined as a continuous system of connected streams bounded by dams or upper headwaters. Our analysis uses the products that under laid the NE Freshwater Resilience Analysis, and we used their methods to determine the complexity metrics for small headwater and creek networks that were excluded from the NE Freshwater Resilience analysis due to thresholds and cutoffs they applied because of the regional scale of their analysis.

This dataset represents the number of size classes meaningfully present within a functionally connected stream network. Size classes were based on the Northeast aquatic habitat classification system (Anderson and Olivero 2008). There were seven size classes for streams based on their catchment drainage area (headwater, creek, small river, medium tributary, medium mainstem, large river, and great river) and two major lake size classes (small-medium lakes 4.1 – 404.7 hectares (10-1,000 acres) and large lakes >404.7 hectares (>1,000 acres)-this includes the Great Lakes). To count as present, the combined length of that size class, across the network, needed to exceed thresholds based on those size classes. Functionally connected stream networks are bounded by fragmented features (dams) and the topmost extent of mapped headwater streams.

Methods

Methods followed those used by the Northeast Freshwater Resilience Analysis report at https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/fwresilience/Pages/default.aspx but expanded the geographic scope of that analysis to include smaller networks left out of that dataset, but still greater than > 1 mi^2 drainage area that were included in the Northeast Connectivity Analysis (Martin and Apse 2011) and thus had dams snapped and qced around them. (Note comids/arcs with drainage areas < 1 mi^2 were not included due to inconsistencies in how these small headwaters were mapped across quads and across states in the northeast in the source NHD Plus). We also then crosswalked these results to the NHD Plus Version 2 dataset to be compatible with others in our analyses.

Size Classes/Number of Freshwater Forms:

The Northeast Aquatic Habitat Classification System (Anderson and Olivero 2008) delineated seven size classes for streams based on their catchment drainage area: headwater (1a), creek (1b), small river (2), medium tributary (3a), medium mainstem (3b), large river (4), and great river (5) and two major lake size classes, small-medium lakes 4.1 – 404.7 hectares (10-1,000 acres) and large lakes

>404.7 hectares (>1,000 acres). Ponds < 10 acres were excluded from the dataset as they are not consistently/comprehensively mapped. The number of size classes (called network complexity within the NE Freshwater Resilience Analysis Report) was measured as a count of stream and lake size classes found within a functionally connected network. The metric ranged from 1 to 9, and was calculated and coded systematically for each network. To ensure that we counted only size classes that had a substantial expression in the stream network, we developed the following criteria based on discussion with experts: size class 1 > 1.6 km length, size class 2 > 3.2 km, size class 3 and up > 4.8 km. For example, a total of 0.5 km length of stream in size class 1 in a network was not counted as an example of that size class because it was too small to represent a full expression of the biota and processes expected for a size 1 stream.

To calculate this attribute for the networks that were not included in the original NE Freshwater Resilience Analysis, we first calculated the number of stream size classes using a file obtained from The Nature Conservancy's Eastern Division Science office containing all of the individual stream segment classifications as well as their BATNETIDs, or the unique functionally connected network ID (Fcn_wuse1_curr112013), clipped to our NY freshwater project boundary. A class was counted as present in the network if the total length of stream in the size class in the network (using sequential selection by attributes, the frequency tool, and summary statistics) met the following criteria: class 1 streams (1a, 1b) > 1.6 km length, size class 2 > 3.2 km, size class 3 and up > 4.8 km. To then include large and small lakes as an additional two classes to include in the sum for each network we used the North Atlantic Habitat Classification System lakes dataset to identify those 10-1000 acres and >1000 acres. Ponds/lakes smaller than 10 acres were eliminated because they are not consistently or comprehensively mapped across the region. We joined this file to the stream segments that the NE Freshwater Resilience Analysis had flagged as containing a lake, using mean as the decision rule in case any segments contained more than 1 lake, but nothing resulted in a non-whole number. To ensure that networks connected to a Great Lake or the ocean received a count for having a large lake, we used the field LakeFlag in the NE Freshwater Resilience Analysis dataset for networks included in their analysis, and did a selection by location intersection (with a 100 m buffer) to identify a connection to a Great Lake or the Atlantic Ocean for the remaining smaller networks left out of the original analysis but included in ours. To create the final Size Class Count field for each network, we added the stream size class count to the lake size class count and then added an additional class if the network was connected to a Great Lake but did not have a LakeMaxSizeClass=2. We then combined our calculations for these smaller networks with those from the Eastern Division's original analysis to create a single class count field.

Finally, we crosswalked these results to the NHD Plus version 2 stream reaches (and subreaches where broken by dams within a reach and separating multiple networks). See the detailed crosswalk methods associated with the "NHD Plus Version 2 to FW Resilience FCN BATNET IDs Crosswalk" layer described in the "Additional Facilitating Layers" section at the end of this document. NHD Plus V2 segments were assigned scores and labels based on how they were crosswalked:

ITcode =
Null, 3,4,5,6, 9 or 10: segments were assigned their V1 score and values.
0, 7, 8 (BatnetID_per_ComID also null or neg): tiny network, new in NHDv2, assigned score of 100.

The number of size classes within the connected network was used to assign a value between 0 - 100 to each stream segment for use in the Habitat Explorer composite climate sensitivity score, according to the table below. Higher score values indicate a higher degree of sensitivity to climate change.

Size class variety within connected network	Displayed Value	Score
Tiny stream network not evaluated-reaches new in NHD Plus V2	Null	100

Tiny network, no classes met length threshold	-9	100
Tiny network with lake, no stream size classes met length threshold	-8	100
1 -2	Real count	100
3-4	Real count	75
5*	Real count	50
6-7	Real count	25
8-9	Real count	0

* this was the cutoff used for complex networks for the regional analysis

Attributes

ITCODE: Iteration code to note at which step BATNETID was assigned to the NHDPlus Version2 stream segment that had been split using the snapped regional dams as used in the original analysis, as described in full in the full metadata document under “NHD Plus Version 2 to FW Resilience FCN BATNET IDs Crosswalk”. Segments coded as Null, 3,4,5,6, 9 or 10 were assigned their V1 network scores and values. Segments coded as 0, 7, 8 (BatnetID_per_ComID also null or negative) mostly represent tiny networks new in NHDv2 assumed to fall within the most sensitive scoring classes due to their short length and assumed lack of size class, slope, and temperature variety.

BATNET_per_COMID: number of unique FCN networks associated with a NHDPlus Version1 stream reach.

SZ_CLASSES: concatenated text string listing the unique stream and lake size classes found within the FCN network (ex. “11_12_20_LL_”, “11_12_31_32_SL_”, “11_12_20_”, etc.).

SSTR_SZCLCT: count of the unique stream and lake size classes meeting required thresholds present in the functionally connected network (FCN) that the stream is a part of.

SSTR_SZCLCT_score: the sensitivity score assigned based on the count of the unique size classes found within the FCN network.

SSTR_SZCLCT_label: description of the SSTR_SZCLCT_score used for the legend.

FCN_V2_vs_V1_Label: label describing how the NHDPlus Version2 stream segment was assigned to a Version 1 FCN network.

Streams: Climate Sensitivity\SCORED Slope Variety

Summary

Resilient stream systems are those that will support a full spectrum of biodiversity and maintain their functional integrity even as species compositions and hydrologic properties change in response to shifts in ambient conditions due to climate change. We examined all connected stream networks in the freshwater project boundary for New York State, excluding only segments with drainage areas < 1 mi2 due to inconsistencies in how these small headwaters were mapped across quads in the source NHD Plus. We looked at four physical properties correlated with resilience: network length, network complexity (number of size classes), number of gradient classes and number of temperature classes. We counted the number of each class type within a connected network. A network was defined as a continuous system of connected streams bounded by dams or upper headwaters. Our analysis uses the products that under laid the NE Freshwater Resilience Analysis, and we used their methods to determine the complexity metrics for small headwater and creek networks that were excluded from the NE Freshwater Resilience analysis due to thresholds and cutoffs they applied because of the regional scale of their analysis.

Methods

Methods followed those used by the Northeast Freshwater Resilience Analysis report at https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/fwresilience/Pages/default.aspx but expanded the geographic scope of that analysis to include smaller networks left out of that dataset, but still greater than > 1 mi2 drainage area that were included in the Northeast Connectivity Analysis (Martin and Apse 2011) and thus had dams snapped and qced around them. (Note comids/arcs with drainage areas < 1 mi2 were not included due to inconsistencies in how these small headwaters were mapped across quads and across states in the northeast in the source NHD Plus). We also then crosswalked these results to the NHD Plus Version 2 dataset to be compatible with others in our analyses.

Gradient (Slope) Classes:

To assess the number of gradient classes in a functionally connected stream network, Anderson and Olivero 2008, first classified every stream and river segment into one of four possible slope classes, following the "4 level" gradient class recommendations for streams and rivers in the Northeast Aquatic Habitat Classification (Streams: <0.1 percent, 0.1-0.5 percent, 0.5-2 percent, >2 percent, Rivers: <0.02 percent, 0.02 < 0.1 percent, 0.1 < 0.5 percent, >= 0.5 percent Anderson and Olivero 2008, Figure 5). The number of distinct gradient classes found in each connected network was tallied and our metric was a count of gradient classes. Based on discussion with experts, we used a minimum criteria of >= 0.8 km total length of a class to qualify as present. This ensured that we counted only gradient classes that had a substantial expression in the stream network.

To calculate this for the networks missing from the original regional analysis that we wanted to include, we used a file obtained from The Nature Conservancy's Eastern Division Science office containing all of the individual stream segment classifications as well as their BATNETIDs, or the unique functionally connected network ID (Fcn_wuse1_curr112013), clipped to our NY freshwater project boundary to:

1. The length of arcs in each network in each temperature class was summed using the frequency tool, with BATNETID and SLP_CL4F as the frequency fields and LengthKM as the summary field.
2. Only selected records that had more than 0.8km, and saved the selection as a file.
3. Used the Frequency tool again to collapse this back down to a single row per slope class, and saved that as a file.
4. Used the Summary Statistics tool with the output table from above as the input table, BatnetID as the case field and SLP_CL4F as the statistics field with Count, and saved this as a table.

We then combined our calculations for these smaller networks with those from the Eastern Division's original analysis to create a single class count field. We then crosswalked these results to the NHD Plus version 2 stream reaches (and subreaches where broken by dams within a reach and separating multiple networks). See the detailed crosswalk methods associated with the "NHD Plus Version 2 to FW Resilience FCN BATNET IDs Crosswalk" layer described in the "Additional Facilitating Layers" section at the end of this document. V2 segments were assigned scores and labels based on how they were crosswalked:

ITcode =
Null, 3,4,5,6, 9 or 10: segments were assigned their V1 score and values.

0, 7, 8 (BatnetID_per_ComID also null or neg): tiny network, new in NHDv2, assigned score of 100.

The number of gradient classes within the connected network was used to assign a value between 0 - 100 to each stream segment for use in the Habitat Explorer composite climate sensitivity score, according to the table below. Higher score values indicate a higher degree of sensitivity to climate change.

Number of gradient classes within the connected network	Score
Tiny stream network not evaluated-reaches new in NHD Plus V2	100
Tiny network, no classes met length threshold	100
Existing variety all too short to count	100
1	100
2	66
3	33
4	0

Attributes

SSTR _SLPCLCT: the total number (count) of gradient classes with >=0.8km summed length across the functionally connected network that the stream is a part of.

SSTR_SLPCLCT_score: the sensitivity score assigned based on the count of the unique slope classes found within the FCN network.

SSTR_SLPCLCT_label: description of the SSTR_SLPCLCT_score used for the legend.

Streams: Climate Sensitivity\SCORED Temperature Variety

Summary

Resilient stream systems are those that will support a full spectrum of biodiversity and maintain their functional integrity even as species compositions and hydrologic properties change in response to shifts in ambient conditions due to climate change. We examined all connected stream networks in the freshwater project boundary for New York State, excluding only segments with drainage areas < 1 mi^2 due to inconsistencies in how these small headwaters were mapped across quads in the source NHD Plus. We looked at four physical properties correlated with resilience: network length, network complexity (number of size classes), number of gradient classes and number of temperature classes. We counted the number of each class type within a connected network. A network was defined as a continuous system of connected streams bounded by dams or upper headwaters. Our analysis uses the products that under laid the NE Freshwater Resilience Analysis, and we used their methods to determine the complexity metrics for small headwater and creek networks that were excluded from the NE Freshwater Resilience analysis due to thresholds and cutoffs they applied because of the regional scale of their analysis.

Methods

Methods followed those used by the Northeast Freshwater Resilience Analysis report at https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/fwresilience/Pages/default.aspx but expanded the geographic scope of that analysis to include smaller networks left out of that dataset, but still greater than > 1 mi^2 drainage area that were included in the Northeast Connectivity Analysis (Martin and Apse 2011) and thus had dams snapped and QC'd around them. (Note comids/arcs with drainage areas < 1 mi^2 were not included due to inconsistencies in how these small headwaters were mapped across quads and across states in the northeast in the source NHD Plus). We also then crosswalked these results to the NHD Plus Version 2 dataset to be compatible with others in our analyses.

Temperature Classes:

The Northeast Aquatic Habitat Classification System assigns every stream reach to one of four expected natural water temperature classes, based on the relative proportion of cold water to warm water species in stream fish composition: cold, cool transitional, warm transitional, and warm. Stream reaches were assigned to a temperature class using a CART model based on stream size, local base flow index, upstream air temperature, and stream gradient (details in Anderson and Olivero 2008). Temperature complexity for this study was measured by a count of the number of temperature classes found in the connected network. To ensure that we counted only temperature classes that had a substantial expression in the stream network, we developed the following criteria based on discussion with experts: size class 1 > 1.6 km length, size class 2 > 3.2 km, size class 3 and up > 4.8 km.

To calculate this for the networks missing from the original regional analysis that we wanted to include, we used a file obtained from The Nature Conservancy's Eastern Division Science office containing all of the individual stream segment classifications as well as their BATNETIDs, or the unique functionally connected network ID (Fcn_wuse1_curr112013), clipped to our NY freshwater project boundary to:

1. The length of arcs in each network in each temperature class (NETEMPCL) was summed using the frequency tool.
2. A class was counted as present in the network if the total length of stream in the temperature class in the network met the following criteria: class 1 streams (1a, 1b) > 1.6 km length, size class 2 > 3.2 km, size class 3 and up > 4.8 km. We implemented this by selecting by attributes (and repeatedly adding to current selection) and saved the selection as a table:

a. (NE_SZCL = '1a' OR NE_SZCL = '1b') AND LENGTHKM >=1.6
    b. (NE_SZCL = '2_') AND LENGTHKM >=3.2
    c. (NE_SZCL = '3a' OR NE_SZCL = '3b' OR NE_SZCL = '4_') AND LENGTHKM >=4.8

3. We collapsed the resulting table to a single row per temperature class using the Frequency tool, and saved that as a file.
4. We then used the ArcGIS summary statistics tool using the above table as an input, BatnetID as the case field and NETEMPCL as the statistics field with Count.
5. Finally, we then joined that temperature class count to BATNETID in the shapefile containing the small networks in NY that were excluded in the original NE Freshwater Resilience Analysis.

We then combined our calculations for these smaller networks with those from the Eastern Division's original analysis to create a single class count field. We then crosswalked these results to the NHD Plus version 2 stream reaches (and subreaches where broken by dams within a reach and separating multiple networks). See the detailed crosswalk methods associated with the "NHD Plus Version 2 to FW Resilience FCN BATNET IDs Crosswalk" layer described in the "Additional Facilitating Layers" section at the end of this document. V2 segments were assigned scores and labels based on how they were crosswalked:

ITcode =
Null, 3,4,5,6, 9 or 10: segments were assigned their V1 score and values.
0, 7, 8 (BatnetID_per_ComID also null or neg): tiny network, new in NHDv2, assigned score of 100.

The number of temperature classes within the connected network was used to assign a value between 0 - 100 to each stream segment for use in the Habitat Explorer composite climate sensitivity score, according to the table below. Higher score values indicate a higher degree of sensitivity to climate change.

Number of temperature classes in the connected network	Score
Tiny stream network not evaluated-reaches new in NHD Plus V2	100
Tiny network, no classes met length threshold	100
Existing variety all too short to count	100
1	100
2	66
3	33
4	0

Attributes

SSTR _TMPCLCT: count of the unique temperature classes found within the FCN network.

SSTR_TEMPCLCT_score: the sensitivity score assigned based on the count of the unique temperature classes found within the FCN network.

SSTR_TEMPCLCT_label: description of the SSTR_TEMPCLCT_score used for the legend.

Streams: Climate Exposure\Streams Exposure Score

Summary

Climate exposure for freshwater streams is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for climate exposure were changes in stream temperature class, extreme precipitation, annual aridity, summer maximum temperature, number of days below freezing, growing degree days, total annual precipitation, and total summer precipitation. Scores were applied to reaches in the NHD+v2 network. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of climate change exposure, based on available evidence and expert opinion. Input indicators used for climate exposure for streams were changes in stream temperature class, extreme precipitation, annual aridity, summer maximum temperature, number of days below freezing, growing degree days, total annual precipitation, and total summer precipitation. These indicators directly or indirectly measure the degree to which ecologically relevant climate variables are expected to change due to the changing climate. Systems with high exposure to climate change are expected to experience more rapid and/or extreme change that could have greater impacts on habitat structure and function. Since there is considerable variability and uncertainty in predictions of future climate, exposure indicators reflect a relative degree of change rather than a specific future value.

The selected indicators were each scored on a range of 0-100, where 0 indicates no meaningful level of change, and 100 indicates the greatest degree of change predicted within the study area. Scoring was based on the absolute value of change, and so was unaffected by the direction of change (e.g. wetter or drier). In most cases, quantiles were used for scoring since ecological thresholds for climate change impacts are not well understood. In all cases, higher scores indicate a relatively greater degree of change in climate conditions, as compared to other locations in the study area.

Each scored indicator was spatially attributed to the same base habitat dataset. For streams, the NHD+V2 stream segments were used as the unit of analysis. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each unit. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. Since most of the input variables are scored on a relative basis, and the underlying data are at a coarse resolution, the resulting score should only be used as a guide for planning and does not replace finer-scale data. We encourage users to monitor for climate change impacts and supplement or substitute this information with their own observed or modeled data as appropriate.

Attributes

ESTR_Escore_all: overall stream exposure to climate change score (0-100). 0 is low, 100 is high.

Streams: Climate Exposure\SCORED Change in Stream Temperature Class

Summary

Stream temperature classes were developed for New York by USGS and partners as an important component of simulating fish species distributions for both current and future scenarios (Stewart et al, *2016*). Climate change is expected to alter hydrological systems through changes in instream flow, stream temperature, and habitat. These changes in turn can have a profound effect on aquatic systems resulting in changes in fish distribution and community composition. The aquatic ecosystems that inhabit the freshwater streams in the Great Lakes region and New York are particularly vulnerable to climate changes because of the gradients of cold-cool-warm aquatic thermal habitats and associated diverse biological communities.

Methods

For a full description of the work including methods and attribute descriptions, please see: Stewart, J.S., Covert, S.A., Estes, N.J., Westenbroek, S.M., Krueger, Damon, Wieferich, D.J., Slattery, M.T., Lyons, J.D., McKenna, J.E., Jr., Infante, D.M., and Bruce, J.L., 2016, FishVis, A regional decision support tool for identifying vulnerabilities of riverine habitat and fishes to climate change in the Great Lakes Region: U.S. Geological Survey Scientific Investigations Report 2016–5124, 15 p., with appendixes, http://dx.doi.org/10.3133/sir20165124.

Stream water temperature was estimated from an ANN model that was developed to predict daily summertime water temperature from measured water temperature coupled with static landscape characteristics and dynamic climate time series. The landscape characteristics were acquired from the Great Lakes Aquatic GAP project, as described by Brenden and others (2006) and the National River Fish Habitat Condition Assessment (Wang and others, 2011). The climate data consisted of air temperature time series from weather stations (National Oceanic and Atmospheric Administration, 2011) for the current time period and future projections of air temperature from downscaled regional climate models. We chose to use ANN models because they are able to handle non-linear relations, interactions among predictors, discontinuous time-series climate data, and are relatively quick to develop while still having high predictive power. The approach also provided a mechanism by which downscaled regional climate model results could be incorporated to estimate the effect of climate change on stream temperature and ultimately fish species occurrence.

We then crosswalked these results to the NHD Plus version 2 stream reaches. See the detailed crosswalk methods associated with the "NHD Plus Version 2 to USGS FishVIS/Aqua GAP Reach IDs Crosswalk" layer described in the "Additional Facilitating Layers" section at the end of this document. Unassessed V2 streams either beyond the FishVIS data extent or which were not matched to a V1 stream were left as unassessed.

The change in stream temperature class for each segment was used to assign a value between 0 - 100 to each stream segment for use in the Habitat Explorer composite climate exposure score, according to the table below. Higher score values indicate a greater amount of change in climate variables.

Change in stream temperature class	Score
Unassessed, assumed no change*	0
No change	0
1 class change	50
≥ 2 class change	100

*Segments unassessed in FISHVIS dataset (49373) plus new V2 segments (1207)

Attributes

FV_V1COMID: COMID from the FishVis source data (Stewart et al. 2016), which was matched ("crosswalked") to the V2 stream reaches.

JULclass: current July stream temperature class.

JLCLF1: predicted future July stream temperature class.

CHJLCLF1: text string that lists both the current and future stream temperature classes.

ESTR_TEMP_CHG_score: scored predicted stream temperature change.

ESTR_TEMP_CHG_label: descriptive label that states the direction and number of stream temperature classes encompassed by the change, upon which the scoring is based.

Streams: Climate Exposure\SCORED Change in Summer Maximum Temperature

Summary

Change in maximum temperature for summer months (June, July, and August) was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in average summer maximum temperature between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to the corresponding NHD+V2 stream reaches, and binned by quantile. These ranges were then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in summer max temp	Class label	Score
4.1 to 4.5 degree (F) change	Least change	0
4.5 to 4.6 degree (F) change	Less change	25
4.6 to 4.8 degree (F) change	Moderate change	50
4.8 to 5.1 degree (F) change	More change	75
5.1 to 6.0 degree (F) change	Most change	100

Attributes

HUC_8: HUC8 ID (text string).

HUC_8d: HUC8 ID (number without leading zeros).

h8zone: simplified ID field for the HUC8 to facilitate joins and computations.

basin: ID field from the source NARCCAP data.

avgt_ANN: change in average annual temperature (degrees F).

maxt_JJA: change in summer maximum temperature (degrees F).

mint_DJF: change in winter minimum temperature (degrees F).

maxt_JJA_score: exposure score associated with the change in summer maximum temperature.

maxt_JJA_label: display label for the change in summer maximum temperature exposure score.

maxt_JJA_label2: display label (#2) for the change in summer max temperature exposure score.

Streams: Climate Exposure\SCORED Stream Change in Days below Freezing

Summary

The change in days below freezing was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based on four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in days below freezing between historical (1970-2000) and future (2041-2070) time periods was reported by HUC 8 basins that overlap with NY. These values were attributed to the corresponding NHD+V2 stream reaches, and binned by quantile. These ranges were then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Days below Freezing	Class label	Score
-20.1 to -24.5 degree (F) change	Least change	0
-24.5 to -25.0 degree (F) change	Less change	25
-25.0 to -25.9 degree (F) change	Moderate change	50
-25.9 to -27.0 degree (F) change	More change	75
-27.0 to -27.8 degree (F) change	Most change	100

Attributes

tx95_ANN: change in number of days above 95 degrees F.

tx32_ANN: change in number of days below freezing (32 degrees F).

tx32_ANN_score: exposure score associated with the change in number of days below freezing.

tx32_ANN_label: display label for the change in number of days below freezing exposure score.

tx32_ANN_label2: display label (#2) for the change in # of days below freezing exposure score.

Streams: Climate Exposure\SCORED Stream Change in Growing Degree Days

Summary

The change in annual growing degree days was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in annual growing degree days between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to the corresponding NHD+V2 stream reaches, and binned by quantile. These ranges were then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Growing Degree Days	Class label	Score
660.2 to 725.5 GDD (50F) change	Least change	0
725.5 to 772.1 GDD (50F) change	Less change	25
772.1 to 807.2 GDD (50F) change	Moderate change	50
807.2 to 869.1 GDD (50F) change	More change	75
869.1 to 911.5 GDD (50F) change	Most change	100

Attributes

gdd50_ANN: change in growing degree days (base temperature = 50 degrees F [10 degrees C]).

gdd50_ANN_score: exposure score associated with the change in growing degree days.

gdd50_ANN_label: display label for the change in growing degree days exposure score.

gdd50_ANN_label2: display label (#2) for the change in growing degree days exposure score.

Streams: Climate Exposure\SCORED Stream Aridity Change

Summary

The Aridity Index is a metric of moisture stress in a system (lower aridity index represents higher moisture stress) and is calculated from precipitation and Potential Evapotranspiration (PET). PET represents the water that an ecosystem could potentially use though evaporation and transpiration. PET is higher with warmer temperatures and more daylight hours. The ratio of precipitation (AET) to PET was summed over all months for a given year, with the modification that precipitation is capped at PET for each month (no surplus is considered when calculating this version of the Aridity Index). Change in aridity was calculated by subtracting the historical average from the future projection, and was smoothed to a 30m resolution. A positive change indicates that water stress is predicted to be lower in the future, while negative values indicate greater water stress under climate change. Aridity Index data were obtained from climatewizardcustom.org for 1962-1991 and a future projection for 2040-2069, using the ensemble average circulation model and the A2 scenario.

Methods

Please see the detailed methods for this variable in the Climate section below. Data on aridity were obtained from climatewizardcustom.org.

Change in aridity was calculated by subtracting the historical 1962-1991 average from the future 2040-2069 projection, and was smoothed to a 30m resolution. The average value of the cells coincident with a NHDPlus Version2 stream segment within each stream reach catchment was determined and then scored.

Quintile rank of aridity change in NY	Score
1st quintile	0
2nd quintile	25
3rd quintile	50
4th quintile	75
5th quintile	100

Attributes

aridity_chg: change in Aridity Index.

ESTR_ARIDITY_CHANGE_score: exposure score associated with the change in Aridity Index.

ESTR_ARIDITY_CHANGE_label: display label for the change in Aridity Index exposure score.

Streams: Climate Exposure\SCORED Stream Change in Total Annual Precipitation

Summary

Change in total annual precipitation was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in total annual precipitation between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to the corresponding NHD+V2 stream reaches, and binned by quantile. These ranges were then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Total Annual Precipitation	Class label	Score
1.1 to 1.5 inch change	Least change	0
1.5 to 1.7 inch change	Less change	25
1.7 to 2.0 inch change	Moderate change	50
2.0 to 2.4 inch change	More change	75
2.4 to 2.8 inch change	Most change	100

Attributes

pcpn_ANN: change in total annual precipitation (inches).

pcpn_ANN_score: exposure score associated with the change in total annual precipitation.

pcpn_ANN_label: display label for the change in total annual precipitation exposure score.

pcpn_ANN_label2: display label (#2) for the change in total annual precipitation exposure score.

Streams: Climate Exposure\SCORED Stream Change in Total Summer Precipitation

Summary

Change in total summer (June, July, August) precipitation was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in total summer precipitation between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to the corresponding NHD+V2 stream reaches, and binned by quantile. These ranges were then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Total Summer Precipitation	Class label	Score
-0.1 to -0.4 inch change	Least change	0
-0.4 to -0.5 inch change	Less change	25
-0.5 to -0.7 inch change	Moderate change	50
-0.7 to -0.9 inch change	More change	75
-0.9 to -1.1 inch change	Most change	100

Attributes

pcpn_DJF: change in winter precipitation (inches).

pcpn_MAM: change in spring precipitation (inches).

pcpn_JJA: change in summer precipitation (inches).

pcpn_SON: change in fall precipitation (inches).

pcpn_1_ANN: change in precipitation greater than 1 inch (inches).

pcpn_JJA_score: exposure score associated with the change in summer precipitation.

pcpn_JJA_label: display label for the change in summer precipitation exposure score.

pcpn_JJA_label2: display label (#2) for the change in summer precipitation exposure score.

Streams: Climate Exposure\SCORED Change in Extreme Precipitation

Summary

This represents the average increase in the frequency of extreme precipitation events from 2011 to 2050. The two event types/sizes used to create the average are large precipitation accumulations over a single day (24 hours) with current recurrence intervals of 1) 10 years and 2) 100 years. In other words, in 2050, how much more often can we expect to see the amount of precipitation that currently is a 100 year recurrence event (1% chance of happening in any year)? Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org), and predictions for a wider variety of events, along with the historical context, can also be viewed for here: http://ny-idf-projections.nrcc.cornell.edu.

Methods

See Climate\Extreme Precipitation for more detail on the source data.

The gridded 0.5 degree resolution extreme precipitation data from Cornell was scored according to how much more frequent events with the same magnitude as what is currently either a 10-year or a 100-year event would become, as shown in the table below, where a high score indicates increased exposure to more frequent flooding by more frequent extreme precipitation events. The scores from the 10-year and 100-year events were averaged together and rounded to the nearest integer to create the final score. The scores were then spatially assigned to individual stream reach segments based on which extreme precipitation cell contained a majority of the stream reach's catchment.

Future return period for a 100y event	Future return period for a 10y event	Change in frequency
100	10	100% = unchanged
87.5	8.75	125% as often
75	7.5	150% (1.5 times) as often
62.5	6.25	175% as often
50	5	200% (twice) as often

Range in future return period: 100y	Range in future return period: 10y	Score
100 - 87.5	10 - 8.75	0
87.5 - 75	8.75 - 7.5	25
75 - 62.5	7.5 - 6.25	50
62.5 - 50	6.25 - 5.0	75
<50	<5.0	100

Attributes

CUR1D100YMAG_IN: current magnitude (in inches) of a 1-day duration extreme precipitation event with a 100-year recurrence interval (a 1% chance of occurring during any given year).

FUTA2100YMAG_PCTCHG: percent change in magnitude of a future 100y event. (ex. if a stream that would currently experience a 100-year event that equates to 10 inches of precipitation is expected to see a 10% increase in its 100-year magnitude, then future 100-year events would be expected to have an 11 inch magnitude (10 + 1/10th of 10 = 10 + 1 = 11).

FUTA2_C100Y_FRECUR: the expected recurrence interval in the future for extreme precipitation events having the same magnitude as an event that currently has a 100-year recurrence interval.

CUR1D10YMAG_IN: current magnitude (in inches) of a 1-day duration extreme precipitation event with a 10-year recurrence interval (a 10% chance of occurring during any given year).

FUTA210YMAG_PCTCHG: percent change in magnitude of a future 10y event.

FUTA2_C10Y_FRECUR: the expected recurrence interval in the future for extreme precipitation events having the same magnitude as an event that currently has a 10-year recurrence interval.

STR_XPPT_100Y_FRECUR: score associated with the increased future frequency of extreme precipitation events of the same magnitude as a current 100-year event.

STR_XPPT_10Y_FRECUR: score associated with the increased future frequency of extreme precipitation events of the same magnitude as a current 10-year event.

ESTR_XPPT_FUT_RECUR_score: average score based on the increased future frequencies of 100-year and 10-year extreme precipitation events.

ESTR_XPPT_FUT_RECUR_label: display label for the final averaged score (ex. "Occurs [at least] 1.75 times more often").

Streams: Recommendations

Includes the following layers (various symbologies of the same dataset):

Stream Recommended Objective

Stream Objective Maintain Group

Stream Objective Reduce Threat Group

Stream Objective Restore Group

Stream Objective Reduce Threat/Restore Group

Stream Highest Climate Risk Group

Stream Low Climate Risk Group

Summary

The recommended objective map is based on the relative value of the summary Condition, Threat, Exposure and Sensitivity scores generated from a variety of indicator data. Our theory is that adaptation planning should be informed by all four types of information, and that it is possible and useful to identify a best general objective from the combination of these four components. Primary conservation objectives are identified based on the combination of Condition and Threat (distinguished by color family), and ratings of relative climate risk to conservation success are based on Exposure and Sensitivity (distinguished by shade). See the complete Methods in the Habitat Explorer app. Due to the uncertainties in the underlying data, and the averaging nature of the summary algorithms, these recommendations are intended only as a general guide and screening tool, and should not override local knowledge or expertise.

Methods

The normalized index for each of the component scores of Condition, Threat, Exposure and Sensitivity (methods described above), were transformed into a binary class for high and low values, as follows:

Factor	'Low' Score Range	'High' Score Range
Condition	0 - 66	67 - 100
Threat	0 - 32	33 - 100
Exposure	0 - 49	50 - 100
Sensitivity	0 - 49	50 - 100

These thresholds were purposely biased to increase the sensitivity of the analysis to problems with condition and threat, such that a small number of low-rated condition indicators would lead to a 'low' overall score for condition, and a small number of high-rated threat indicators would lead to a 'high' overall score for threats.

Each of the possible 16 combinations of low and high classes were assigned a general conservation objective (based on the Current Condition and Future Threat) and a relative level of climate risk (using Climate Change Exposure and Sensitivity), according to the table below:

C: 0:<67, 1:>67	T: 0:<33 1:>33	S: 0:<50, 1:>50	E: 0:<50, 1:>50	STRAT_CD	STRAT_DESC
1	0	0	0	1000	Maintain - Lower risk
1	0	0	1	1001	Maintain – Moderate risk
1	0	1	0	1010	Maintain – High risk
1	0	1	1	1011	Maintain - Highest risk
1	1	0	0	1100	Reduce Threats – Lower risk
1	1	0	1	1101	Reduce Threats – Moderate risk
1	1	1	0	1110	Reduce Threats – High risk
1	1	1	1	1111	Reduce Threats – Highest risk
0		0	0	0	Restore – Lower risk
0		0	1	1	Restore – Moderate risk
0		1	0	10	Restore – High risk
0		1	1	11	Restore – Highest risk
0		0	0	100	Reduce Threat & Restore – Lower risk
0		0	1	101	Reduce Threat & Restore – Moderate risk
0		1	0	110	Reduce Threat & Restore – High risk
0		1	1	111	Reduce Threat & Restore – Highest risk

In general, the principles underlying these recommendations are straightforward. Condition and Threat can first be considered independent of climate change. Areas that are currently in a good condition and have low future threats are assumed to be functional and self-sustaining, requiring little intervention beyond monitoring. A maintain objective does not imply that the resource should be held in a static state and prevented from changing, but rather that any change that occurs is expected to follow natural ecological dynamics. Areas that are in good condition now, but that have modeled threats that could meaningfully reduce condition in the future, are recommended to focus on threat reduction strategies to secure the long-term status of the resource. If conditions are poor, but the sources of degradation no longer occur and future declines are not predicted, then it is recommended to focus on restoration of condition. If conditions are poor and there are ongoing or new threats predicted to cause further declines, restoration will have limited benefit unless managers also address the threats or plan for ongoing active management in the long term. Either way, management of these areas is likely to be difficult and resource-intensive.

These four general recommended objectives are then refined to account for the level of climate change risk. We use climate risk to describe both the risk of potential negative impacts from climate change, and the risk of uncertain outcomes for management, due to both the changing climate and the unpredictability of ecological response. We assign a risk level based on sensitivity and exposure, whereby risk is lowest when both sensitivity and exposure are low, and highest when both are high. When only one factor is high, we weight sensitivity higher than exposure, for two reasons. First, high exposure is expected to have less impact if sensitivity is low. Second, we have greater uncertainty in our measures of exposure since they are rated on a relative basis, we do not know how much our exposure score represents meaningful differences in ecological impact, and there is inherent uncertainty in the underlying climate models. For these reasons we chose to take a conservative approach that if exposure is higher than expected, high sensitivity will greatly increase risk.

These recommendations are intended only as a general guide and screening tool. In particular, due to the uncertainties in the underlying data and the averaging nature of the summary algorithms, these recommendations should not override local knowledge or expertise. Consult the Navigator Guidebook (http://www.naturalresourcenavigator.org/get-started/guidebook/) for help refining these objectives based on other information in the Navigator, additional data that may be available to the user, and the user's own professional judgement.

Attributes

CSTR_Cscore_all: overall stream current condition score (0-100). 100 is good condition, 0 is poor condition.

TSTR_Tscore_all: overall stream future threat score (0-100). 0 is low threat, 100 is high threat.

ESTR_Escore_all: overall stream exposure to climate change score (0-100). 0 is low, 100 is high.

SSTR_Sscore_all: overall stream sensitivity to climate change score (0-100). 0 is low, 100 is high.

Cgoodpoor: overall condition score broken into binary 0/1 low (0-66) and high (67-100) categories.

Tgoodpoor: overall threat score broken into binary 0/1 low (0-32) and high (33-100) categories.

Egoodpoor: overall exposure score broken into binary 0/1 low (0-49) and high (50-100) categories.

Sgoodpoor: overall sensitivity score broken into binary 0/1 low (0-49) and high (50-100) categories.

STRAT_digits: concatenated CTES binary scores to give unique combinations (number).

STRAT_code: concatenated CTES binary scores to give unique combinations (text string).

STRAT_DESC: description that combines the recommended general conservation objective (based on the Current Condition and Future Threat) and a relative level of climate risk (using Climate Change Exposure and Sensitivity).

null_exclude: code to identify stream reaches where one or more required scored indices is not available (null) and thus the combined CTES recommendation cannot be determined. Primarily for stream reaches outside of New York.

labelorder: used to order recommendation groups for the map the legend.

Streams: Supporting Data\Stream Geology

Summary

Classes of buffering capacity of stream geology were determined by the Northeast Aquatic Habitat Classification System (Olivero and Anderson 2008). The goal of that effort was to develop a standard classification system and GIS dataset to describe and map stream systems across thirteen northeastern states (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and District of Columbia.). They designed the classification and GIS dataset to consistently represent the natural flowing-water aquatic habitat types across the region in a manner deemed appropriate and useful for conservation planning by the participating states. The aquatic habitat types were structured after the "macrohabitat" level of classification of Higgins et al. 2005 which defines individual stream reach or lake types based on variables that influence aquatic communities at the reach scale and that can be modeled in a GIS. Stream geology buffering capacity is a critical factor determining aquatic biological assemblages and was included as one of four variables: stream size, gradient, temperature class and geology.

Aquatic organisms need water pH to be within a certain range for optimal growth, reproduction, and survival. Most aquatic organisms prefer pH of 6.5-8. Streams and lakes with calcium carbonate concentrations less than 2 mg/L and pH levels below 5, no longer support fish and many other forms of aquatic biota. Certain types of aquatic biota are also only found in very highly buffered or calcareous streams with pHs continuously near or above a pH of 8. Water chemistry parameters such as pH, acid neutralizing capacity, and conductivity are strongly influenced by the minerals and ions that leech out of underlying bedrock and surficial material.

Methods

The relationship of the mapped bedrock and surficial geology types in the eastern U.S. acid neutralizing capacity of the bedrock were developed by 1) investigating the relationship of underlying geology to known stream pH locations, 2) studying Norton's (1980) descriptions of the formations and visually overlaying of Norton's maps with the compiled eastern regional geology dataset, and 3) examining the relationships between rare aquatic species and geology.

Attributes

COMID: the link field to any NHD Plus 1:100,000 Version 1 arc related attribute (e.g. stream classification size, gradient, temp class etc.).

NEGEOCL: stream and river geology class.

D_NEGEOCL: stream and river geology class description.

Citation

For more information regarding the Northeast Aquatic Habitat Classification System, go to http://rcngrants.org/content/northeastern-aquatic-habitat-classification-project.

Simplified classification data and reports can be downloaded here:

https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/mapsdata/Pages/default.aspx.

Olivero, A.P. and M.G. Anderson. 2008. Northeast aquatic habitat classification system. The Nature Conservancy, Eastern Regional Office in collaboration with Northeast Association of Fish and Wildlife Agencies, 88 pages.

Streams: Supporting Data\Stream Size

Summary

Stream size classes were determined by the Northeast Aquatic Habitat Classification System (Olivero and Anderson 2008). The goal of that effort was to develop a standard classification system and GIS dataset to describe and map stream systems across thirteen northeastern states (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and District of Columbia.). They designed the classification and GIS dataset to consistently represent the natural flowing-water aquatic habitat types across the region in a manner deemed appropriate and useful for conservation planning by the participating states. The aquatic habitat types were structured after the “macrohabitat” level of classification of Higgins et al. 2005 which defines individual stream reach or lake types based on variables that influence aquatic communities at the reach scale and that can be modeled in a GIS. Stream size is a critical factor determining aquatic biological assemblages and was included as one of four variables: stream size, gradient, temperature class and geology.

Methods

The Northeast Aquatic Habitat Classification System delineated seven size classes for streams based on their catchment drainage area: headwater (1a), creek (1b), small river (2), medium tributary (3a), medium mainstem (3b), large river (4), and great river (5) and two major lake size classes, small-medium lakes 4.1 – 404.7 hectares (10-1,000 acres) and large lakes >404.7 hectares (>1,000 acres). Ponds < 10 acres were excluded from the dataset as they are not consistently/comprehensively mapped. For the full methodology, please see Olivero and Anderson 2008.

Attributes

COMID: the link field to any NHD Plus 1:100,000 Version 1 arc related attribute (e.g. stream classification size, gradient, temp class etc.).

NESZCL: stream and river size class.

D_NESZCL: stream and river size class description.

Citation

For more information regarding the Northeast Aquatic Habitat Classification System, go to http://rcngrants.org/content/northeastern-aquatic-habitat-classification-project.

Simplified classification data and reports can be downloaded here:

https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/mapsdata/Pages/default.aspx.

Olivero, A.P. and M.G. Anderson. 2008. Northeast aquatic habitat classification system. The Nature Conservancy, Eastern Regional Office in collaboration with Northeast Association of Fish and Wildlife Agencies, 88 pages.

Streams: Supporting Data\Stream Slope

Summary

Stream gradient or slope classes were determined by the Northeast Aquatic Habitat Classification System (Olivero and Anderson 2008). The goal of that effort was to develop a standard classification system and GIS dataset to describe and map stream systems across thirteen northeastern states (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, West Virginia, and District of Columbia.). They designed the classification and GIS dataset to consistently represent the natural flowing-water aquatic habitat types across the region in a manner deemed appropriate and useful for conservation planning by the participating states. The aquatic habitat types were structured after the "macrohabitat" level of classification of Higgins et al. 2005 which defines individual stream reach or lake types based on variables that influence aquatic communities at the reach scale and that can be modeled in a GIS. Stream gradient is a critical factor determining aquatic biological assemblages and was included as one of four variables: stream size, gradient, temperature class and geology.

Stream gradient influences stream bed morphology, flow velocity, sediment transport/deposition, substrate and grain size. The presence of riffles is a key factor determining the types of fish and invertebrate assemblages present and gradient generally separates streams with a well-developed pool-riffle-run habitat structure from flat streams or step pool streams.

Methods

The final NAHCS quantitative gradient classes were developed by 1) studying breaks used in the existing state classifications and examining the relationship of gradient classes to known places in the region and 2) studying rare species distributions across gradient classes. As to the former, many states used a qualitative description of stream gradient in their aquatic habitat descriptions (e.g. high gradient, moderate gradient, low gradient), but these had different meanings depending on the state. To calibrate this, they circulated maps of regional gradient patterns and asked the team members whether the proposed regional breaks represented the major patterns of gradient and related stream biotic changes noted on the ground in their states. Gradient is measured as the slope of the flow line, calculated as rise over run and notated as a percentage.

Attributes

COMID: the link field to any NHD Plus 1:100,000 Version 1 arc related attribute (e.g. stream classification size, gradient, temp class etc.).

NESLPCL: stream and river slope class.

D_NESLPCL: stream and river slope class description.

Citation

For more information regarding the Northeast Aquatic Habitat Classification System, go to http://rcngrants.org/content/northeastern-aquatic-habitat-classification-project.

Simplified classification data and reports can be downloaded here:

https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/mapsdata/Pages/default.aspx.

Olivero, A.P. and M.G. Anderson. 2008. Northeast aquatic habitat classification system. The Nature Conservancy, Eastern Regional Office in collaboration with Northeast Association of Fish and Wildlife Agencies, 88 pages.

Streams: Supporting Data\Stream Current Temperature Class

Summary

Stream temperature classes were developed for New York by USGS and partners as an important component of simulating fish species distributions for both current and future scenarios (Stewart et al, 2016). Climate change is expected to alter hydrological systems through changes in instream flow, stream temperature, and habitat. These changes in turn can have a profound effect on aquatic systems resulting in changes in fish distribution and community composition. The aquatic ecosystems that inhabit the freshwater streams in the Great Lakes region and New York are particularly vulnerable to climate changes because of the gradients of cold-cool-warm aquatic thermal habitats and associated diverse biological communities.

Simulations of fish species occurrence and stream temperature can be displayed under current and future conditions based on 13 different global circulation models. These data are available for viewing in "FishVis," a web-based decision-support mapping application. It was developed to help users visualize potential climate-driven responses for thermally representative fish species in streams across the Great Lakes region.

Methods

Stream water temperature was estimated from an ANN model that was developed to predict daily summertime water temperature from measured water temperature coupled with static landscape characteristics and dynamic climate time series. The landscape characteristics were acquired from the Great Lakes Aquatic GAP project, as described by Brenden and others (2006) and the National River Fish Habitat Condition Assessment (Wang and others, 2011). The climate data consisted of air temperature time series from weather stations (National Oceanic and Atmospheric Administration, 2011) for the current time period and future projections of air temperature from downscaled regional climate models. We chose to use ANN models because they are able to handle non-linear relations, interactions among predictors, discontinuous time-series climate data, and are relatively quick to develop while still having high predictive power. The approach also provided a mechanism by which downscaled regional climate model results could be incorporated to estimate the effect of climate change on stream temperature and ultimately fish species occurrence.

Attributes

JULclass: current Thermal class (July mean) (Lyons and others, 2009): Late 20th Century (present day).

JLCLF1: predicted future Thermal class (July mean) (Lyons and others, 2009): Mid 21st Century (2046-2065).

CHJLCLF1: text string that lists both the current and future temperature classes to identify the Change in thermal class (July mean): Mid 21st Century (2046-2065) minus Late 20th Century (present day).

Limitations

The stream temperature and habitat changes presented are not predictions of what will happen in the future so much as they are representations of what might happen given a set of assumptions about future energy development and use.

Citation

For a full description of the work including methods and attribute descriptions, please see: Stewart, J.S., Covert, S.A., Estes, N.J., Westenbroek, S.M., Krueger, Damon, Wieferich, D.J., Slattery, M.T., Lyons, J.D., McKenna, J.E., Jr., Infante, D.M., and Bruce, J.L., 2016, FishVis, A regional decision support tool for identifying vulnerabilities of riverine habitat and fishes to climate change in the Great Lakes Region: U.S. Geological Survey Scientific Investigations Report 2016–5124, 15 p., with appendixes, http://dx.doi.org/10.3133/sir20165124.

Streams: Supporting Data\Regional Dams & Obstacles

Summary

Locations of dams and other significant anthropogenic barriers that affect aquatic connectivity and that were used to separate and delineate Functionally Connected stream Networks (FCNs). Based on the National Inventory of Dams supplemented by each state's dataset of dam locations. We show this version, created in 2013, because it was used to create the stream networks in the Northeast Freshwater Resilience Analysis conducted by The Nature Conservancy (Anderson et al. 2013b) and used as indicators of Stream Sensitivity in the Natural Resource Navigator. For current information on the location and status of dams in NY as well as their attributes, please see http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1130.

Methods

Data was provided by The Nature Conservancy, Eastern Conservation Science and had previously been used in the Northeast Freshwater Resilience study. Data was clipped to the freshwater study extent.

Attributes

Unique_ID: unique identifier string for the dam, including the state abbreviation.

DAM_NAME: Name of the above dam.

Limitations:

From NYS DEC's Dam Inventory Dataset: 1. While we try to maintain an accurate inventory, this data should not be relied upon for emergency response decision-making. We recommend that critical data, including dam location and hazard classification, be verified in the field. The presence or absence of a dam in this inventory does not indicate its regulatory status. Any corrections should be submitted to the Dam Safety Section with supporting information. 2. There are approximately 15 dams not included in this dataset because they do not have X Y locations.
New York State Department of Environmental Conservation (NYSDEC) provides these geographic data "as is". NYSDEC makes no guarantee or warranty concerning the accuracy of information contained in the geographic data. NYSDEC further makes no warranty, either expressed or implied, regarding the condition of the product or its fitness for any particular purpose. The burden for determining fitness for use lies entirely with the user. Although these data have been processed successfully on a computer system at NYSDEC, no warranty expressed or implied is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes. This disclaimer applies both to individual use of the data and aggregate use with other data. It is strongly recommended that careful attention be paid to the contents of the metadata file associated with these

data. NYSDEC shall not be held liable for improper or incorrect use od the data described and/or contained herein.

Citation:

Anderson, Mark, Arlene Olivero Sheldon, Colin Apse, Alison A. Bowden, Analie R. Barnett, Braven Beaty, Catherine Burns, Darran Crabtree, Doug Bechtel, Jonathan Higgins, Josh Royte, Judy Dunscomb, and Paul Marangelo. 2013b. Assessing Freshwater Ecosystems for their Resilience to Climate Change (a.k.a. the Northeast Freshwater Resilience Analysis report). The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/fwresilience/Pages/default.aspx

Streams: Supporting Data\Lateral Connectivity

Summary

Areas within the Active River Area with contiguous natural land cover that is adjacent to the stream channel. In size 2 and larger rivers, these areas could provide for connectivity between overbank flows and floodplains therefore providing flood attenuation benefits. For headwater streams and larger, these could also represent forested, shrub or otherwise vegetated riparian buffers which could offer water purification benefits.

The percentage of the ARA or base zone floodplain portions of the ARA that were laterally connected to the stream channel as measured by having contiguous natural land cover adjacent to ARA input water cells were calculated for scoring the stream condition and threat indicators. These indicators are referred to as indicators of “Floodplain Connectivity”.

Methods

This analysis uses the Active River Area, which is based upon dominant processes and disturbance regimes to identify areas within which important physical and ecological processes of the river or stream occur. The framework identifies five key subcomponents of the active river area: 1) material contribution zones, 2) meander belts, 3) riparian wetlands, 4) floodplains, and 5) terraces (Smith et al. 2008). See more at: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/floodplains/Pages/default.aspx#sthash.wpDofAnH.dpuf

For larger streams (NEAHC size classes 2+), lateral connectivity is related primarily to processes related to overbank flow from the river across the floodplain. For headwater and small streams (size classes 1a and 1b), lateral connectivity is related primarily to processes of material contribution and allochthonous inputs by surrounding natural areas to the stream system (as well as being partially related to amount in stream buffers, at least for smaller streams where ARA is mostly the 30 m. buffer width) and not by extensive wetlands and baseflow zones.

The different processes involved and other previous dichotomous treatment of headwater stream networks compared to floodplain rivers (see Upper Delaware River Assessment report) lead to the different treatment of 1a and 1b streams relative to size 2+ rivers:

For headwater and small streams (1a & 1b), the full ARA minus water input cells was considered as the base against which the % in natural habitat cover and contiguously adjacent to the input water cells was calculated for each catchment (mapped 1:1 to NHD stream reach).

For small and large rivers (classes 2+), just the base flow zones of the ARA minus water input cells were considered as the base against which the % in natural habitat cover and contiguously adjacent to the input water cells was calculated for each catchment (mapped 1:1 to NHD stream reach).

This was necessary also from a sample size perspective because the ARA of many 1a streams was almost entirely composed of input water or material contributing zones with few pixels within zones of base flow. This modification to use the full ARA should help to partly ameliorate stochastic fluctuations in the index value associated with dividing with a small denominator. Note: it doesn't entirely do away with the problem when it comes to catchments of extremely small size (example, catchment between nodes of incoming tributaries separated by just a few tens of meters).

INPUTS:

- Active River Area attributed to zone (input water, baseflow, & material contributing zones) and to NEAHC size class.
- Natural cover (excludes ag and developed) within the ARA, developed for Floodplain Complex (FPC) delineation using 2011 and 2050 hybrid habitat LULC.
- NHD catchments for indicator percent area calculations.

STEPS:

1. Create analysis extent [hereafter "LatARA"]: Use full ARA (minus input water cells) for NEAHC size class 1a & 1b headwater and small streams (as coded into the ARA data); ARA base flow zones only (still excluding input water cells) for size class 2 and larger rivers. All raster cells within the analysis extent/mask, coded as "1" with everything else nodata.

2. Subset natural cover: extract areas of natural cover from ARA-wide input natural cover that fall within the LatARA, coded as "1" with everything else nodata.

3. Extract water cells: extract all input water cells in full ARA data, coded as "1" with everything else nodata.

4. Create cost surface where input water cells = 0 cost, natural habitat = 0 cost, and everything else within the LatARA (ag, dev) = 1 cost.

5. Calculate cost distance with source = input water raster (#3) and the cost raster being the one developed above (#4).

6. Extract laterally-connected natural habitat contiguously adjacent to ARA input water cells (the streams): use conditional statements to pull out those cells where the costdistance equals zero and which were not source input water cells.

The resulting raster data (raster value equals 1) shows the extent of the laterally connected areas within the ARA.

Attributes

VALUE: all values equal 1 and all non-nodata grid cells represent areas that are laterally connected to the stream and river input water areas of the ARA.

Citations

Fanok, S., M. DePhilip, E. Creveling, M.-B. DeLucia, and T. Moberg. 2010. A Freshwater Conservation Assessment for the Upper Delaware River Basin: Floodplains, Headwaters, Wetlands, and Freshwater Conservation Areas. The Nature Conservancy's Delaware River Basin Integrated Landscape Team.

Olivero, A. and M. G. Anderson. 2008. Northeastern Habitat Classification System. The Nature Conservancy, Boston, MA.

Streams: Supporting Data\Stream Floodplain Complexes

Summary

As part of the NY Freshwater Conservation Blueprint analyses, NY Natural Heritage identified floodplain complexes within each Ecological Drainage Unit (EDU) to help assess the condition of river and stream systems in the study area. NHP used the Active River Area (ARA) data coupled with NHD-Plus stream reach flowlines to which had been added NEAHC stream size class classifications to define floodplain complexes in the following way, modified slightly from the Delaware Assessment (Fanok et al. 2010):

- Floodplain core: Areas of contiguous natural cover greater than 150 acres in the ARA. NHP also created cores with > 250 acres of natural cover (the original threshold used in the Delaware Assessment) as a comparison. Only floodplains for rivers with drainage areas greater than 200 sq. miles were included in the analysis.

- Floodplain corridor: Includes cores and "Natural and undeveloped cover patches of any size along a stream reach that contains a core" (corridor rule 2a) and "Natural and undeveloped cover patches greater than 100 acres that are adjacent to a core" (corridor rule 2b).

- Floodplain complex: Unites floodplain "cores and corridors along major rivers and across rivers of different sizes". These were created by first manually merging and grouping adjacent floodplain cores and corridors along the same stretch of river into unique complex units and then lumping floodplain complexes within 2 km. of other complexes into larger floodplain complex groups (mapped as "hotdog" shaped buffers surrounding the stream reaches associated with each complex group).

For the current analysis we modified this approach in four important ways:

1. We expanded the analysis to include floodplains along small rivers with drainage areas greater than 38 sq. miles (NEAHC size class 2 small rivers) for the same reason that NHP reduced the threshold acreage requirement of floodplain cores; namely, because smaller floodplains throughout New York but especially within the Upper Susquehanna River Basin and across the Southern Tier were underrepresented in the original Freshwater Blueprint dataset. For New York, we felt including the floodplains of these small rivers was appropriate because two important transitions begin at approximately this size: rivers transition from erosional to transfer and/or depositional zones. Because of these changes to available habitat, fish assemblages also begin to change (Olivero and Anderson 2008).

2. We restricted the selection of “Natural and undeveloped cover patches of any size along a stream reach that contains a core” (corridor rule 2a) to those reaches containing cores where the ARA river size class and the NEAHC reach size class matched. We did this to avoid systematic errors we encountered associated with the reach COMID reassignment process whereby included into the 2a corridors were all small scattered patches of natural cover within extensive and/or widely disconnected areas along tributary streams segments or non-isolated lake shorelines many reaches separated from the reach of the original core.

3. To compensate for the areas excluded due to the second modification above, we applied a less strict definition of contiguous when defining a class of secondary cores: Areas of contiguous natural cover greater than 150 acres in the ARA inclusive of patches that are adjacent at any location (i.e. corner-touches allowed) and of patches separated by no more than 70 m. of open water. The first condition allows inclusion of long thin linear floodplain features less than 30 m. wide (our analysis cell size) that might be broken into lots of little offset yet still touching cells during the vector to raster conversion process. The second condition allows inclusion of blocks of floodplain only separated by the channels of incoming tributaries or side channels as well as large blocks of floodplain on opposite banks of a small river which individually total less than 150 acres but collectively exceed 150 acres.

4. The analog of the 2b corridor rule for these “secondary cores”, which already extended many corridors into adjacent reaches, was to then include any patches of undeveloped cover (both natural and ag combined) directly adjacent to the secondary cores, which themselves have already met the over 100 acre 2b requirement). In this case, in order to be conservative in not extending the floodplain complex concept too loosely, corner-touch adjacency was not allowed. (Note, this may be revisited upon further peer review.)

The result was the identification of additional “coreless” floodplain corridors and complexes along the larger rivers analyzed for the NY Freshwater Conservation Blueprint, plus a large number of complexes along small rivers previously excluded from analysis, that were missing in the previously delivered Task 4 products.

Methods

ARA areas within the study area were clipped from the full ARA dataset covering the entire northeastern U.S. obtained from the Eastern Division office of The Nature Conservancy. Raster attribute data includes both ARA zone identification as well as ARA size class information.

NHD-Plus reach catchments and flowlines with associated NEAHC reach size classes were obtained from the NY Natural Heritage Program.

The determination of natural and undeveloped (natural + ag) cover within the ARA was made based on the current 2011 hybrid habitat classification map developed for this project.

Preparation of the input data, assigning reach COMIDs to ARA areas, and determination of primary cores was done following the methodology and steps detailed in the ArcPy scripts provided by the NYNHP and described in the appendix of the NY Freshwater Conservation Blueprint report, except that statewide data was processed collectively rather than iteratively for each EDU.

Detailed modification steps (briefly described above) used to limit rule 2a corridors, delineate secondary cores, determine modified 2b corridors, automate the manual clumping of cores and corridors into unique floodplain complexes, and assign membership of these individual complexes to larger Floodplain Complex Groups based on maximum separation of sequential (upstream-downstream) complexes of no more than 2 km. (corresponding to the "hotdog" Floodplain complex buffers used by NYNHP) are documented in the additional metadata that accompanies the GIS file geodatabases containing the final Floodplain Complex data.

Attributes

FPcoreID: unique identifier for each Primary core.

CRRD1_ID: identifier for Primary cores grouped if connected by Secondary cores, also reused as unique identifier for secondary cores.

FPcmplexID: unique identifiers for each Floodplain Complex and assigned to the constituent cores and corridors that make it up.

FPC_GRP_ID: unique identifiers for each Floodplain Complex Group (assigned to Group "hotdog" buffers only).

CORE_N, CRRD_N, and CMPLX_N: the count per floodplain complex (or floodplain complex group) of the number of individual primary cores and secondary cores (and floodplain complexes) per floodplain complex (or floodplain complex group).

CMPLXTYPE: code describing the floodplain complex as containing at least one primary core (1) or only containing secondary cores (2).

GRP_TYPE: code describing the floodplain complex group as containing at least one floodplain complex with at least one primary core (1) or only containing floodplain complexes with secondary cores (2).

Max_NESZCL: maximum NEAHC reach size class within the floodplain complex group.

Max_TIDAL: code to describe if the floodplain complex group contains tidal reaches (1) or not (0).

Limitations

These data are not to be distributed or made accessible to anyone other than staff of the New York State Chapters of The Nature Conservancy without written permission from The New York Natural Heritage Program.

Citations

White, E.L., J.J. Schmid, T.G. Howard, M.D. Schlesinger, and A.L. Feldmann. 2011. New York State freshwater conservation blueprint project, phases I and II: Freshwater systems, species, and viability metrics. New York Natural Heritage Program, The Nature Conservancy. Albany, NY. 85 pp. plus appendix. http://nynhp.org/FBP

Fanok, S., M. DePhilip, E. Creveling, M.-B. DeLucia, and T. Moberg. 2010. A Freshwater Conservation Assessment for the Upper Delaware River Basin: Floodplains, Headwaters, Wetlands, and Freshwater Conservation Areas. The Nature Conservancy's Delaware River Basin Integrated Landscape Team.

Olivero, A. and M. G. Anderson. 2008. Northeastern Habitat Classification System. The Nature Conservancy, Boston, MA.

Streams: Supporting Data\Active River Area Components

Summary

The Active River Area (ARA) framework is a spatially explicit, holistic view of rivers that includes both the channels and the riparian lands necessary to accommodate the physical and ecological processes associated with the river system. The framework informs river conservation by providing an approach to account for the areas and processes that form, change and maintain a wide array of habitat types and conditions in and along rivers and streams.

The ARA is divided into 5 zones: 1) input water cells = open surface water in rivers, streams, ponds, and lakes; 2) base zone wetflats = riparian wetlands (riverine and palustrine); 3) base zone non-wetflat = non-wetland floodplains, river terraces, and meander belts; 4) material contribution zone wetflats = wetlands and permanently wet flats (<2 % slope with a high flow moisture index) above the floodplain; and 5) material contribution zone non-wetflats = additional upland material contributing areas above the floodplain.

The functional floodplain and associated riparian wetlands can be pulled out of the ARA by extracting and combining the base zones (zones 2 and 3) for further analysis.

Methods

Three GIS techniques are used to identify the active river area. First, a cost surface was created using a 30-m resolution DEM and the PATHDISTANCE method (ESRI, 2006) to create a surface of the relative costs of traveling upslope from the stream. Second, to capture areas beyond those influenced by out-of-bank flows, “wet” riparian areas resulting from high groundwater and overland runoff from adjacent uplands were identified. This used a flow accumulation model with the 30-m DEM to identify locations that are permanently wet based on a high flow moisture index and a low (i.e., < 2%) slope. These areas were combined with known wetland occurrences from the National Wetland Inventory and the National Land Cover Data (NLCD). The third step adds the material contribution areas, which are identified as both headwater areas at the top of watersheds and areas 30-60m along each side of stream channels that are not otherwise captured by steps 1 and 2 above. 10%-relative elevation increments are determined for the entire watershed using the SLICE method.

ARA areas within the study area were clipped from the full ARA dataset covering the entire northeastern U.S. obtained from the Eastern Division office of The Nature Conservancy.

Attributes

VALUE: code that represents both the ARA base flow or material contribution zone and the size of the river or stream from which the Ara at that location was derived.

ARA_Label: descriptive label that simply describes the ARA by its corresponding base flow or material contribution zone regardless of stream size.

Citation

Smith, M.P., Schiff, R., Olivero, A. and MacBroom, J.G., 2008. THE ACTIVE RIVER AREA: A Conservation Framework for Protecting Rivers and Streams. The Nature Conservancy, Boston, MA. http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/floodplains/Pages/default.aspx

FORESTS

Forests: Current Condition\Forest Condition Score

Summary

Forest Condition is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for forest condition were patch size, forest regeneration, large snag density, relative canopy diversity, and invasive plant prevalence. Input data were at multiple scales, including counties, 216 km^2 hexagons, and 30m grids. Summary scores were calculated on a 30m grid for forested habitat types, and are best interpreted as general trends across a project area. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of forest condition, based on available evidence and expert opinion. Input indicators used for forest condition were patch size, forest regeneration, large snag density, relative canopy diversity, and invasive plant prevalence. These indicators directly or indirectly measure the degree of human modification of the system, which alters conditions beyond a range of naturally occurring variation. Natural systems with high condition are expected to be more diverse and productive, with greater ability to sustain function over time without intervention. Indicators were also selected to be spatially uncorrelated, in order to avoid biasing the final index by 'double-counting' multiple indicators that are driven by common factors.

The selected indicators were each scored on a range of 0-100, where 100 indicates a natural or unaltered state, and 0 indicates complete loss of the system or its functional or structural attributes. In some cases, absolute thresholds for acceptable variation are not well-documented, so even breaks or quantiles were used for scoring, with an underlying assumption that the full range of conditions exists within the project area, and that the trait varies linearly with condition without critical thresholds. In all cases, higher scores indicate higher condition, not necessarily higher values of the indicator.

Each scored indicator was spatially attributed to the same base habitat dataset. For forests, the NETWHC forest habitat types, as extracted from our Land Use/Land Cover layer, were used the define the extent of analysis on a 30m x 30m raster grid. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each pixel. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. Since some of the input variables are scored on a relative basis, and the data have varying spatial resolutions, the resulting score should only be used as a guide for planning and does not replace direct assessment of conditions on the ground. We encourage users to supplement or substitute this information with additional data and their own knowledge as appropriate.

Forests: Current Condition\SCORED Patch Size

Summary

This dataset represents forest patches greater than 10 acres within New York State. Forest patches are defined as areas of contiguous natural cover bounded by non-natural edge or linear fragmenting features (roads, railroads, transmission lines). Forest patches were delineated based on non-forest edge (from the NLCD) and the following linear fragmenting features:

- Electric transmission lines (from Ventyx, LLC, March 2013),
- Natural gas pipelines (from Ventyx, LLC, March 2013),
- Railroads (from 2008 ESRI StreetMap data), and
- Roads (from TIGER road dataset).

Methods

Analysis Boundary: The analysis was conducted for the states of New York and New Jersey.

Land Cover: Clipped the NLCD 2006 to the analysis boundary. The following land cover types were selected from the 2006 National Land Cover Database (NLCD) to define "natural cover": deciduous forest, coniferous forest, mixed [deciduous-coniferous] forest, scrub-shrub, woody wetland, and emergent wetland.

Transmission: Obtained the March 2013 Ventyx data (TNC's licenses Ventyx data and is hosted in TNC servers) representing electric transmission lines and natural gas pipelines, clipped them to the analysis boundary, merged them, and reprojected them.

Railroads: Clipped ESRI StreetMap 2008 railroad data to the analysis boundary and reprojected the shapefile.

Roads: Clipped TIGER roads datasets to the analysis boundary and reprojected them. Conversion from Polyline to Raster was successful for the TIGER dataset but not for the ESRI dataset.

Implemented the following steps for each of the 3 linear infrastructure datasets (roads [TIGER], transmission lines [Ventyx], and railroads [ESRI]) and put outputs in \temp_datasets folder:

1. Clipped each dataset to the analysis boundary and reprojected to regional Albers.
2. Added a new field to the infrastructure shapefiles called FRAG (type = short integer; precision = 4) and left it populated with zeros.
3. Convert to Raster: Used **Polyline to Raster** tool: Value field = FRAG, Cell assignment type = MAXIMUM_LENGTH, Priority field = NONE, Cellsize = nlcd06_nynj
    - Example output for railroads: \temp_datasets\rr
4. Reclassify NoData to 1s: Used **Reclassify** tool: reclass field = value
    - Example output for railroads: \temp_datasets\rr_recl
5. Merge infrastructure rasters: Used **Raster Calculator** tool: multiplied 3 infrastructure rasters together ("trans_recl" * "rr_recl" * "tiger_recl") → output = infracombo
6. Create natural vegetation raster: Use **Reclassify** tool on NLCD 2006; reclass field = value

Old Values	New Values
0 – 39	0
40 – 59	1
60 – 89	0
90 – 99	1
NoData	NoData

7. Combine infrastructure and natural vegetation rasters: Used **Raster Calculator** tool: multiplied infrastructure raster ("infracombo") and natural vegetation raster ("nat_veg") together → output = veginfracombo
8. Reclassify 0s to NoData: Used **Reclassify** tool: reclass field = value

9. Convert to Polygon: Used **Raster to Polygon** tool: Field = value; simplify polygons box was checked.
10. Add ACREAGE Field (type = double) and Calculate Acreage.

Patches were grouped into logistic size classes, roughly corresponding to functional thresholds for habitat quality and resilience to disturbance. The size classes were scored from 0 to 100, with lower values indicating poorer forest condition

Patch size	Score
<1	0
1-10	10
10-100	25
100-1,000	50
1,000-10,000	75
10,000-100,000	90
>100,000	100

Attributes

Value: Patch size class

Patch_Score: Condition score assigned to the patch size class

Patch_Label: Description of patch size class used for labeling

Limitations

This dataset is limited by the accuracy of the input infrastructure and NLCD 2006 data. While we calculated forest patches down to 0.15 of an acre, due to the transformation between raster and polygon, we encourage the user to focus on the larger than 10 Acre patches.

Forests: Current Condition\SCORED Invasive Plant Impact

Summary

Data on invasive plant abundance and frequency were extracted from FIA phase 2+ data for the 2009-2014 inventory. Invasive plant cover was calculated for each plot. Counties were scored based on a combination of average cover and the percent of plots with invasives. In some cases, counties with less than 5 plots were combined for scoring. Since these data are generalized across a large area, they indicate the probability of a particular forest stand having a problematic abundance of invasive plants, but actual conditions on the ground will vary widely and may be better or worse than scored in any given location.

Methods

FIA data were obtained from the U S Forest Service website, including the 2014 inventory cycle, and the recently added Phase 2+ expanded set of variables collected at a subset (about 12%) of plots. We used the data from the Invasive Plants inventory to obtain a count of plots with invasive plant species present and their average % cover. Because the phase 2+ data are not collected at every FIA plot, and because some parts of the state have lower forest cover, we aggregated the data across 2 or 3 counties in some cases in order to have at least 5 data points in each summary unit. These county-based units were then scored based on the frequency of invasives detection (the percent of plots with invasive present), and the average cover across plots. Counties where forest monitoring plots had the highest likelihood of having invasives, and the highest cover of them, were given the lowest scores for condition.

Invasives class (based on FIA frequency and percent cover)

Detection Frequency	Avg Cover	Invasives Class	Score
High (>75%)	Med (10-30%) or High (>30%)	5	0
High (>75%)	Low (<10%)	4	25
Med (25-75%)	Med (10-30%) or High (>30%)	3	25
Med (25-75%)	Low (<10%)	2	50
Low (10-25%)	Low (<10%) or Med (10-30%)	1	75
Very low (0-10%)	Low (<10%)	0	100

Attributes

Value: Invasives class

InvIndex_Score: Condition score assigned to the invasives class

InvIndex_Label: Description of patch size class used for labeling

Citations

For a full description of the FIA methodology, see the Field Manual here: http://www.fia.fs.fed.us/library/field-guides-methods-proc/

For a documentation of the FIA database and analysis, see the User Guide here: http://www.fia.fs.fed.us/library/database-documentation/

Forests: Current Condition\SCORED Large Snag Density

Summary

Large snags provide important wildlife habitat and may be less abundant in stands that have been clearcut, highgraded, or harvested too frequently. It is possible that high snag density may also result from a large disturbance event and at high values may become detrimental to forest health, but maximum thresholds have not been established.

Methods

FIA data were obtained from the U S Forest Service website, including the 2014 inventory cycle. The average density of large snags (standing dead trees greater than 12 inches DBH) per acre was calculated for each plot. The plots were attributed to our hexagon grid and an average value calculated per hexagon. Each hex was scored from 0 to 100 using thresholds derived from criteria from the NPS Vital Signs project (http://www.natureserve.org/sites/default/files/publications/files/tierney_faber-langendoen_mitchell_monitoring_forest_integrity_frontiers_2009.pdf) and the Forest Guild recommendations for retention of large snags during harvests. (https://www.forestguild.org/publications/research/2010/FG_Biomass_Guidelines_NE.pdf)

Large snag density (# lg snags per acre)	Score
< 2	0
2-4	33
5-9	67
>= 10	100

Attributes

Value: Average large snag density (standing dead trees greater than 12 inches DBH per acre) by hex

Citations

For a full description of the FIA methodology, see the Field Manual here: http://www.fia.fs.fed.us/library/field-guides-methods-proc/

For a documentation of the FIA database and analysis, see the User Guide here: http://www.fia.fs.fed.us/library/database-documentation/

Forests: Current Condition\SCORED Forest Regeneration

The dataset is a regeneration index with a four-part rating scale, representing the adequacy of regeneration based on seedling and sapling abundance data from the Forest Inventory and Analysis Database. The index includes seedlings and saplings for all native canopy species, excluding non-native and understory trees. These ratings in the regeneration index can be interpreted as the sufficiency of regeneration to tolerate varying levels of browse pressure and/or other stresses such as invasive plants. They also provide a guide to determine if management actions are warranted.

Methods:

Based on the methods used for the PRS by McWilliams et al. (1995), we calculated a regeneration index based on seedling and sapling abundance. We modified the seedling and sapling weighting applied by McWilliams et al. (1995), since the standard FIA data does not include some data collected by the PRS (USDA 2001). The PRS included seedlings above 2 inches tall and height data for all stems. This enabled them to weight stems by height class, which we substituted with the equivalent diameter class (Table 2). The weighting factors were included in the calculation of a forest regeneration index (FRI) for each microplot:

FRI = 20 * Ct(seedlings) + 50 * Ct(saplings)

Where Ct(x) is the count of stems at each microplot. Since we did not have the data to split the seedlings into finer height classes, we applied the higher weighting of 20 to give all seedlings maximum weight in the index. Index values for the four microplots were summed to obtain a value for each independent FIA plot. These values were assigned to a category on a four-part scale rating the adequacy of regeneration and we calculated the percentage of plots falling in each category. We used the regeneration adequacy criteria for deer impact classes used in SILVAH2 (Marquis et al. 1992) as the basis for minimum index thresholds, adjusted to scale proportionally with our use of both seedlings and saplings at all four microplots combined (See table below).

Description of forest regeneration categories derived from thresholds for deer browse impact classes from SILVAH (Marquis et al. 1992).

Category	Index Range	Equivalent stem density	Description	Level of Concern: Recommended Action
Poor	0-200	Not more than 769 seedlings or 307 saplings per acre	Regeneration inadequate under any level of browse pressure	Very High: Intervention likely required
Fair	201-400	770-1538 seedlings or 308-615 saplings per acre	Regeneration sufficient under low browse pressure	High: Intervention possibly needed, further evaluation required
Good	401-600	1539-2308 seedlings or 616-923 saplings per acre	Regeneration sufficient under moderate browse pressure	Medium: Continue monitoring using FIA
Very Good	>600	More than 2308 seedlings or 923 saplings per acre	Regeneration sufficient to tolerate high or severe browse pressure	Low: Continue moni

Each FRI value was mapped to the corresponding plot location in GIS. While we recognize that FIA plot coordinates are fuzzed and swapped for landowner privacy, we considered the introduced error to be acceptable for this statewide analysis, given that fuzzing is restricted to within 1 mile and only a portion of private plots are swapped with similar plots within the same county. We used the point data to model predicted value surfaces for canopy FRI with ordinary kriging using Geostatistical Analyst in ArcGIS 9.3.1. A full sector, 4-neighbor spherical neighborhood without anisotropy was used to retain local-scale variation. The models were selected to reduce mean predicted error and approach a value of one for root-mean-square standardized error (ESRI 2001). The final interpolated surface was masked by forest cover (NLCD 2001) to reflect forest patches 200 acres or greater in size.

Regeneration index for canopy species	Score
0-200	25
200-400	50
400-600	75
>600	100

Attributes

Value: Regeneration index class

Regen_Score: Score assigned to the regeneration index class

Regen_label: Range of values for regeneration index class, used for labeling

Citation

See Shirer and Zimmerman (2010) for a complete description of the regeneration analysis: http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/placesweprotect/easternnewyork/final-nys-regen-091410-2.pdf

Limitations

Given the natural variation in regeneration across forest types and site conditions, and the lack of clear guidance in the scientific literature on sustainable levels of regeneration for different forests, use of a universal rating scheme should be interpreted with caution. These data are best used to evaluate regional patterns, and caution should be used when inferring regeneration to direct management at the local scale.

Forests: Current Condition\SCORED Relative Canopy Diversity

Summary

Index of relative diversity of canopy tree species as compared to the average canopy diversity of the corresponding forest type, evaluated for USFS FIA plots and averaged across 50 km hexagons.

Methods

The data on canopy tree richness was obtained from the FIA database, downloaded from the US Forest Service website in 2013 and including inventory data through 2011. The number of canopy tree species was generated for each plot, and was subtracted from the average canopy richness of all plots in NY of the same forest type (according to the USFS classification) and within the same ecoregion. This allowed us to assess whether a plot was more or less diverse than expected. This relative richness was then averaged by the hexagonal grid, and the hexagons scored such that values around 0 (no different from type average) were given a middle-range condition score, negative values (less diverse than average) were given low scores, and positive values (more diverse than average) had the highest values.

Relative canopy richness (avg)	Score
<-2	0
-2- -0.5	25
<-0.5 – 0.5	50
0.5-2	75
>2	100

Attributes

Value: Relative canopy diversity class

RelSpR_Score: Condition score assigned to the canopy diversity class

RelSpR_Label: Description of canopy diversity class used for labeling

RelSpR_Descr: Description of the range of relative canopy richness values used to define the class

Citations

For a full description of the FIA methodology, see the Field Manual here: http://www.fia.fs.fed.us/library/field-guides-methods-proc/

For a documentation of the FIA database and analysis, see the User Guide here: http://www.fia.fs.fed.us/library/database-documentation/

Forests: Current Condition\Atmospheric Deposition Sensitivity

Summary

Although impacts from acid deposition have already affected current forest conditions, we chose to not include sensitivity to deposition as part of the summary Condition score. There was not a consistent statewide dataset on impacts from acid deposition to include in current condition; since deposition varies across the state, high sensitivity does not necessarily translate to higher impacts. Sensitivity to acid deposition was created by overlaying EPA alkalinity data and the reclassified Acidic Deposition effects on terrestrial ecosystems dataset developed by the Southern Appalachian Mountains Initiative. A sensitivity index was calculated based on the highest sensitive value from both data sets. The "unioned" data set was then dissolved by the new sensitivity value to create the final data set with 4 classes: Class 1- Most Sensitive, Class 2 - Sensitive, Class 3 - Marginally Sensitive, Class 4 - Not Sensitive. Note that some areas on Long Island and at the periphery of the state were not evaluated. This work was done by B.J. Cosby and C.T. Driscoll in a report to TNC, and the resultant map was published with other work in Lovett et al. (2009).

Attributes

Value: Sensitivity class code

Label: Sensitivity class description

Citation

Lovett, G. M., Tear, T. H., Evers, D. C., Findlay, S. E., Cosby, B. J., Dunscomb, J. K., Driscoll, C. T., & Weathers, K. C. (2009). Effects of air pollution on ecosystems and biological diversity in the eastern United States. *Annals of the New York Academy of Sciences*, *1162*(1), 99-135.

Forests: Future Threats\Forest Threat Score

Summary

Forest Threat is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for forest threat were change in local connectedness, change in patch size or fragmentation, invasive plants, and forest pest/pathogen risk. Input data were at multiple scales, including counties, and 30m grids. Summary scores were calculated on a 30m grid for forested habitat types, and are best interpreted as general trends across a project area. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of future forest condition, or threat, based on available evidence and expert opinion. Input indicators used for forest threat were change in local connectedness, change in patch size or fragmentation, invasive plants, and forest pest/pathogen risk. These indicators directly or indirectly measure future modification of the system, which could alter habitat conditions beyond a range of naturally occurring variation. Systems with high threat are expected to have eventual declines in diversity and productivity, and require intervention to maintain their current structure and function. Since it is not always possible to predict the location or degree of future habitat modifications, some threat indicators reflect the risk or likelihood of change, rather than an expected amount of change.

The selected indicators were each scored on a range of 0-100, where 0 indicates no meaningful level of alteration, and 100 indicates a level of threat that could lead to complete loss of the system or its functional or structural attributes. Scoring was based on the expected impact on habitat condition of the threat, not the change in the source of the threat itself. In some cases, thresholds for acceptable degree of modification were not well-documented, so even breaks, relative values, or number of changes in condition classes were used for scoring. In all cases, higher scores indicate a greater expectation of declines in future condition, not necessarily higher values of the indicator itself.

Each scored indicator was spatially attributed to the same base habitat dataset. For forests, the NETWHC forest habitat types, as extracted from our Land Use/Land Cover layer, were used the define the extent of analysis on a 30m x 30m raster grid. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each pixel. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. Since some of the input variables are scored on a relative basis, and the underlying data have varying spatial resolutions, the resulting score should only be used as a guide for planning and does not replace local-scale information. We encourage users to supplement or substitute this information with additional data and their own knowledge as appropriate.

Forests: Future Threats\SCORED Connectedness Change

Summary

To evaluate future landscape permeability, we used a method developed by The Nature Conservancy as part of the Resilient Sites regional analysis (Anderson et al., 2012).

From Anderson et al. (2012): Fragmentation, in combination with habitat loss, poses one of the greatest challenges to conserving biodiversity in a changing climate. Not surprisingly, the need to maintain connectivity has emerged as a point of agreement among scientists (Heller and Zavaleta 2009, Krosby et al. 2010). In theory, maintaining a permeable landscape, when done in conjunction with protecting and restoring sufficient areas of high quality habitat, should facilitate the expected range shifts and community reorganization.

The local connectedness metric measures how impaired the structural connections are between natural ecosystems within a local landscape. Roads, development, noise, exposed areas, dams, and other structures all directly alter processes and create resistance to species movement by increasing the risk (or perceived risk) of harm. This metric is an important component of resilience because it indicates whether a process is likely to be disrupted or how much access a species has to the microclimates within its given neighborhood.

Methods

We use the same method used to map local connectedness under current conditions, as described below under Forests: Sensitivity, but used our future land use/land cover map (details under Landuse/Landcover) as the input raster. The same resistance weights were used for both future and current analyses. A connectedness value was calculated for each 30-m natural raster cell within NY. We then used raster calculator to subtract the current connectedness from the future to obtain the predicted change in connectedness that would result from the predicted LULC changes. Forest lands that were converted to development or agriculture in the future land use model were assigned a code based on their future land use class. Change values were classed and scored to reflect the degree of threat to forest condition, from increases in connectedness scoring 0 (no threat) to complete loss of habitat scoring 100.

Change in connectedness (fut_traverse – cur_traverse)	Score
1-2 (habitat lost to ag or dev)	100
<-.5	75
-.5 - -.1	50
-.1 - 0	25
0-1	0

Attributes

Value: Connectedness change class

ConnLoss_Score: Threat score assigned to the connectedness change class

ConnLoss_Label: Description of connectedness change class used for labeling

Limitations

See Resilient Sites report. Since connectedness was only calculated for natural cover, lands that were converted to agriculture or development in the land use model received no value for future connectedness, and so change could not be calculated (we did not assume that connectedness of these cover types was zero).

Citation

The full report on the resilience analysis and methods can be found here: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/default.aspx

Forests: Future Threats\SCORED Fragmentation

Summary

Land use change can alter the health of terrestrial habitats by altering the shape, size, and spatial arrangement of habitat patches. In order to explore the impact of predicted land use changes on the configuration of natural habitat, we assessed habitat fragmentation using the modeled future land use/land cover map and proposed energy transmission lines. Data on future expansion of other linear fragmenting features, i.e. highways and railroads, were not available, so those features were assumed to not change from the current configuration. New residential roads are assumed to be captured within areas of future development.

Methods

The forest fragmentation analysis of habitat patch size previously conducted to identify forest patches greater than 10 acres within New York State by TNC-PA for TNC-NY was replicated for both current (2011) and future (2050) conditions using the updated landcover classification and extending the analysis to all counties that contain at least part of the extended freshwater boundary study area. The new analysis used a number of updated datasets not used in the original analysis in order to satisfy the increased spatial extent.

Landcover: Hybrid current (2011) and future (2050) habitat data was used as input. The Current "regional" habitat map prepared for the InVEST analysis was used to extend the landcover data regionally (future data only covers NY state). No changes in future condition were considered outside of NY State. Landcover (current and future) was recoded to forest or not forest based on a NLCD-to-NETWHC crosswalk table developed by NatureServe, such that all forests, shrublands, and forested and emergent wetlands (but not saltmarsh or "Glade and Savanna" grasslands) were considered forest. Only forested cells were retained.

Roads: Like for the previous analysis, the U.S. road dataset used was the 2014 TIGER Line roads from U.S. Census Bureau downloaded for each U.S. county in the study area and supplemented with Canadian roads downloaded from Open Street Map. Overlapping U.S. and Canada roads were removed. Lines coded so as to indicate they were not roads (pedestrian, bike, and bridle paths) were also removed.

Railroads: 2014 TIGER Line data for rail lines is only available as part of a national-scale coarser resolution dataset that fails to consistently distinguish between active and inactive or abandoned rail lines. State DOTs provide more current and often higher resolution data on active and inactive rails. As a result, GIS data was downloaded from DOTs for all states in the study region (NY [active only], PA, NJ, CT, RI, MA, VT, and NH [NH = PDF map only]), and coded as to their active, inactive, or abandoned status. Non-coincident TIGER rail data was also included to supplement inactive and abandoned lines in NY for completeness. All data was combined into one line feature dataset, then only the active lines were extracted for use in the analysis. In some cases rail lines are duplicated between state datasets and not exactly coincident, but it was beyond the scope of this project to determine which set of rail lines (if any) were the correct ones with respect to air photos and other ground-truthed data. Generally, overlapping rail lines should fall within the same or adjacent 30m grid cells, and forest slivers "between" the non-agreeing rail line positions will be too small to meet the 50 acre threshold used in this analysis, but it should be noted that the forest "cuts" along some rail lines may be wider than would be otherwise expected.

Electrical transmission lines and natural gas pipelines were extracted from a TNC-licensed Ventyx dataset for full US and clipped to extended study region. All existing transmission lines and gas pipelines were included for the current lines to represent Right-Of-Way (ROW) cuts through forests; all proposed lines and pipelines were added for the future lines. No other energy footprint data was used (the footprint data was only available as point data and not as polygon footprints).

Note that proposed transmission lines and pipelines were the only future addition to forest cuts explicitly added as data on proposed new highway and rail lines was not available. New residential roads within future developed areas expansion are implicitly included because areas new development represent conversion from natural cover to developed and are not included in forest cover.

All current linear "cut" features were combined into one vector line feature dataset then converted to 30m raster. The same was done for the future proposed "cut" features, and the current and proposed rasters were combined for the future "cuts" raster.

Areas of current and future forest LULC that fell within the counties of the analysis region and were not coincident with road/rail/powerline/piplelone ROW cuts were extracted and represent the current and future forest patches.

Raster forest patches were converted to polygons with the "simplify polygons" option applied to create smoothed edges and to connect raster cells that otherwise only meet corner-to-corner. ArcGIS's Multipart-to-Singlepart tool was used to separate noncontiguous forests into separate patches. Area was calculated (1 sq. m. = 0.000247105 acres) for each forest patch.

In order to compare future to current patch size, to evaluate potential change, we converted the patch polygons to raster and attributed each cell with the size of its membership patch. We could then calculate a future – current difference in patch size, and divide this by the current size to obtain a percent change. We also designated pixels that were newly converted to natural cover (and so had no current patch size value) and pixels converted to non-natural cover (and so had no future patch size). Scoreing was based on the scale and direction of change. The symbology for this layer shows detail within the increasing classes but these all received a zero in scoring for threat as a net gain in patch size represents no threat to forest condition regardless of the amount of increase.

Change in patch size	Score
Habitat lost	100
Habitat gained	0
>50% decline	75
25-50% decline	50
5-25% decline	25
<5% change	0
5-25% increase	0
25-50% increase	0
>50% increase	0

Attributes

Value: Fragmentation class assigned based on patch size change

Frag_Score: Threat score assigned to the patch size change class

Frag_Label: Description of patch size change class used for labeling

Limitations

The same limitation described for the future land use/land cover map apply here, with regard to both the spatial arrangement of natural cover and to the lack of predicted future changes in landcover beyond the borders of NYS. It is possible that not all proposed electric and gas transmission lines will be constructed, or that there may be additional transmission lines not currently proposed. It is also possible that new linear features, such as new highway exits, extensions, bypasses, and railroads will be built that are not currently proposed. In addition, flooding may force the future abandonment or movement of existing infrastructure.

Forests: Future Threats\SCORED Invasive Plants

Summary

The total number of high-threat invasive plant species for terrestrial habitats detected in the county is used as an indicator of potential invasion risk. Forest stands in areas with larger numbers of invasive plant species have a higher probability of one or more invasives becoming established in the forest interior. Data on presence of invasive species are combined from iMap (2013) and USFS FIA (2014).

Methods

iMap Invasives

A list of high threat invasive plant species was developed by a working grouping of TNC staff (Jordan, Zimmerman, and Shirer) utilizing results from the "New York State Plant Ranking System for Evaluating Non-Native Plant Species for Invasiveness". Invasive Species Assessment Score for 183 species and ranking system can be found at: http://www.nyis.info/?action=israt. Presence data were exported from the iMap database on 6/14/13 by iMap staff and processed by TNC to generate a count of priority invasives by county in NY. (iMapInvasives New York is New York State's on-line all-taxa invasive species database and mapping tool. http://www.nyimapinvasives.org/)

The dataset includes presence/absence data by county for 13 invasive plant species that were determined to be a high threat to terrestrial ecosystems in New York State. Naming convention follows USDA Plant Database (http://plants.usda.gov).

Scientific Name	Common Name	Symbol
Acer platanoides	Norway maple	ACPL
Alliaria petiolata	Garlic mustard	ALPE4
Berberis thunbergii	Barberry	BETH
Celastrus orbiculatus	Oriental bittersweet	CEOR7
Cynanchum louiseae	Black swallow-wort	CYLO11
Cynanchum rossicum	European swallow-wort	CYRO8
Cynanchum spp. (species unknown)	NA	NA
Euonymus alatus	Burningbush	EUAL
Polygonum cuspidatum	Japanese knotweed	POCU6
Polygonum sachalinense	Giant knotweed	POSA
Polygonum ×bohemicum	Bohemian knotweed	POBO10
Ligustrum obtusifolium	Border privet	LIOB
Lonicera maackii	Amur honeysuckle	LOMA6
Lonicera morrowii	Morrow's honeysuckle	LOMO2
Lonicera spp (species unknown)	NA	NA
Lonicera tatarica	Tatarian honeysuckle	LOTA
Lonicera x bella	Showy fly honeysuckle	LOBE
Lonicera xylosteum	Dwarf honeysuckle	LOXI
Microstegium vimineum	Japanese stiltgrass	MIVI
Persicaria perfoliata	Mile-a-minute	POPE10
Rhamnus cathartica	Common buckthorn	RHCA3
Rubus phoenicolasius	Wine raspberry	RUPH

Note: The highlighted species are the same genus and fill the same functional niche and were grouped for analysis.

FIA

FIA data were obtained from the US Forest Service website, including the 2014 inventory cycle, and the recently added Phase 2+ expanded set of variables collected at a subset (about 12%) of plots. We used the data from the Invasive Plants inventory to obtain a list of invasive plant species in each plot. These were restricted to our priority list of problematic invasives and summarized by county to obtain a county-level list of priority species present.

The two lists, FIA and iMap, were combined and duplicate records were removed. The resulting combined list by county was converted to a count of species, which was then scored from 0 to 100 as an indicator of the relative pressure of invasion on interior forests, with the assumption that a greater number of invasive plants present in the area created a higher risk that one or more could become established in a particular forest stand.

Number of priority invasive plant sp by county	Score
<=5	0
6-10	33
11-15	67
16-20	100

Attributes

Value: number of priority invasive plant species by county

InvRichness_Score: Threat score assigned based on the county invasives richness

Limitations

The iMap Database is populated by land managers and citizen scientist and survey effort is not consistent across the state. Additionally, species identification is not verified for all records. The iMap database is continually updated and distribution data may be out of date. While we attempted to enhance these data with the FIA inventory, those data are only available at a coarse resolution. We make an assumption that these data indicate a greater risk on invasion, but the vulnerability of a forest to invasion also depends on disturbances, vectors of dispersal, and local conditions.

Forests: Future Threats\SCORED Pest Pathogen Risk

Includes metadata for the following layers:

Beech Bark Disease Risk

Balsam Woolly Adelgid Risk

Emerald Ash Borer Risk

Hemlock Woolly Adelgid Risk

Maple Decline Risk

Oak Decline & Gypsy Moth Risk

Winter Moth Risk

Eastern Spruce Budwork Risk

Summary

Data layers were acquired from National Insect & Disease Risk Maps website (http://www.fs.fed.us/foresthealth/technology/nidrm2012.shtml) and include a composite map of the future risk of all pest and pathogens, and risk from eight individual pests. Data is depicted as % of total basal area lost.

Description from the FHTET website:

National Insect & Disease Risk Maps are a nationwide strategic assessment and database of the potential hazard for tree mortality due to major forest insects and diseases. The goal of NIDRM is to summarize landscape-level patterns of potential insect and disease activity, consistent with the philosophy that science-based, transparent methods should be used to allocate pest-management resources across geographic regions and individual pest distributions. In other words: prioritize investment for areas where both hazard is significant and effective treatment can be efficiently implemented.

Methods:

See: http://www.fs.fed.us/foresthealth/technology/nidrm2012.shtml for methods used by FHTET. No post possessing was done.

Pest/pathogen risk (pct loss of total basal area from all pest species, by 2027, predicted by NIDRM) was scored based on the recommended thresholds from NIDRM.

Pct loss of total basal area	Score
0-10	0
10-25	50
25-100	100

Attributes

Value: Pest/pathogen risk class

InvRisk_Score: Threat score assigned based on the percent loss of total basal area

InvRisk_Label: Description of pest/pathogen risk class used for labeling

Limitations

See: http://www.fs.fed.us/foresthealth/technology/nidrm2012.shtml

Forests: Future Threats\Pest Pathogen Host Abundances

Includes metadata for the following layers:

Beech Bark Disease Host Abundance

Balsam Woolly Adelgid Host Abundance

Emerald Ash Borer Host Abundance

Hemlock Woolly Adelgid Host Abundance

Asian Longhorned Beetle – Maple Host Abundance

Gypsy Moth & Winter Moth – Oak Host Abundance

Summary

We used modeled data on the basal area of individual tree species (USFS) to depict the host tree abundance and distribution of six forest pest and pathogens. These data, available at a 250 m scale statewide, were used to estimate what proportion of the basal area in any location was at risk. Forest pest and pathogens and associated host trees include:

Pests and Pathogens	Hosts Mapped
Asian Longhorned Beetle	Sugar and Red Maple
Balsam Wooly Adelgid	Balsam fir
Beech Bark Disease	American beech
Hemlock Woolly Adelgid	Eastern Hemlock
Emerald Ash Borer	White, green, and black ash
Gypsy and Winter Moth	Red, white, and chestnut oak

Methods

We used modeled data on the basal area of individual tree species available at a 250 m scale statewide (Wilson et al. 2013) from the USFS. Raster calculator was used to add host species basal area for Asian Longhorn beetle, emerald ash borer, and gypsy/winter moth.

Attributes

Pixel Value=The percent of total basal area of the mapped host tree species.

Limitations

See USFS dataset for limitations.

Citation

Wilson, Barry T.; Lister, Andrew J.; Riemann, Rachel I.; Griffith, Douglas M. 2013. Live tree species basal area of the contiguous United States (2000-2009). Newtown Square, PA: USDA Forest Service, Northern Research Station. http://dx.doi.org/10.2737/RDS-2013-0013

Forests: Climate Sensitivity\Forest Sensitivity Score

Summary

Forest climate sensitivity is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for forest sensitivity were elevation range, habitat vulnerability rating, landform variety, canopy species richness, and local connectedness. Input data were at multiple scales, including counties, and 30m grids. Summary scores were calculated on a 30m grid for forested habitat types, and are best interpreted as general trends across a project area. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of climate change sensitivity, based on available evidence and expert opinion. Input indicators used for forest sensitivity were elevation range, habitat vulnerability rating, landform variety, canopy species richness, and local connectedness. These indicators directly or indirectly measure the degree to which an ecosystem is likely to be affected by the changing climate. Systems with high sensitivity to climate change are expected to experience greater changes in habitat structure and function, and be less likely to return to their previous state, in response to changes in climate. Since there is limited documentation of observed climate change response across a range of habitat conditions, sensitivity indicators largely measure attributes of diversity and connection that are expected to confer an increased ability to resist or recover from change.

The selected indicators were each scored on a range of 0-100, where 0 indicates the lowest degree and 100 indicates the greatest degree of climate change sensitivity within the study area. Scoring was largely based on the number of condition classes found within a connected stream network. In all cases, higher scores indicate a relatively greater degree of sensitivity to climate change, as compared to other locations in the study area.

Each scored indicator was spatially attributed to the same base habitat dataset. For forests, the NETWHC forest habitat types, as extracted from our Land Use/Land Cover layer, were used the define the extent of analysis on a 30m x 30m raster grid. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each pixel. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. The resulting score should only be used as a guide for planning, since it is unknown what levels of sensitivity result in significant differences in climate change response. We encourage users to monitor for climate change impacts and supplement or substitute this information with additional observed or modeled data as appropriate.

Forests: Climate Sensitivity\SCORED Elevation Range

Summary

To evaluate terrestrial complexity we used metrics developed by The Nature Conservancy as part of the Resilient Sites regional analysis (Anderson et al., 2012). The full report on the analysis and methods can be found here:
http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/default.aspx

Species distributions may increase or decrease in elevation in concert with climate changes, particularly in hilly and mountainous landscape where the effects of elevation are magnified by slope.

In flat landscapes, small elevation changes may have a dramatic effect on hydrologic processes such as flooding. (Anderson et al., 2012)

Methods

From Anderson et al. (2012): To measure local elevation range we created an elevation range index by compiling a 30-meter digital elevation model for the region (USGS 2002) and using a focal range analysis to tabulate the range in elevation within a 100-acre circle around each cell. Scores for each cell ranged from 1 to 795 meters with a mean of 59.4 m and a standard deviation of 54.3. The data were highly skewed towards zero and were log transformed for further analysis (mean 3.64 and standard deviation of 1.08).

Elevation range was transformed to a standard normal distribution and is symbolized based on the degree of deviation from the average condition within each ecoregion. We used the stddev breaks that ERO used, and coded them so the smaller bins to either side of the mean had slightly smaller changes in class value.

Elevation range class (deviation relative to ecoregional average)	Score
>2 stddev below	100
1-2 stddev below	75
.5-1 stddev below	60
.5 stedev below - .5 stddev above	50
.5-1 stddev above	40
1-2 stddev above	25
>2 stddev above	0

Attributes

Value: elevation range class code

ElevRange_Score: Sensitivity score assigned to the elevation range class

ElevRange _Label: Description of elevation range class used for labeling

ElevRange _Descr: Description of the range of standard deviation values use to define the elevation range class

Citation

Anderson, M.G., M. Clark, and A. Olivero Sheldon. 2012. Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region. The Nature Conservancy, Eastern Conservation Science. 168 pp.

Forests: Climate Sensitivity\SCORED Landform Variety

Summary

To evaluate terrestrial complexity we used metrics developed by The Nature Conservancy as part of the Resilient Sites regional analysis (Anderson et al., 2012). The full report on the analysis and methods can be found here: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/default.aspx

Topography describes the natural surface features of an area, and these natural features can be grouped into local units known as landforms (e.g. cliffs, summits, coves, basins, valleys). Landforms are a primary edaphic controller of species distributions, even without climatic considerations, due to the variation in rates of erosion and deposition, in soil depth and texture, in nutrient availability, and in the distribution of moisture. Each landform, then, represents a local expression of solar radiation, soil development, and moisture availability; a variety of landforms results in a variety of meso and micro climates. When climate is considered, landform variation increases the persistence of species and buffers against direct climate effects by providing many combinations of temperature and moisture within a local neighborhood. (Anderson et al., 2012)

Methods

From Anderson et al. (2012): We used a simple 11 unit model that captures the major differences in settings and combines some landform types that typically occur as pairs (e.g. cliff/steep slope, cove/slope bottom) so they did not skew the results. The types include the following:

- Cliff/steep slope
- Summit/ridgetop NE sideslope
- SE sideslope
- Cove/slope bottom,
- Low hill
- Low hilltop flat
- Valley/toeslope
- Dry flat
- Wet flat
- Water/lake/river

To calculate the landform variety metric we tabulated the number of landforms within a 100-acre circle around every 30-meter cell in the region using a focal variety analysis on the 11 landform types. Scores for each cell ranged from 1 to 11 with a mean of 6.05 and a standard deviation of 1.85.

Landform variety was transformed to a standard normal distribution and is symbolized based on the degree of deviation from the average condition within each ecoregion. We used the stddev breaks that ERO used, and coded them so the smaller bins to either side of the mean had slightly smaller changes in class value.

Landform variety class (deviation relative to ecoregional average)	Score
>2 stddev below	100
1-2 stddev below	75
.5-1 stddev below	60
.5 stedev below - .5 stddev above	50
.5-1 stddev above	40
1-2 stddev above	25
>2 stddev above	0

Attributes

Value: Landform variety class code

LFvar_Score: Sensitivity score assigned to the landform variety class

LFvar _Label: Description of landform variety class used for labeling

LFvar _Descr: Description of the range of standard deviation values use to define the landform variety class

Citation

Anderson, M.G., M. Clark, and A. Olivero Sheldon. 2012. Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region. The Nature Conservancy, Eastern Conservation Science. 168 pp.

Forests: Climate Sensitivity\SCORED Forest Connectedness

Summary

To evaluate current landscape permeability, we used a method developed by The Nature Conservancy as part of the Resilient Sites regional analysis (Anderson et al., 2012). The full report on the analysis and methods can be found here: http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/default.aspx

From Anderson et al. (2012): Fragmentation, in combination with habitat loss, poses one of the greatest challenges to conserving biodiversity in a changing climate. Not surprisingly, the need to maintain connectivity has emerged as a point of agreement among scientists (Heller and Zavaleta 2009, Krosby et al. 2010). In theory, maintaining a permeable landscape, when done in conjunction with protecting and restoring sufficient areas of high quality habitat, should facilitate the expected range shifts and community reorganization.

The local connectedness metric measures how impaired the structural connections are between natural ecosystems within a local landscape. Roads, development, noise, exposed areas, dams, and other structures all directly alter processes and create resistance to species movement by increasing the risk (or perceived risk) of harm. This metric is an important component of resilience because it indicates whether a process is likely to be disrupted or how much access a species has to the microclimates within its given neighborhood.

Methods

The input for the model was the current land use/land cover product (see metadata under Landuse/Landcover\Current (2011) NYS LULC). We used the land cover categories in a weighting scheme to assign resistance values, where 1 is the lowest resistance and 10 is the highest.

class	name	resistance
11	Water	5
15	Inundated Developed	5
16	Inundated Uplands	5
17	Inundated Wetlands	5
21	Developed, Open Space	8
22	Developed, Low Intensity	8
23	Developed, Medium Intensity	9
24	Developed, High Intensity	10
80	New Agriculture	7
81	Hay/Pasture	7

82	Cultivated Crops	7
200	Outcrop & Summit Scrub	1
400	Coastal Grassland & Shrubland	1
600	Central Oak-Pine	1
700	Coastal Plain Swamp	1
800	Salt Marsh	1
900	Boreal Upland Forest	1
1000	Alpine	1
1100	Cliff and Talus	1
1200	Rocky Coast	1
1300	Northern Peatland	1
1400	Northeastern Floodplain Forest	1
1500	Glade and Savanna	1
1600	Northern Hardwood & Conifer	1
1700	Central Hardwood Swamp	1
1800	Ruderal Shrubland & Grassland	1
1900	Northern Swamp	1
2000	Wet Meadow / Shrub Marsh	1
2100	Emergent Marsh	1
2200	Coastal Plain Peatland	1
2300	Southern Bottomland Forest	1
2400	Southern Oak-Pine	1
2500	Flatrock	1
2600	Plantation and Ruderal Forest	1
2700	Central Oak-Pine/Longleaf Pne	1
2800	Salt/Emergent Marsh	1

The method used to map local connectedness for the region was resistant kernel analysis, developed and run by Brad Compton using software developed by the UMASS CAPS program (Compton et al. 2007, http://www.umasscaps.org/). Detailed methods can be found in the Resilient Sites report linked above.

The final result was a grid of 90-meter cells for the entire state where each cell was scored with a local connectivity value from 0 (least connected) to 100 (most connected). This raster grid of current traversibility for NYS was scored on even breaks:

Connectedness	Score
0-0.2	100
0.2-0.4	75
0.4-0.6	50
0.6-0.8	25
0.8-1	0

Attributes

Value: Connectedness class

Conn_Score: Sensitivity score assigned to the connectedness class

Conn_Label: Description of connectedness class used for labeling

Conn_Range: Description of the range of values use to define the connectedness class

Limitations

See Resilient Sites report

Forests: Climate Sensitivity\SCORED Habitat Vulnerability

Summary

Vulnerability assessments performed at state and regional scales were applied to habitat types and bioclimatic zones in order to create a spatial visualization of habitat vulnerability ratings. Since no one assessment comprehensively covers all of the habitat types and zones within NY, assessments were combined from three reports on habitat vulnerability for various areas: the Northeast (Manomet 2013), New York (Hilke and Galbraith 2013), and Maine (Whitman et al. 2013). Vulnerability to climate change was assigned a 4-part rating from Least to Highly Vunerable (rating systems differed among the original reports) for those habitats where data were available.

Methods

The habitat types assessed in each of the source assessment report were crosswalked to the NETWHC macrogroups according to habitat type descriptions and spatial distributions. The bioclimatic zone boundaries portrayed in the NY and NE assessments were visually approximated to fall on latitude lines of 44 and 41.5 degrees, since the reports did not detail how the zones were defined. Since Zone 3 was not included in the NY assessment, all ratings in that zone were taken from the NE assessment. Habitats in the Maine assessment were assumed to apply to zones 1 and 2 only. The Maine rating system of High/Medium/Low was converted to the equivalent NE ratings of Highly Vulnerable, Vulnerable, and Less Vulnerable respectively. The climate vulnerability ratings were mapped to the current distribution of each NETWHC macrogroup within each zone – no further spatial variability was incorporated. Vulnerability classes were scored as follows:

Habitat Vulnerability	Score
1=least vulnerable	25
2=less vulnerable	50
3=vulnerable	75
4=highly vulnerable	100

Attributes

Value: Habitat vulnerability class code

HabVuln_Score: Sensitivity score assigned to the habitat vulnerability class

HabVuln _Label: Description of Habitat vulnerability class used for labeling

Citations

Hilke, C. and Galbraith, H. 2013. Assessing the Vulnerability of Key Habitats in New York: A Foundation for Climate Adaptation Planning. National Wildlife Federation, Northeast Regional Center. Montpelier, VT

Manomet Center for Conservation Sciences and National Wildlife Federation. 2013. The Vulnerabilities of Fish and Wildlife Habitats in the Northeast to Climate Change. A report to the

Northeastern Association of Fish and Wildlife Agencies and the North Atlantic Landscape Conservation Cooperative. Manomet, MA.

Whitman, A., A. Cutko, P. deMaynadier, S. Walker, B. Vickery, S. Stockwell, and R. Houston. 2013. Climate Change and Biodiversity in Maine: Vulnerability of Habitats and Priority Species. Manomet Center for Conservation Sciences (in collaboration with Maine Beginning with Habitat Climate Change Working Group) Report SEI-2013-03. 96 pp. Brunswick, Maine.

Limitations

The vulnerability ratings were based on expert opinion on exposure and sensitivity – see source reports for full methodology. The latitudinal zones applied are only an approximation for bioclimatic zones and may not adequately capture the spatial variance in vulnerability. Assessments done at the regional scale or for other states were used to fill gaps in habitat coverage but may not accurately reflect vulnerability in NY.

Forests: Climate Sensitivity\SCORED Canopy Species Richness

Summary

The diversity of tree species within a stand can be reduced by selective harvesting of high value species (highgrading), as well as by pest outbreaks. Higher diversity is expected to improve resilience by helping to maintain forest cover in response to disturbance.

Methods

FIA data were obtained from the US Forest Service through the FIA DATA MART (http://apps.fs.fed.us/fiadb-downloads/datamart.html) on December 3 2013 and represent the available data updated through the 2011 inventory for NY. Data were processed in Microsoft Access using FIADB (v 5.1). Survey plot locations with forestland (COND_STATUS_CD = 1) and private ownership (OWNGRP=40) were extracted for the NY 2011 evaluation group and mapped based on the coordinates provided by FIA. Because these coordinates are only an approximation of plot location due to the fuzzing and swapping procedure applied by the USFS to protect landowner privacy, plots were generalized to a 50-km hexagonal grid, which served as the basis for analysis. Standard FIADB queries were then modified to summarize the indicator attributes by the map hexagons. Stand-level attributes were adjusted to reflect multiple conditions within plots as well as non-forest plots in the sample, except for species richness which was taken as the simple average of total species per plot.

Average canopy species richness (FIA)	Score
1st quintile (0 - 4.270588)	100
2nd quintile (4.270588 - 5.262745)	75
3rd quintile (5.262745 - 5.866667)	50
4th quintile (5.866667 - 6.686275)	25
5th quintile (6.686275 – 11)	0

Attributes

Value: Quintile rank of average canopy species richness by hex

CanopyR_Score: Sensitivity score assigned to the canopy richness class

CanopyR_Label: Description of canopy richness class used for labeling

Limitations

FIA data are collected at the stand level statewide over a 5-yr cycle with a density of 1 plot per 6000 acres. Data may have high uncertainty when summarized to scales smaller than counties. In addition, fuzzing and swapping introduces error into the spatial assignment of plots to hexagons. While we used a hexagon size that was intended to incorporate multiple plots, some areas with little private forest land only contained one plot per hexagon. Data summaries reported at the hexagon scale may not apply to all forest lands within the area. These data are best used to assess regional patterns and should not be used to infer information regarding individual properties.

Citations

For a full description of the FIA methodology, see the Field Manual here: http://www.fia.fs.fed.us/library/field-guides-methods-proc/

For a documentation of the FIA database and analysis, see the User Guide here: http://www.fia.fs.fed.us/library/database-documentation/

Forests: Climate Exposure\Forest Exposure Score

Summary

Forest climate exposure is summarized as the equally weighted average of indicators scored from 0-100. Input indicators used for forest exposure were changes in aridity, summer maximum temperatures, days below freezing, growing degree days, total annual precipitation, summer precipitation, and declines in canopy species. Summary scores were calculated on a 30m grid for forested habitat types, and are best interpreted as general trends across a project area. See the details for each of the individual indicators for more information.

Methods

Each of the variables used in this analysis were selected as being an important component or indicator of climate change exposure, based on available evidence and expert opinion. Input indicators used for forest exposure were changes in aridity, summer maximum temperatures, days below freezing, growing degree days, total annual precipitation, summer precipitation, and declines in canopy species. These indicators directly or indirectly measure the degree to which ecologically relevant climate variables are expected to change due to the changing climate. Systems with high exposure to climate change are expected to experience more rapid and/or extreme change that could have greater impacts on habitat structure and function. Since there is considerable variability and uncertainty in predictions of future climate, exposure indicators reflect a relative degree of change rather than a specific future value.

The selected indicators were each scored on a range of 0-100, where 0 indicates no meaningful level of change, and 100 indicates the greatest degree of change predicted within the study area. Scoring was based on the absolute value of change, and so was unaffected by the direction of change (e.g. wetter or drier). In most cases, quantiles were used for scoring since ecological thresholds for climate change impacts are not well understood. In all cases, higher scores indicate a relatively greater degree of change in climate conditions, as compared to other locations in the study area.

Each scored indicator was spatially attributed to the same base habitat dataset. For forests, the NETWHC forest habitat types, as extracted from our Land Use/Land Cover layer, were used the define the extent of analysis on a 30m x 30m raster grid. Scored values across all indicators were summed, and then divided by the number of indicators to obtain a composite score for each pixel. In the default algorithm, used for the distributed map, all indicators were equally weighted. The Habitat Explorer application within the Natural Resource Navigator Map Tool allows adjustment of these weights to create custom analyses.

The final component score, ranging from 0-100, is symbolized by even breaks. Since most of the input variables are scored on a relative basis, and the underlying data are at a coarse resolution, the resulting score should only be used as a guide for planning and does not replace finer-scale data. We encourage users to monitor for climate change impacts and supplement or substitute this information with their own observed or modeled data as appropriate.

Forests: Climate Exposure\SCORED Forest Summer Maximum Temperature Change

Summary

Change in maximum temperature for summer months (June, July, and August) was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in average summer maximum temperature between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to our forest habitat raster. Each pixel was then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in summer max temp	Class label	Score
4.1 to 4.5 degree (F) change	Least change	0
4.5 to 4.6 degree (F) change	Less change	25
4.6 to 4.8 degree (F) change	Moderate change	50
4.8 to 5.1 degree (F) change	More change	75
5.1 to 6.0 degree (F) change	Most change	100

Forests: Climate Exposure\SCORED Forest Change in Days Below Freezing

Summary

The change in days below freezing was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in days below freezing between historical (1970-2000) and future (2041-2070) time periods was reported by HUC 8 basins that overlap with NY. These values were attributed to our forest habitat raster. Each pixel was then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Days below Freezing	Class label	Score
-20.1 to -24.5 degree (F) change	Least change	0
-24.5 to -25.0 degree (F) change	Less change	25
-25.0 to -25.9 degree (F) change	Moderate change	50
-25.9 to -27.0 degree (F) change	More change	75
-27.0 to -27.8 degree (F) change	Most change	100

Forests: Climate Exposure\SCORED Forest Change in Growing Degree Days

Summary

The change in annual growing degree days was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in annual growing degree days between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to the corresponding NHD+V2 stream reaches, and binned by quantile. These values were attributed to our forest habitat raster. Each pixel was then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Growing Degree Days	Class label	Score
660.2 to 725.5 GDD (50F) change	Least change	0
725.5 to 772.1 GDD (50F) change	Less change	25
772.1 to 807.2 GDD (50F) change	Moderate change	50
807.2 to 869.1 GDD (50F) change	More change	75
869.1 to 911.5 GDD (50F) change	Most change	100

Forests: Climate Exposure\SCORED Forest Aridity Change

Summary:

The Aridity Index is a metric of moisture stress in a system (lower aridity index represents higher moisture stress) and is calculated from precipitation and Potential Evapotranspiration (PET). PET represents the water that an ecosystem could potentially use though evaporation and transpiration. PET is higher with warmer temperatures and more daylight hours. The ratio of precipitation (AET) to PET was summed over all months for a given year, with the modification that precipitation is capped at PET for each month (no surplus is considered when calculating this version of the Aridity Index). Change in aridity was calculated by subtracting the historical average from the future projection, and was smoothed to a 30m resolution. A positive change indicates that water stress is predicted to be lower in the future, while negative values indicate greater water stress under climate change. Aridity Index data were obtained from climatewizardcustom.org for 1962-1991 and a future projection for 2040-2069, using the ensemble average circulation model and the A2 scenario.

Methods

The Climate Wizard service uses historical data from the PRISM (Parameter-elevation Regressions on Independent Slopes Model) Climate Mapping Program (Gibson et al., 2002) and future climate data from the the WCRP (World Climate Research Program) CMIP3 (Coupled Model Intercomparison Project phase 3) multi-model dataset, downscaled by Maurer et al. (2007). Historical data are available at a 4 km resolution and future data at 12 km.

The Aridity Index is a metric quantifying moisture stress and aridity in a system (lower aridity index represents higher moisture stress) and is calculated from precipitation and Potential Evapotranspiration (PET). PET is a metric representing the water that an ecosystem could potentially use though evaporation and transpiration. PET was calculated from monthly temperature and monthly average number of daylight hours based on a modified version of the Thornethwaite equation (Hamon, 1961). PET is higher with warmer temperatures and more daylight hours. The ratio of precipitation (AET) to PET was summed over all months for a given year, with the modification that precipitation is capped at PET for each month. If precipitation in a given month is greater than PET, it is capped at the value of PET (no surplus is considered when calculating this version of the Aridity Index).

Aridity Index data for NY were obtained from climatewizardcustom.org for 1962-1991 and a future projection for 2040-2069, using the ensemble average circulation model and the A2 scenario. Change in aridity was calculated by subtracting the historical average from the future projection, and was smoothed to a 30m resolution. A positive change indicates that water stress is predicted to be lower in the future, while negative values indicate greater water stress under climate change. The statewide data were classed by quintiles and associated with the forest habitats in our land cover layer and scored for exposure from 0 to 100.

Quintile rank of aridity change in NY	Score
1st quintile	0
2nd quintile	25
3rd quintile	50
4th quintile	75
5th quintile	100

Attributes

Value: Aridity change class, based on quintile rank of NY values

Aridity_Score: Exposure score assigned to the aridity change class

Aridity_Label: Description of aridity change class used for labeling

Citation

"PRISM Group, Oregon State University, created 4 Feb 2007." The PRISM Group, Oregon State University retains rights to ownership of the data and information.

Girvetz EH, Zganjar C, Raber GT, Maurer EP, Kareiva P, et al. (2009) Applied Climate-Change Analysis: The Climate Wizard Tool. PLoS ONE 4(12): e8320. doi:10.1371/journal.pone.0008320

Forests: Climate Exposure\SCORED Forest Total Annual Precipitation Change

Summary

Change in total annual precipitation was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in total annual precipitation between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to our forest habitat raster. Each pixel was then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Total Annual Precipitation	Class label	Score
1.1 to 1.5 inch change	Least change	0
1.5 to 1.7 inch change	Less change	25
1.7 to 2.0 inch change	Moderate change	50
2.0 to 2.4 inch change	More change	75
2.4 to 2.8 inch change	Most change	100

Forests: Climate Exposure\SCORED Forest Total Summer Precipitation Change

Summary

Change in total summer (June, July, August) precipitation was generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins and attributed to NHD+v2 stream reaches.

Methods

Please see the detailed methods for this variable in the Climate section. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

The change in total summer precipitation between historical (1970-2000) and future (2041-2070) time periods, was reported by HUC 8 basins that overlap with NY. These values were attributed to our forest habitat raster. Each pixel was then scored for relative degree of change, as shown in the table below, for use in the Habitat Explorer combined exposure score.

Change in Total Summer Precipitation	Class label	Score
-0.1 to -0.4 inch change	Least change	0
-0.4 to -0.5 inch change	Less change	25
-0.5 to -0.7 inch change	Moderate change	50
-0.7 to -0.9 inch change	More change	75
-0.9 to -1.1 inch change	Most change	100

Forests: Climate Exposure\SCORED Expected Decline in Canopy Species

Summary

While it was determined for the land cover change model to not convert natural habitat types based on climate change, due to the short time frame of the analysis, we do expect climate change to begin to affect growth, reproduction, and mortality rates for long-lived plant species even as they persist on the landscape. Some species will benefit from climate change, while others will decline, and the degree and type of impact will differ by location, with the result that the composition of forested habitats will change in varying and novel ways. Because management decisions for forested habitats need be made on a much longer time horizon than other types of natural resources, precisely because they are dominated by such long-lived species, we decided that consideration of long-term climate suitability for tree species was meaningful to include in the toolkit. We used the USFS predictions of range shifts for 134 tree species to 2100, available through the Climate Change Tree Atlas (http://www.nrs.fs.fed.us/atlas), to assess the degree to which climate change was likely to alter the composition of forested habitats, following methodology applied by the USFS in other states (Handler et al. 2014).

In order to understand not just which species were going to fare better or worse with climate change, but the degree to which that change might affect the condition of the forest, we incorporated modeled data on the basal area of individual tree species (Wilson et al. 2013). These data, available at a 250 m scale statewide, were used to estimate what proportion of the basal area in any location was at risk of loss due to climate-induced declines. This climate stress may act in concert with other threats, such as pest infestations, to significantly threaten the viability of future forests.

Methods

The modeling approach used to develop the TreeAtlas data is decribed here:
http://www.fs.fed.us/nrs/atlas/models/

Declining list by ecoregion

Tree Atlas data for each species were clipped to the ecoregional boundaries, and Importance Values were summed across each ecoregion for current day and the ensemble of three GCMs (PCM, GFDL, and HadleyCM3) under high (A1fi) and low (B1) emission scenarios. The percent change in Importance Value from current to future (F:C) was used to assign a change class based on USFS categories (http://www.fs.fed.us/nrs/atlas/products/#ra).

Code	Description	F:C
0	Not present	0:0
1	Extirpated	0:*
2	Large decrease (f:c<0.5)	<0.5
3	Small decrease (0.5<f:c<0.8)	0.5-0.8
4	No change (0.8<f:c<1.2)	0.8-1.2
5	Small increase (1.2<f:c<2)	1.2-2
6	Large increase (f:c>2)	>2
7	New entry	*:0

We selected species that were declining (in class 1,2, or 3 for the Low scenario and class 1 or 2 in the High scenario) for each ecoregion. We removed species with low (sumIV<10% of the # of grids in the ecoregion) current importance and removed species with ModFacs > 6, indicating beneficial adaptive capacity. We did not remove species based on model reliability.

Ecoregion	USFS Tree Codes for regionally declining species
Great Lakes	12,125,129,241,261,315,318,371,375,379,531,541,543,601,743,746,761,763,951,97, 94,762
High Allegany	12,94,97,125,241,261,315,318,371,375,531,543,601,746,761,763,762,541
Lower New England	12,94,97,125,129,241,261,315,371,375,379,531,541,543,601,743,746,761,762,763
North Atlantic Coast	43,126,129,261,313,316,318,367,372,379,531,541,743,762,832,833,901,931
Northern Appalachians	12,95,97,105,315,319,371,375,531,543,746,763,261
St. Lawrence	12,71,94,95,97,105,129,241,261,315,319,371,375,379,531,543,601,741,746,761,763, 541
Western Appalachians	125,261,315,318,356,371,531,743,746,761,763,541,762

Percent basal area

Percent basal area for each species was calculated by dividing by the total basal area grid. Using the list of declining species for each ecoregion, we summed the percent basal area of all declining species for each ecoregion. The ecoregions were then combined to create a statewide map. The resulting grid of ‘percent basal area declining’ was masked to the extent of natural habitats (everything not developed or ag) in curr_hybrid_preSLR [decided to not restrict to forested types only since trees occur in most other habitats too].

For use in the Navigator habitat assessment, we scaled the data back up to avoid over-precision from a product that was based on multiple and much coarser source models. We therefore calculated an average percent declining basal area for each ecoregional subsection, which were then scored by even breaks to reflect the relative degree of climate change impact on forest composition. This attribute was considered a measure of exposure because canopy trees are also ecosystem architects that shape the structure and function of habitats for other species.

Avg expected canopy decline by ecosubsection	Score
<20%	0
20-39%	33
40-59%	67
>=60%	100

Attributes

Value: average percent of basal area in declining species for each ecoregional subsection

Limitations

Limitations of the TreeAtlas models are documented by the USFS here: http://www.fs.fed.us/nrs/atlas/tree/resources/help.php. The TreeAtlas models suitable habitat, and does not intend to present the migration of species. The basal area data by species is modeled from FIA plots and may differ from true abundance in the field, which may be altered by harvest regimes or disturbance history. See publications by Wilson et al. above for a full discussion.

Ecoregional summaries of the TreeAtlas data, while recommended by the Forest Service to reduce the influence of outliers, may mask variation in the suitability of habitat for some species within ecoregions, particularly those with high elevational gradients. In addition, abrupt transitions at ecoregional boundaries may be created by the inclusion of a species in the declining list of one ecoregion and not another, even if that species occurs in both regions. However the ecoregional boundaries do reflect true breaks in some species distributions and so hard breaks may not always be an artifact. The distributions of individual species on the declining lists could be examined in such cases. In general, these data should be used at a coarse scale to infer general patterns, and should not be taken as a predictor of trends for any particular forest stand.

Citations

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Forests: Recommendations

Includes the following layers (various symbologies of the same dataset):

Forest Recommended Objective

Forest Objective Maintain Group

Forest Objective Reduce Threat Group

Forest Objective Restore Group

Forest Objective Reduce Threat/Restore Group

Forest Highest Climate Risk Group

Forest Low Climate Risk Group

Summary

The recommended objective map is based on the relative value of the summary Condition, Threat, Exposure and Sensitivity scores generated from a variety of indicator data. Our theory is that adaptation planning should be informed by all four types of information, and that it is possible and useful to identify a best general objective from the combination of these four components. Primary conservation objectives are identified based on the combination of Condition and Threat (distinguished by color family), and ratings of relative climate risk to conservation success are based on Exposure and Sensitivity (distinguished by shade). See the complete Methods in the Habitat Explorer app. Due to the uncertainties in the underlying data, and the averaging nature of the summary algorithms, these recommendations are intended only as a general guide and screening tool, and should not override local knowledge or expertise.

Methods

The normalized index for each of the component scores of Condition, Threat, Exposure and Sensitivity (methods described above), were transformed into a binary class for high and low values, as follows:

Factor	'Low' Score Range	'High' Score Range
Condition	0 - 66	67 - 100
Threat	0 - 32	33 - 100
Exposure	0 - 49	50 - 100
Sensitivity	0 - 49	50 - 100

These thresholds were purposely biased to increase the sensitivity of the analysis to problems with condition and threat, such that a small number of low-rated condition indicators would lead to a 'low' overall score for condition, and a small number of high-rated threat indicators would lead to a 'high' overall score for threats.

Each of the possible 16 combinations of low and high classes were assigned a general conservation objective (based on the Current Condition and Future Threat) and a relative level of climate risk (using Climate Change Exposure and Sensitivity), according to the table below:

C: 0:<67, 1:>67	T: 0:<33 1:>33	S: 0:<50, 1:>50	E: 0:<50, 1:>50	STRAT_CD	STRAT_DESC
1	0	0	0	1000	Maintain - Lower risk
1	0	0	1	1001	Maintain – Moderate risk
1	0	1	0	1010	Maintain – High risk
1	0	1	1	1011	Maintain - Highest risk
1	1	0	0	1100	Reduce Threats – Lower risk
1	1	0	1	1101	Reduce Threats – Moderate risk
1	1	1	0	1110	Reduce Threats – High risk
1	1	1	1	1111	Reduce Threats – Highest risk
0		0	0	0	Restore – Lower risk
0		0	1	1	Restore – Moderate risk
0		1	0	10	Restore – High risk
0		1	1	11	Restore – Highest risk
0		0	0	100	Reduce Threat & Restore – Lower risk
0		0	1	101	Reduce Threat & Restore – Moderate risk
0		1	0	110	Reduce Threat & Restore – High risk
0		1	1	111	Reduce Threat & Restore – Highest risk

In general, the principles underlying these recommendations are straightforward. Condition and Threat can first be considered independent of climate change. Areas that are currently in a good condition and have low future threats are assumed to be functional and self-sustaining, requiring little intervention beyond monitoring. A maintain objective does not imply that the resource should be held in a static state and prevented from changing, but rather that any change that occurs is expected to follow natural ecological dynamics. Areas that are in good condition now, but that have modeled threats that could meaningfully reduce condition in the future, are recommended to focus on threat reduction strategies to secure the long-term status of the resource. If conditions are poor, but the sources of degradation no longer occur and future declines are not predicted, then it is recommended to focus on restoration of condition. If conditions are poor and there are ongoing or new threats predicted to cause further declines, restoration will have limited benefit unless managers also address the threats or plan for ongoing active management in the long term. Either way, management of these areas is likely to be difficult and resource-intensive.

These four general recommended objectives are then refined to account for the level of climate change risk. We use climate risk to describe both the risk of potential negative impacts from climate change, and the risk of uncertain outcomes for management, due to both the changing climate and the unpredictability of ecological response. We assign a risk level based on sensitivity and exposure, whereby risk is lowest when both sensitivity and exposure are low, and highest when both are high. When only one factor is high, we weight sensitivity higher than exposure, for two reasons. First, high exposure is expected to have less impact if sensitivity is low. Second, we have greater uncertainty in our measures of exposure since they are rated on a relative basis, we do not know how much our exposure score represents meaningful differences in ecological impact, and there is inherent uncertainty in the underlying climate models. For these reasons we chose to take a conservative approach that if exposure is higher than expected, high sensitivity will greatly increase risk.

These recommendations are intended only as a general guide and screening tool. In particular, due to the uncertainties in the underlying data and the averaging nature of the summary algorithms, these recommendations should not override local knowledge or expertise. Consult the Navigator Guidebook (http://www.naturalresourcenavigator.org/get-started/guidebook/) for help refining these objectives based on other information in the Navigator, additional data that may be available to the user, and the user's own professional judgement.

Forests: Supporting Data\Forest Habitat Types

Summary

The Northeast Terrestrial Wildlife Habitat Classification (NETWHC) was used as the basis for mapping natural habitats. We applied the classification at the macrogroup level. This layer displays only the upland forested habitat types assessed in the Navigator, not including forested wetlands or floodplains.

The NETWHC is a 30 meter grid that maps upland and wetland wildlife habitats/ecological systems for the Northeast, including all 13 states from Maine to Virginia, west to New York, Pennsylvania and West Virginia. The NTWHCS is based on NatureServe's Ecological Systems Classification, augmented with additional information from individual state wildlife classifications and other information specific to wildlife managers. A terrestrial ecological system is defined as a mosaic of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients, in a pattern that repeats itself across landscapes. Systems occur at various scales, from "matrix" forested systems of thousands of hectares to small patch systems, such as cliffs, basin wetlands, or barrens on a particular bedrock type, of a hectare or 2.

The purpose of that mapping effort is to provide a common framework and language for conservation planning and wildlife management across jurisdictional borders. Specifically, the NE Terrestrial Habitat Classification System and this map are meant to: provide a standardized and consistent habitat and ecosystem classification at multiple scales across states; facilitate interstate communication about habitats; offer managers a tool for understanding regional biodiversity patterns; allow for more effective and efficient habitat conservation across the region, including the prioritization of habitat conservation activities

Methods

The forested macrogroup classes, not including forested wetlands or floodplains, were extracted from the Northeast Terrestrial Habitat Map.

Information on the creation of the Northeast Terrestrial Habitat Map can be found here:

http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/habitatmap/Pages/default.aspx

The report on the classification is available here:
http://www.natureserve.org/publications/pubs/NE_Hab_Class&Map_0708_FinalRept.pdf

Citation

Please cite these data as: Ferree, C and M. G. Anderson. 2013. A Map of Terrestrial Habitats of the Northeastern United States: Methods and Approach. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

Forests: Supporting Data\Rare Geophysical Terrestrial Settings

Summary

Geophysical diversity contributes to regional climate change adaptation by providing a variety of settings in which species can find the right combination of resources and climate conditions to match their habitat requirements. In particular, settings that are rare within a given habitat type may provide conditions that are hard to find and that can be important to species with narrow habitat requirements. This map displays the occurrences of those geophysical settings (a combination of elevation class and geologic class) within each terrestrial natural habitat type that represent less than 1% of the total area of that terrestrial habitat type within NYS.

Methods

We combined the macrogroups from the Northeast Terrestrial Habitat Map (http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/habitatmap/Pages/default.aspx) with geology and elevation zones to create a map of unique geophysical setting combinations present in NYS.

Using the Spatial Analyst tool "Combine," we combined the raster of terrestrial macrogroups with Geology Class and Elevation Zone from the TNC Ecological Land Units assessment (http://gis.tnc.org/data/MapbookWebsite/map_page.php?map_id=178&sType=TITLE&sKind=northern%20appalappala). The Combine tool enables the creation of a raster with a unique output value assigned to each unique combination of input values from multiple rasters.

Terrestrial macrogroups:

2: Outcrop & Summit Scrub	9: Cliff and Talus

4: Coastal Grassland & Shrubland	10: Rocky Coast
6: Central Oak-Pine	11: Glade and Savanna
7: Boreal Upland Forest	12: Northern Hardwood & Conifer
8: Alpine	13: Ruderal Shrubland & Grassland

Geology Class:

1: Coarse sediments
2: Fine sediments
3: Acidic sed/metased
4: Acidic shale
5: Calcareous sed/metased
6: Mod calcareous sed/metased
7: Acidic granitic
8: Mafic/intermediate granitic
9: Ultramafic

Elevation Zone:

1000: Coastal (0-20')
2000: Low (to 800 or 1000')
3000: Low-mod (to 1700 or 2000')
4000: Mod (to 2500 or 2800')
5000: High (to 3250 or 4500')
6000: Very high (>3250 or 4500')

Tabular analysis was then performed on the attribute table to calculate the total area of each macrogroup and the percent area of each geophysical setting (elevation x geology combination). Those settings that comprised less than 1% of a macrogroup were selected and included in the final map.

Forests: Supporting Data\Underprotected Geophysical Terrestrial Settings

Summary

Geophysical diversity contributes to regional climate change adaptation by providing a variety of settings in which species can find the right combination of resources and climate conditions to match their habitat requirements. Adequate representation of multiple occurrences of the full range of geophysical settings in the state's protected areas helps to ensure that these places will be available to support species that need to adapt to climate change and potentially migrate in an attempt to find new suitable habitats. This map shows those geophysical settings (elevation range x geologic class) within terrestrial habitats that are less than 10% protected (GAP1-3) by area within NYS.

Methods

Using the Protected Lands and the same map of geology x elevation x habitat type that was created for the rare geophysical setting analysis (see above), we applied the "Tabulate Area" tool (ArcGIS 10.2

Spatial Analyst) to summarize the area of each geophysical setting in protected areas, broken down by GAP status.

We then performed a tabular analysis to calculate the percent of each geophysical setting that was in GAP 1, 2, or 3 protection statewide. Those settings that were at less than 10% protected, regardless of their total area, were selected as 'underprotected' and displayed in the map layer.

Forests: Supporting Data\Geophysical Settings

Summary

Ecological Land Units (ELUs) are a composite of geology, landform, and elevation zones. They are intended to model the biophysical character of the region. Conservation planning at any scale requires an understanding of patterns of environmental variation and biological diversity. Data on biological distributions of individual species are often inadequate for a large-scale analysis of biodiversity. In the absence of suitable biological datasets, conservation science has recognized that physical diversity can be an acceptable surrogate for biological diversity. This recognition led to the development of the ecological land unit, or ELU, by The Nature Conservancy (TNC). The ELU is a composite of several layers of abiotic information that critically influence the form, function, and distribution of ecosystems - elevation zone, bedrock geology, and landforms. Each 30m grid cell is assigned a given elevation, bedrock, and landform class.

Methods

We combined the macrogroups from the Northeast Terrestrial Habitat Map (http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/habitatmap/Pages/default.aspx) with geology and elevation zones to create a map of unique geophysical setting combinations present in NYS.

Using the Spatial Analyst tool "Combine," we combined the raster of terrestrial macrogroups with Geology Class and Elevation Zone from the TNC Ecological Land Units assessment (http://gis.tnc.org/data/MapbookWebsite/map_page.php?map_id=178&sType=TITLE&sKind=northern%20appalappala). The Combine tool enables the creation of a raster with a unique output value assigned to each unique combination of input values from multiple rasters.

Terrestrial macrogroups:

2: Outcrop & Summit Scrub	9: Cliff and Talus
4: Coastal Grassland & Shrubland	10: Rocky Coast
6: Central Oak-Pine	11: Glade and Savanna
7: Boreal Upland Forest	12: Northern Hardwood & Conifer
8: Alpine	13: Ruderal Shrubland & Grassland

Geology Class:

1: Coarse sediments
2: Fine sediments
3: Acidic sed/metased

4: Acidic shale
5: Calcareous sed/metased
6: Mod calcareous sed/metased
7: Acidic granitic
8: Mafic/intermediate granitic
9: Ultramafic

Elevation Zone:

1000: Coastal (0-20’)
2000: Low (to 800 or 1000’)
3000: Low-mod (to 1700 or 2000’)
4000: Mod (to 2500 or 2800’)
5000: High (to 3250 or 4500’)
6000: Very high (>3250 or 4500’)

Forests: Supporting Data\Matrix Forest Blocks

Summary

Matrix forest blocks are large contiguous areas whose size and natural condition allow for the maintenance of ecological processes, viable occurrences of matrix forest communities, embedded large and small patch communities, and embedded species populations. The goal of the matrix forest selection was to identify viable examples of the dominant forest types that, if protected and allowed to regain their natural condition, would serve as critical source areas for all species requiring interior forest conditions or associated with the dominant forest types. Matrix occurrences are bounded by features from the 1:100k US Census Bureau’s TIGER line dataset such as roads, railroads, major utility lines, and major shorelines. The bounding block feature types were chosen due to their ecological impact on biodiversity in terms of fragmentation, dispersion, edge-effects, and invasion of alien species. Minimum size thresholds for block size vary by ecoregion from 10,000-25,000 acres. Only forest blocks falling at least partially in NY are shown - regional forest blocks may be downloaded from http://easterndivision.s3.amazonaws.com/Terrestrial/distribute_matrix.zip

Methods

Matrix occurrences are bounded by features from the 1:100k US Census Bureaus TIGER line dataset such as roads, railroads, major utility lines, and major shorelines. The bounding block feature types were chosen due to their ecological impact on biodiversity in terms of fragmentation, dispersion, edge-effects, and invasion of alien species. Minimum size thresholds for block size vary by ecoregion from 10,000-25,000 acres.

Matrix forest blocks are classified based on geophysical setting, using a TWINSPAN analysis to group similar conditions and to assign an Ecological Land Unit (ELU) type to each block. ELU groups may be used to ensure adequate representation of forest block conservation. MFBs within the Great Lakes ecoregion were added in 2012 and were not assigned an ELU type. The displayed map later is restricted to those blocks occurring partly or wholly within NYS.

Background on the principles used for defining matrix forest blocks can be found here:

Anderson M.G. 2008. Conserving Forest Ecosystems: Guidelines for Size, Condition and Landscape Requirements. In Askins, R.A. (ed) Saving Biological Diversity: Balancing Protection of Endangered Species and Ecosystems. Springer-Verlag. Pp 119 - 136. http://books.google.com/books?hl=en&lr=&id=UThZO4TUf44C&oi=fnd&pg=PA1&dq=Saving+Biological+Diversity:+Balancing+Protection+of+Endangered+Species+and+Ecosystems&ots=Xvdz_TVLpa&sig=GARddsdNfK46VELDNHaBuSza4BQ#v=onepage&q=anderson&f=false

Attributes

NAME name of matrix block

ECOREG ecoregion the block is primarily within

ACRES size of block in acres

TIER tier 1 = portfolio, 2 = alternative portfolio

ELU_GRP ELU stratification group within ecoregion

ELUGRP_TXT description of ELU group

Limitations

Block boundaries are defined based on assumptions about the fragmenting effects of road features and so may not reflect true ecological boundaries. The interior of blocks may be fragmented by features not included in the roads dataset used. Thresholds for minimum block size are based on theoretical thresholds of ecological function, habitat requirements, and disturbance regimes. Large unfragmented blocks not included in this dataset may still provide valuable wildlife habitat and functions.

Citation

http://easterndivision.s3.amazonaws.com/Terrestrial/distribute_matrix.zip

Forests: Supporting Data\Current Linkage Zones

Summary

This map depicts the Least Cost Paths (LCP) and the Conditional Minimum Transit Cost linkage zones among forest blocks.

Forest Block Linkages:

A least cost path balances travel distance and ease of travel -- here designated as the amount of natural land within 1 kilometer. The goal is to describe the most permeable part of the landscape between a pair of forest blocks. LCPs may help identify habitat stepping stones, riparian zones, or even wide swaths of natural land and thus should be viewed within the context of the landscape, not simply as a line on the ground.

Linkage Zones:

A zone between two forest blocks depicts the area around all the paths represented by the cost of the single LCP plus 20%. The goal is to describe the most permeable part of the landscape between a pair of forest blocks. The LCP and the associated linkage zone may help identify habitat stepping stones, riparian zones, or even wide swaths of natural land and thus should be viewed within the context of the landscape.

Methods:

These layers are modeled by the New York Natural Heritage Program. The LCP is based on a surface depicting the amount of natural land in the landscape, which is derived from the NOAA C-CAP Land Cover data set MRLC Land Use/Land Cover dataset (30 meter raster data) (http://www.csc.noaa.gov/digitalcoast/).

Processing Overview:

1. To create a generalized representation of natural land for the study area, we extracted all natural land categories: Grassland/Herbaceous (8), Deciduous Forest (9), Evergreen Forest (10), Mixed Forest (11), Scrub/Shrub (12), Palustrine Forested Wetland (13), Palustrine Scrub/Shrub Wetland (14), Palustrine Emergent Wetland (15), Estuarine Forested Wetland (16), Estuarine Scrub/Shrub Wetland (17), and Estuarine Emergent Wetland (18).
2. We then conducted a roving-window (focal statistics) analysis on this extracted layer, using a circle of radius 1000 meters, to create a surface depicting the proportion of natural land within 1000 meters.
3. We then reduced the resolution of the raster data set from 30-m cells to 330-m cells using the Aggregate tool (cell factor of 11) in ArcGIS with the output cell representing the mean of the cells aggregated. This layer was used to represent the resistance surface.
4. Each matrix forest block occurring at least partially within New York State was evaluated as a patch. Least Cost Paths (LCP) were evaluated from and to every patch.
5. A single LCP is derived as a balance of straight distance and "cost" to travel, which comes from the surface of proportion natural land. A key assumption is that forest species see the natural landscape as easier to travel through than the developed landscape and thus areas with a higher proportion of natural land are more permeable to our species of interest. The formula describing the balance between distance and cost used in this assessment is:

Cost for traveling one step = distance * average cost between points$^{1.5}$

Points are represented by single nodes along the path, and vary in their distance depending on the homogeneity of the cost surface. The total cost of the LCP is the sum of all the step to step costs.

6. The linkage zone is then an aggregation of all the paths between two patches with a total cost less than the LCP plus 20%.

For more details about the approach used here to develop these linkages, see: Howard, T., and M. Schlesinger. 2012. PATHWAYS: Wildlife Habitat Connectivity in the Changing Climate of the Hudson Valley. New York Natural Heritage Program, Albany, NY. 143 pages. (available here: http://nynhp.org/pathways)

The approach for developing linkage zones follows the theory developed in Pinto, N., and T. H. Keitt. 2009. Beyond the least-cost path: evaluating corridor redundancy using a graph-theoretic approach. Landscape Ecology 24:253–266.

Limitations

This analysis was intentionally focused on natural lands, but we recognize that there are species that thrive in both developed and modified lands.

These paths and zones are based on land cover maps that not reflect local conditions. Thresholds for functional connectivity of individual species or populations are unknown. Detailed population viability, movement, and genetics studies may be needed to support wildlife management decisions.

Forests: Supporting Data\Percent Natural Loss in Linkages

Summary

Areas currently important to landscape-level connectivity may be threatened by future development, leading to lost function and potentially a switch to alternate pathways. In addition, creation of new natural habitat may increase the suitability of some areas for wildlife movement. In order to asess the impact of future land cover changes on key linkages in the landscape, we looked at the risk of natural cover loss in current linkages, and modeled 2050 linkages based on our future land use projection. The resulting maps indicate both where current linkages are most likely to be stable, where they are threatened, and where alternate pathways may be available.

Methods

Current-day conditions refers to the CCAP land-cover data set for 2005, from which we extract the natural land types [Grassland/Herbaceous (8), Deciduous Forest (9), Evergreen Forest (10), Mixed Forest (11), Scrub/Shrub (12), Palustrine Forested Wetland (13), Palustrine Scrub/Shrub Wetland (14), Palustrine Emergent Wetland (15), Estuarine Forested Wetland (16), Estuarine Scrub/Shrub Wetland (17), and Estuarine Emergent Wetland (18)], and then calculated the proportion of these types, overall, within a 1000-meter radius. A reduced-resolution version of this surface was used to model the least-cost paths (LCP) and conditional minimum transit costs (CMTC) among matrix forest blocks. Travel costs *within* a block were considered to be negligible.

Exactly the same process was used for the projected 2050 land-use layer developed as part of this project. Although we only included forest blocks occurring within New York State, the unique shape of the state makes the state boundaries unreasonably restrictive when considering connections among blocks. Because of this, we followed our approach for the current-day blocks and included nearby natural land cover data for PA, CT, MA, and VT. As there was no 2050s layer for these states, we simply used the current-day values for locations out-of-state. Therefore users should focus on the connections within New York.

For more details about the approach used to develop these linkages, see: Howard, T., and M. Schlesinger. 2012. PATHWAYS: Wildlife Habitat Connectivity in the Changing Climate of the Hudson Valley. New York Natural Heritage Program, Albany, NY. 143 pages. (available here: http://nynhp.org/pathways) The approach for developing linkage zones follows the theory developed in Pinto, N., and T. H. Keitt. 2009. Beyond the least-cost path: evaluating corridor redundancy using a graph-theoretic approach. Landscape Ecology 24:253–266.

Limitations

The same limitations as for the current day linkages apply

Forests: Supporting Data\2050 Linkage Zones

Summary

Connectivity zones are an aggregation of all paths between each pair of matrix forest blocks with a total cost less than the Least Cost Path plus 20%. Path cost is the sum of the movement resistance values assigned to the underlying LULC map. Future linkages were based on our predicted 2050 land use map. Least cost path analysis was run by the NY Natural Heritage Program.

Methods

These linkages were generated using the same approach as the current linkage zones above, but used the 2050 landuse projection as the input for the resistance grid.

Limitations

The same limitations as for the current day linkages and for the land use projection apply.

NON-FORESTED UPLANDS

Non-Forested Uplands: Supporting Data\Non-Forested Uplands – Combined Sources

Summary

Combined map of non-forested non-wetland habitats as mapped by the NETWHC and the NYNHP.

Methods

The two products described below were merged and all grid cells having a value for either source dataset were assigned a value of 1.

Non-Forested Uplands: Supporting Data\Non-Forested Upland Habitat Classes – NETWHC

Summary

The Northeast Terrestrial Wildlife Habitat Classification (NETWHC) was used as the basis for mapping natural habitats. We applied the classification at the macrogroup level. This layer displays only the non-forested upland habitat types, including all grassland, scrub/shrub, and rocky/barren habitats, and ruderal shrub/grasslands.

The NTWHCS is a 30 meter grid that maps upland and wetland wildlife habitats/ecological systems for the Northeast, including all 13 states from Maine to Virginia, west to New York, Pennsylvania and West Virginia. The NTWHCS is based on NatureServe's Ecological Systems Classification, augmented with additional information from individual state wildlife classifications and other information specific to wildlife managers. A terrestrial ecological system is defined as a mosaic of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients, in a pattern that repeats itself across landscapes. Systems occur at various scales, from "matrix" forested systems of thousands of hectares to small patch systems, such as cliffs, basin wetlands, or barrens on a particular bedrock type, of a hectare or 2.

The purpose of that mapping effort is to provide a common framework and language for conservation planning and wildlife management across jurisdictional borders. Specifically, the NE Terrestrial Habitat Classification System and this map are meant to: provide a standardized and consistent habitat and ecosystem classification at multiple scales across states; facilitate interstate communication about habitats; offer managers a tool for understanding regional biodiversity patterns; allow for more effective and efficient habitat conservation across the region, including the prioritization of habitat conservation activities

Methods

The non-forested upland macrogroup classes, including all grassland, scrub/shrub, and rocky/barren habitats, and ruderal shrub/grasslands, were extracted from the Northeast Terrestrial Habitat Map.

Information on the creation of the Northeast Terrestrial Habitat Map can be found here:

http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/habitatmap/Pages/default.aspx

The report on the classification is available here: http://www.natureserve.org/publications/pubs/NE_Hab_Class&Map_0708_FinalRept.pdf

Citation

Please cite these data as: Ferree, C and M. G. Anderson. 2013. A Map of Terrestrial Habitats of the Northeastern United States: Methods and Approach. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

Non-Forested Uplands: Supporting Data\Non-Forested Upland Communities – NYNHP

Summary

Occurrences of non-forested non-wetland community types as mapped by the New York Natural Heritage Program.

Methods

The New York Natural Heritage Program maintains a database of assessed occurrences of significant natural communities in New York, classified according to the Ecological Communities of New York State (Edinger, 2014). We used this dataset to extract the occurrences of types within the Open Uplands and Barrens and Woodlands subsystems.

Limitation

The NYNHP database is not a comprehensive survey of all communities in New York, but an inventory of significant occurrences that Heritage ecologists have evaluated and mapped.

Citation

Edinger, G.J., D.J. Evans, S. Gebauer, T.G. Howard, D.M. Hunt, and A.M. Olivero (editors). 2014. Ecological Communities of New York State. Second Edition. A revised and expanded edition of Carol Reschke's Ecological Communities of New York State. New York Natural Heritage Program, New York State Department of Environmental Conservation, Albany, NY.

WETLANDS

Wetlands: Climate Sensitivity\Wetland Density

Summary

As part of their analysis of Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region (see citation below), The Nature Conservancy created landscape complexity metrics, or ways of estimating the variety of microclimates present in a landscape, which can help facilitate adaptation to climate change by offering options to resident species. They considered landform variety and elevational gradients, but a large part of the Northeastern United States is flat and wet, the result of past glaciations. Moreover, climate models disagree on whether the region will get wetter or drier, or both. In these flat areas, landform variety is low, elevation change is minimal, and wetlands are extensive. Visual examination of the landform variety and elevation range maps described above suggested that this information alone did not always provide enough separation between sites, with respect to the long term resilience of extensive wetland areas. Further, modeled measures of moisture accumulations had the highest rates of error in extremely flat landscapes. After experimentation with local rugosity measures, they determined that directly measuring wetland density provided the best available gauge of small and micro-scale topographic diversity and patterns of freshwater accumulation. They assumed that areas with high density of wetlands had higher topographic variation, and therefore offered more options to species, and that small isolated wetlands were more vulnerable to shrinkage and disappearance than wetlands embedded in a landscape crowded with other wetlands. Thus, the hypothesis was that wetland dependent species and communities would be more resilient in a landscape where there was a higher density of wetland features corresponding to more opportunities for suitable habitat nearby.

Methods

From Anderson et al. 2012: To assess the density of wetlands, we created a wetland grid for the region by combining the National Wetland Inventory, NLCD (2001) wetlands, and Southern Atlantic GAP programs wetlands datasets (http://www.basic.ncsu.edu/segap/index.html). We revised this source wetland dataset using the landform models to identify and remove erroneously mapped wetlands on summits, cliffs, steep slopes, and ridgetop landforms. To match the 100-acre scale of landform variety and elevation range, we generated the percent of wetlands within a 100-acre circle for each 30-meter cell in the region using a focal sum function in GIS. Additionally, to gauge the wetland density of the larger context, we generated the percent of wetlands of an area one magnitude larger (1000 acre circle) around each 30-meter cell in the region (Note: for the coastal areas where much of the area within the 100-acre or 1000-acre circles was actually ocean, the percent of wetlands was based on only the percent of the land area, not ocean area, within the 100-acre or 1000-acre circle around each cell).

To summarize the wetland density for each cell, we combined the values from search distances, weighting the 100-acre wetland density twice as much as the 1000-acre wetland density and summing the values into an integrated metric. Lastly, we log-transformed the values to approximate a normal distribution and divided by the maximum value to yield a dataset normalized between 0-100. Raw scores for each cell ranged from 0 to 100 percent with a mean of 7.1 percent and a standard deviation of 15.6 percent for the 100-acre search radius and a mean of 7.1 percent and standard deviation of 12.4 percent for the 1000-acre radius. The combined weighted value had a mean of 10.5 and standard deviation of 21.1.

Attributes

Refer to report cited below for attribute descriptions.

Limitations

Please cite data as:

Anderson, M.G., M. Clark, and A. Olivero Sheldon. 2012. Resilient Sites for Terrestrial Conservation in the Northeast and Mid-Atlantic Region. The Nature Conservancy, Eastern Conservation Science. 168 pp.

Full report available at:
https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/ne/Pages/default.aspx

Wetlands: Supporting Data\DEC Wetlands

Summary

These are regulatory freshwater wetlands in New York State. Coverages are based on official New York State Freshwater Wetlands Maps as described in Article 24-0301 of the Environmental Conservation Law. Coverages are not, however, a legal substitute for the official maps. Coverages are available on a county basis for all areas of New York State outside the Adirondack Park. Please see the Adirondack Park Agency wetland layer for those wetlands.

In 1975, The New York State Legislature passed the Freshwater Wetlands Act with the intent to preserve, protect and conserve freshwater wetlands and their benefits, consistent with the general welfare and beneficial economic, social and agricultural development of the state. To be protected under the Freshwater Wetlands Act, a wetland must be 12.4 acres (5 hectares or larger). Wetlands smaller than this may be protected if they are considered of unusual local importance. Around every wetland is an 'adjacent area' of 100 feet that is also regulated to provide protection for the wetland.

The Act requires DEC to map all those wetlands regulated by the Act. Landowners who are within the regulated adjacent area (usually 100 ft) surrounding the wetland or whose properties include regulated wetland are notified of that fact. The maps also allow other interested parties to know where jurisdictional wetlands exist. DEC prepares draft maps, notifies landowners whose property may contain protected wetlands, and provides an opportunity for comment on the accuracy of the maps. DEC then reviews the comments received, adjusts the maps if necessary, and then officially files the final maps with the clerks of all local governments. Wetlands are a changing resource, and the law provides the opportunity for amending the maps. Any changes to the maps require affected landowners to be provided with notification and an opportunity for public comment.

Different wetlands provide different functions and benefits and in varying degrees. The Act requires DEC to rank wetlands in classes based on the benefits and values provided by each wetland. The wetland class helps to determine the best uses for each wetland. Higher class wetlands provide the greatest level of benefits and are afforded a higher level of protection. Lower class wetlands still provide important functions and benefits, but typically require less protection to continue to provide these functions. The permit requirements are more stringent for a higher class wetland than for a lower class wetland.

Methods

Wetland borders are derived from individual 1 to 24,000 quads, either by digitizing or by scanning followed by semi-automated raster to vector conversion. Labels are added and coded with the wetland identification and class. Annotation indicating the wetland identification code is also added. The quads comprising a county are edge matched and map joined to form a county coverage. Quadrangle borders of wetlands that cross quads are dissolved away. Where contiguous wetlands on adjacent regulatory quad sheets do not match, arcs are added along the quad border between the wetland pieces on either side of the border so that a continuous polygon is formed. Wetland class in the coverage is checked against an ASCII file derived from the official classification sheets. Class and wetland ID are added to arcs using an automated procedure that derives arc attribute values from polygon attribute values. Data are tiled as coverages showing wetlands of a single county. Detailed protocols are maintained by the Habitat Inventory Unit. For further information on related files and coverages, see the README file at http://cugir.mannlib.cornell.edu/READMES/fwrdme.html. Data were accessed from the original source in November 2016 for this web version.

Attributes

WETID: The wetland identification code of the wetland. When a wetland contains included uplands, water bodies, tidal wetlands or other features, the polygon of the non-wetland feature is coded with UPL, WAT, TID or OTH, respectively, in columns 8 - 10 of this field and with the wetlands identification code of the surrounding wetland in the first 7 columns. Only the wetland identification code is a valid value for arcs. Wetlands with an extended adjacent area have an asterisk (*) directly following the wetland identification code as part of WETID. Found in PAT and AAT.

CLASS: The regulatory class of the wetland as derived from the wetlands classification sheets. Values are 1, 2, 3, and 4 for Class I, II, III, and IV wetlands, respectively. A value of 0 is used for non-wetland features. A value of 9 is used for wetlands that do not have a class. Only non-zero values for class are valid for arcs. Found in PAT and AAT.

Limitations

1. The documentation in the Entity and Attribute Overview section of the metadata, and the README referred to in that section, are integral parts of the Regulatory Freshwater Wetlands data. Failure to use the documentation in conjunction with the digital data constitutes a misuse of the data. 2. The digital freshwater wetlands data provided are not a legal substitute for the official Regulatory Freshwater Wetlands maps maintained by the Department of Environmental Conservation pursuant to Environmental Conservation Law Section 24-0301. Should a discrepancy exist between the digital data and the official maps, the official maps are the correct source of information. 3. The official regulatory freshwater wetlands maps may be amended from time to time; digital data obtained at an earlier date may therefore become obsolete. Digital data also may be altered independently of official map amendments in order to make improvements. These digital data cannot be relied on as a definitive statement of the location of freshwater wetlands. Wetland boundaries are subject to delineation by Department of Environmental Conservation regional personnel. 4. The borders of wetlands shown on both the official maps and the digital data are approximate at a scale of 1 to 24,000. Traditional cartographic or digital comparison of the wetland maps to mapped information that is collected and digitized at a larger scale than 1 to 24,000 is not cartographically acceptable and is subject to error. 5. It is inappropriate to make further distributions of the data, because digital wetlands data are not official regulatory maps and are subject to change. All requests for the digital wetlands data should be referred to the Cornell University Geospatial Information Repository <http://cugir.mannlib.cornell.edu> or to the Habitat Inventory Unit, New York State Department of Environmental Conservation, 625 Broadway, 5th Floor, Albany, New York 12233-4754, telephone (518)402-8961.

Wetlands: Supporting Data\DEC Freshwater Wetlands Check Zones

Summary

What is the NYS Freshwater Wetlands "check zone?"

New York's freshwater wetlands maps only show the approximate location of the actual wetland boundary. They are not precise, regardless of how closely you zoom in on the map. The "check zone" is an area around the mapped wetland in which the actual wetland may occur. If you are proposing a project that may encroach into this area, you should check with your regional DEC office to make sure where the actual wetland boundary is. If necessary, they may have a biologist come out and perform a field delineation for you to help you avoid impacts in the wetland or the regulated 100-foot buffer zone.

Methods

These were created by placing a 500 ft buffer around the DEC Wetlands dataset, accessed in November 2016 from the NYS GIS Clearinghouse. Further details pending once DEC has given us license to display it. For now these data are unavailable.

Limitations

Wetlands: Supporting Data\APA Wetlands - Polygons

Summary

The Freshwater Wetlands Act (Act), Article 24 of the Environmental Conservation Law, provides DEC and the Adirondack Park Agency (APA) with the authority to regulate freshwater wetlands in the state. In the Adirondack Park, the APA regulates wetlands and surrounding sensitive areas, including wetlands above one acre in size, or smaller wetlands if they have free interchange of flow with any surface water. Inside the Adirondack Park, wetlands are classified according to their vegetation cover type. APA wetlands classifications follow coding nomenclature of the National Wetlands Inventory (NWI), which is based on the classification hierarchy of Cowardin et al. (1979). Data on CD-ROM from New York State Adirondack Park Agency, Ray Brook, New York 12977.

Methods

For complete metadata, please see https://apa.ny.gov/gis/shared/htmlpages/data.html#wetl.

Limitations

Although these data have been processed successfully on a computer system at the NYS APA, no warranty expressed or implied is made regarding the accuracy or utility of the data on any other system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and aggregate use with other data. It is strongly recommended that these data be directly acquired from the NYS APA, and not indirectly through other sources which may have changed the data in some way. It is also strongly recommended that careful attention be paid to the contents of the metadata file associated with these data. The NYS APA shall not be held liable for improper or incorrect use of the data described and/or contained herein. These data shall not be used for legal jurisdictional determinations.

Wetlands: Supporting Data\NWI Wetlands

Summary

The US FWS National Wetlands Inventory (NWI) is a publically available resource that provides detailed information on the abundance, characteristics, and distribution of US wetlands. The wetland classification codes are a series of letter and number codes that have been developed to adapt the national wetland classification system to map form. These alpha-numeric codes correspond to the classification nomenclature that best describes the habitat. (for example, PFO1A). The codes are based on the Wetlands and Deepwater Habitats Classification Hierarchy that shows the relationship of wetland systems (ex: estuarine), subsystems (ex: intertidal), classes (ex: emergent wetland), and subclasses (ex: persistent emergent wetland) along with special modifiers used to describe water regime, water chemistry, soil, and/or other special characteristics of the wetland or deepwater habitat. NWI Version 2 data were accessed on 12/2016.

Methods

For complete metadata and the original data, please see https://www.fws.gov/wetlands/Data/Metadata.html

Limitations

The use of trade, product, industry or firm names or products is for informative purposes only and does not constitute an endorsement by the U.S. Government or the Fish and Wildlife Service. Links to non-Service Web sites do not imply any official U.S. Fish and Wildlife Service endorsement of the opinions or ideas expressed therein or guarantee the validity of the information provided. Base cartographic information used as part of the Wetlands Mapper has been provided through a license agreement with ESRI and the Department of the Interior.

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery and/or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Exclusions - Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

By policy, the Service also excludes certain types of "farmed wetlands" as may be defined by the Food Security Act or that do not coincide with the *Cowardin et al.* definition. Contact the Service's Regional

Wetland Coordinator for additional information on what types of farmed wetlands are included on wetland maps.

Precautions - Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

The Wetlands Geodatabase is an ongoing effort consisting of data additions, updates, and other data modifications. All datasets utilized outside of the Wetlands Geodatabase or the Wetlands Mapper and supporting web services are only effective as of the date of extraction or delivery by the Wetlands Geodatabase Administrator. The Wetlands Mapper displays the current status of wetlands data availability.

This data set represents the extent, approximate location and type of wetlands and deepwater habitats in the United States and select U.S. trust territories.

These data were developed in conjunction with the publication Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31. Alpha-numeric map codes have been developed to correspond to the wetland and deepwater classifications described.

These spatial data are not designed to stand alone. They were originally developed as topical overlays to the U.S. Geological Survey 1:24,000 or 1:25,000 scale topographic quadrangles or digital imagery. Note that coastline delineations were drawn to follow the extent of wetland or deepwater features as described by this project and may not match the coastline shown in other base maps. The map products were neither designed nor intended to represent legal or regulatory products.

Comments regarding the interpretation or classification of wetlands or deepwater habitats can be directed to the U.S. Fish and Wildlife Service, Division of Ecological Services or by contacting Wetlands_Team@fws.gov.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government. For additional information visit the product summary and metadata web pages.

Wetlands: Supporting Data\Wetlands Geophysical Setting

Summary

We combined the terrestrial NTWHCS with Ecological Land Units (a composite of geology and elevation zones) in order to characterize the unique geophysical setting combinations present in NYS. ELUs are a composite of geology, landform, and elevation zones. They are intended to model the biophysical character of the region. More about ELUs can be found at http://gis.tnc.org/data/MapbookWebsite/map_page.php?map_id=178&sType=TITLE&sKind=northern%20appalachian

Methods

We combined the macrogroups from the Northeast Terrestrial Habitat Map (http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/habitatmap/Pages/default.aspx) with geology and elevation zones to create a map of unique geophysical setting combinations present in NYS.

Using the Spatial Analyst tool "Combine," we combined the raster of terrestrial macrogroups with Geology Class and Elevation Zone from the TNC Ecological Land Units assessment (http://gis.tnc.org/data/MapbookWebsite/map_page.php?map_id=178&sType=TITLE&sKind=northern%20appalappala). The Combine tool enables the creation of a raster with a unique output value assigned to each unique combination of input values from multiple rasters.

Wetland macrogroups:

Central Hardwood Swamp	Northern Peatland
Coastal Plain Peatland	Northern Swamp
Coastal Plain Swamp	Salt Marsh
Emergent Marsh	Wet Meadow / Shrub Marsh

Geology Class:

1: Coarse sediments
2: Fine sediments
3: Acidic sed/metased
4: Acidic shale
5: Calcareous sed/metased
6: Mod calcareous sed/metased
7: Acidic granitic
8: Mafic/intermediate granitic
9: Ultramafic

Elevation Zone:

1000: Coastal (0-20')
2000: Low (to 800 or 1000')
3000: Low-mod (to 1700 or 2000')
4000: Mod (to 2500 or 2800')
5000: High (to 3250 or 4500')
6000: Very high (>3250 or 4500')

Wetlands: Supporting Data\Wetland Habitat Types

Summary

The Northeast Terrestrial Wildlife Habitat Classification (NETWHC) was used as the basis for mapping natural habitats. We applied the classification at the macrogroup level. This layer displays only the wetland habitat types, including forested and emergent wetlands, floodplain forests, and coastal wetlands.

The NTWHCS is a 30 meter grid that maps upland and wetland wildlife habitats/ecological systems for the Northeast, including all 13 states from Maine to Virginia, west to New York, Pennsylvania and West Virginia. The NTWHCS is based on NatureServe's Ecological Systems Classification, augmented with additional information from individual state wildlife classifications and other information specific to wildlife managers. A terrestrial ecological system is defined as a mosaic of plant community types that tend to co-occur within landscapes with similar ecological processes, substrates, and/or environmental gradients, in a pattern that repeats itself across landscapes. Systems occur at various scales, from "matrix" forested systems of thousands of hectares to small patch systems, such as cliffs, basin wetlands, or barrens on a particular bedrock type, of a hectare or 2.

The purpose of that mapping effort is to provide a common framework and language for conservation planning and wildlife management across jurisdictional borders. Specifically, the NE Terrestrial Habitat Classification System and this map are meant to: provide a standardized and consistent habitat and ecosystem classification at multiple scales across states; facilitate interstate communication about habitats; offer managers a tool for understanding regional biodiversity patterns; allow for more effective and efficient habitat conservation across the region, including the prioritization of habitat conservation activities

Methods

The wetland habitat types, including forested and emergent wetlands, floodplain forests, and coastal wetlands, were extracted from the Northeast Terrestrial Habitat Map.

Information on the creation of the Northeast Terrestrial Habitat Map can be found here:

http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/habitatmap/Pages/default.aspx

The report on the classification is available here:
http://www.natureserve.org/publications/pubs/NE_Hab_Class&Map_0708_FinalRept.pdf

Citation

Please cite these data as: Ferree, C and M. G. Anderson. 2013. A Map of Terrestrial Habitats of the Northeastern United States: Methods and Approach. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA.

CLIMATE CHANGE

Climate\Change in climate metrics (NARCCAP)

Includes the metadata for the following layers:

Climate\Change in average annual temperature

Climate\Change in summer maximum temperature

Climate\Change in winter minimum temperature

Climate\Change in number of growing degree days

Climate\Change in number of days above 95 degrees F

Climate\Change in number of days below 32 degrees F

Climate\Change in total precip greater than 1 inch

Climate\Change in total annual precipitation

Climate\Change in total spring precipitation

Climate\Change in total summer precipitation

Climate\Change in total fall precipitation

Climate\Change in total winter precipitation

Summary

These data were generated from global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP). Future and historical simulations are based four Regional Climate Models nested within at least one of three atmosphere-ocean general circulation models, to yield a set of seven RCM-AOGCM combinations. All future projections are based on the relatively high SRES A2 emissions scenario. The change in the mean of these seven simulations between historical (1970-2000) and future (2041-2070) was averaged by HUC8 basins. Data on climate variables were provided by the Northeast Regional Climate Center (http://www.rcc-acis.org).

Methods

Global climate model projections from the North American Regional Climate Change Assessment Program (NARCCAP) are shown by basin areas. The NARCCAP dataset provides daily values of maximum and minimum temperature and precipitation on a 50 km grid. Eleven NARCCAP grids are used each is created using a regional climate model (RCM) driven by one of three atmosphere-ocean general circulation models (AOGCM) or a historical Reanalysis dataset. The spatial resolution of the NARCCAP simulations preclude the inclusion of projections on station-specific graphs.

All future projections cover the period 2041-2070 and are based on the relatively high SRES A2 emissions scenario. Simulations are also generated for the 1971-2000 historical period. Future (and historical) simulations are based four RCMs:

- Canadian Regional Climate Model (CRCM)
- MM5 – Penn State NCAR Mesoscale Model (MM5I)
- Regional Climate Model Ver. 3 (RCM3)
- Weather Research and Forecasting Model (WRF)

nested within at least one of three AOGCMS:

- Community Climate System Model (CCSM)
- Third Generation Coupled Global Climate Model (CGCM3)
- Geophysical Fluid Dynamics Laboratory GCM (GFDL)

yielding a set of seven RCM-AOGCM combinations:

- o CRCM-CCSM
- o CRCM-CGCM3
- o MM5I-CCSM
- o RCM3-GFDL
- o RCM3-CGCM3
- o WRF-CCSM
- o WRF-CGM3

The remaining four NARCCAP grids (each RCM driven by NCEP/DOE AMIP-II Reanalysis) are used to bias adjust the historical and future AOGCM simulations. The Reanalysis is not a climate model, but a representation of historical atmospheric conditions based on observed data. Differences between RCM simulations and the "true" climate occur for a variety of reasons, particularly boundary conditions that result from the limited spatial domain of the RCMs and between-model differences in the physical handling of complex atmospheric processes. To account for this, a bias grid was computed for each RCM by subtracting the average monthly RCM-NCEP simulations from the corresponding historical RCM-AOGCM combination. This bias grid was then used to adjust both the historical and future RCM-AOGCM simulations. For instance, suppose the historical June average temperature at a grid point is 54 °F in the WRF-NCEP simulation and the corresponding temperature in the historical WRF-CGCM3 simulation is 54.6 °F. This 0.6 °F bias would be subtracted from both the historical WRF-CGCM3 and future WRF-CGCM3 simulations prior to plotting on the graphs.

The average change between future and current was calculated for each basin, and attributed by HUC code for mapping. In the case of two HUC8s along the St. Lawrence River that were modified between NHDv1 and NHDv2, we assigned the basin NARCCAP values as follows: Previously both the US and Canada sides were part of the same HUC8, and there were two HUC8s (04150309 and (04150310) along the river from upstream to downstream. In NHD V2 the two sides of the river were split off, the Canada ones remaining as-was, but the US side was combined into one new HUC8 (04150301). The new US HUC8 is not in the NARCCAP exposure data and it spans two different areas in their older HUC8 dataset. As a result, we split the new HUC into two parts matching the prior configuration, and gave each part the climate values of its Canadian counterpart.

Citation

Data provided by: Northeast Regional Climate Center (http://www.rcc-acis.org). Contact: Art Degaetano <atd2@cornell.edu>

Climate\Change in Aridity Index

Summary

The Aridity Index is a metric of moisture stress in a system (lower aridity index represents higher moisture stress) and is calculated from precipitation and Potential Evapotranspiration (PET). PET represents the water that an ecosystem could potentially use though evaporation and transpiration. PET is higher with warmer temperatures and more daylight hours. The ratio of precipitation (AET) to PET was summed over all months for a given year, with the modification that precipitation is capped at PET for each month (no surplus is considered when calculating this version of the Aridity Index). Change in aridity was calculated by subtracting the historical average from the future projection, and was smoothed to a 30m resolution. A positive change indicates that water stress is predicted to be lower in the future, while negative values indicate greater water stress under climate change. Aridity Index data were obtained from climatewizardcustom.org for 1962-1991 and a future projection for 2040-2069, using the ensemble average circulation model and the A2 scenario.

Methods

The Climate Wizard service uses historical data from the PRISM (Parameter-elevation Regressions on Independent Slopes Model) Climate Mapping Program (Gibson et al., 2002) and future climate data from the the WCRP (World Climate Research Program) CMIP3 (Coupled Model Intercomparison Project phase 3) multi-model dataset, downscaled by Maurer et al. (2007). Historical data are available at a 4 km resolution and future data at 12 km.

The Aridity Index is a metric quantifying moisture stress and aridity in a system (lower aridity index represents higher moisture stress) and is calculated from precipitation and Potential Evapotranspiration (PET). PET is a metric representing the water that an ecosystem could potentially use though evaporation and transpiration. PET was calculated from monthly temperature and monthly average number of daylight hours based on a modified version of the Thornethwaite equation (Hamon, 1961). PET is higher with warmer temperatures and more daylight hours. The ratio of precipitation (AET) to PET was summed over all months for a given year, with the modification that precipitation is capped at PET for each month. Similar to how deficit is calculated, if precipitation in a given month is greater than PET, it is capped at the value of PET (no surplus is considered when calculating this version of the Aridity Index).

Aridity Index data for NY were obtained from climatewizardcustom.org for 1962-1991 and a future projection for 2040-2069, using the ensemble average circulation model and the A2 scenario. Change in aridity was calculated by subtracting the historical average from the future projection, and was smoothed to a 30m resolution. A positive change indicates that water stress is predicted to be lower in the future, while negative values indicate greater water stress under climate change.

Citation

"PRISM Group, Oregon State University, created 4 Feb 2007." The PRISM Group, Oregon State University retains rights to ownership of the data and information.

Girvetz EH, Zganjar C, Raber GT, Maurer EP, Kareiva P, et al. (2009) Applied Climate-Change Analysis: The Climate Wizard Tool. PLoS ONE 4(12): e8320. doi:10.1371/journal.pone.0008320

Climate\Extreme Precipitation

Includes the metadata for the following layers:

Climate\Extreme Precipitation (100 year Event): Future Recurrence

Climate\Extreme Precipitation (100 year Event): Future Average Percent Increase

Climate\Extreme Precipitation (100 year Event): Current Magnitude

Climate\Extreme Precipitation (10 year Event): Future Recurrence

Climate\Extreme Precipitation (10 year Event): Future Average Percent Increase

Climate\Extreme Precipitation (10 year Event): Current Magnitude

Summary

The climatology of very large precipitation events was updated by the Northeast Regional Climate Center (NRCC) and the outputs are available at http://precip.eas.cornell.edu/. On a national level, a comprehensive climatology of rainfall events has not been updated since the early 1960s. The NRCC methodology for creating this atlas relies on work done by several previous local and regional extreme rainfall studies including Technical Paper 40, NOAA Atlas 14, and Wilks 1993. Technical documentation is available at http://precip.eas.cornell.edu/docs/xprecip_techdoc.pdf.

Methods

NRCC methods for generating these data are available in Castellano, C. and A. DeGaetano. 2015. Downscaled Projections of Extreme Rainfall in New York State, Technical Document. Northeast Regional Climate Center, Cornell University, Ithaca, NY. http://ny-idf-projections.nrcc.cornell.edu/idf_tech_document.pdf

More information on these data, as well as data for other time periods, emission scenarios, and event return periods or recurrence intervals, are available here: http://ny-idf-projections.nrcc.cornell.edu

Data provided by: Northeast Regional Climate Center, Cornell University (http://www.rcc-acis.org) and viewable in other forms here: http://ny-idf-projections.nrcc.cornell.edu. Contact: Art DeGaetano <atd2@cornell.edu>

SEA LEVEL RISE

Sea Level Rise\Current MHHW Shorelines

Summary

Estimated current Mean High High Water (MHHW) shorelines based on available LiDAR and NED elevation data. Shorelines show modelled current MHHW line derived from source data at original source resolution. Shorelines are provided for reference purposes to aid in visually interpreting the quality of the underlying elevation data as well as the relative amount of future lateral change in the inundation area within and among 30 m. resolution majority-inundated LULC pixels.

Methods

MHHW-adjustments were performed by the original data providers.

The current boundary between the inundated and non-inundated portions of the three regional MHHW-adjusted digital elevation models (DEMs) was extracted prior to the majority-rule aggregation step where the data was resampled to a 30 m. resolution grid. The shorelines were attributed with respect to the original data provider, the source data type and spatial resolution, and the time period for the shoreline (current or future) and then combined into a single layer for each time period.

Attributes

Provider: original data provider (Scenic Hudson or the Coastal Resiliency program of The Nature Conservancy).

SourceType: original data source (LiDAR or USGS NED data) and source raster resolution.

ModelYear: time period of the modelled shoreline (current of future).

Citations

Scenic Hudson, 2013 (see http://www.scenichudson.org/slr for the interactive sea level rise web mapper).

Developing a Framework for Assessing Coastal Vulnerability to Sea Level Rise in Southern New England, USA. Gilmer, B. and Z. Ferdaña. in K. Otto-Zimmermann (ed.), Resilient Cities 2: Cities and Adaptation to Climate Change Proceedings of the Global Forum 2011, Local Sustainability 2, © Springer Science+Business Media B.V. (2012).

Sea Level Rise\Future MHHW Shorelines

Summary

Estimated future Mean High High Water (MHHW) shorelines based on available LiDAR and NED elevation data and predicted sea level rise (SLR). Shorelines show modelled future MHHW line derived from source data at original source resolution based on adding the predicted regional estimate of SLR to the current MHHW elevation. Potential vertical accretion within wetlands and horizontal erosion and accretion due to the action of waves and currents were not modeled.

Methods

MHHW-adjustments were performed by the original data providers.

The future boundary between the inundated and non-inundated portions of the three regional MHHW-adjusted digital elevation models (DEMs) was extracted prior to the majority-rule aggregation step where the data was resampled to a 30 m. resolution grid. The shorelines were attributed with respect to the original data provider, the source data type and spatial resolution, and the time period for the shoreline (current or future) and then combined into a single layer for each time period.

Attributes

Provider: original data provider (Scenic Hudson or the Coastal Resiliency program of The Nature Conservancy).

SourceType: original data source (LiDAR or USGS NED data) and source raster resolution.

ModelYear: time period of the modelled shoreline (current of future).

Citations

Scenic Hudson, 2013 (see http://www.scenichudson.org/slr for the interactive sea level rise web mapper).

Developing a Framework for Assessing Coastal Vulnerability to Sea Level Rise in Southern New England, USA. Gilmer, B. and Z. Ferdaña. in K. Otto-Zimmermann (ed.), Resilient Cities 2: Cities and Adaptation to Climate Change Proceedings of the Global Forum 2011, Local Sustainability 2, © Springer Science+Business Media B.V. (2012).

Sea Level Rise\Current SLR Innundation

Summary

Areas of current sea level rise (SLR) inundation are those areas that are not classified as open water but that are estimated to be majority inundated at present based on elevation relative to Mean High High Water (MHHW) and that do not show any change in the lateral extent of inundation under future sea level rise (SLR) conditions. Future changes in inundation depth and duration due to future SLR would still be expected to occur in these areas.

The proportion of each aggregated 30 x 30 m. LULC habitat cell above and below MHHW, as well as if any change in the proportion inundated occurred between current and future conditions, was used when determining if majority inundation warranted a change in expected habitat or land use type. Original source data ranged from 1.0 and 1.5 m. resolution LiDAR data for the Hudson River north of NYC and for eastern Long Island (Suffolk County), respectively, to 10.0 m. resolution NED data for NYC and Nassau and Westchester Counties.

Current wetlands have been excluded as they may viably exist within the intertidal zone. Remaining inundated developed areas and uplands may represent areas with habitat classification and/or elevation errors.

Methods

Full methods are described in the “Sea Level Rise\Future SLR Inundation” layer below.

This layer represents just those areas from the current (2011) hybrid LULC habitat classification within NY State that were classified into one of three SLR-related inundation classes.

Raster Value (LULC code)	LULC code description
15	Inundated Developed
16	Inundated Upland
17	Inundated Wetland (future only)

Attributes

Raster Value: hybrid LULC code

Descrip: hybrid LULC code description

Citations

Developing a Framework for Assessing Coastal Vulnerability to Sea Level Rise in Southern New England, USA. Gilmer, B. and Z. Ferdaña. in K. Otto-Zimmermann (ed.), Resilient Cities 2: Cities and Adaptation to Climate Change Proceedings of the Global Forum 2011, Local Sustainability 2, © Springer Science+Business Media B.V. (2012).

Scenic Hudson, 2013 (see http://www.scenichudson.org/slr for the interactive sea level rise web mapper)

NYS Sea Level Rise Task Force Report. 2010. http://www.dec.ny.gov/energy/67778.html

NYS 2100 Commission Report:
http://www.governor.ny.gov/sites/governor.ny.gov/files/archive/assets/documents/NYS2100.pdf

Sea Level Rise\Future SLR Inundation

Summary

Areas of current sea level rise (SLR) inundation are those areas that are not classified as open water but that are estimated become majority inundated based on a change in the lateral extent of inundation under future sea level rise (SLR) conditions.

The ability of vertical accretion within current wetlands to match SLR is dependent on rates of sediment supply, belowground root production and decay rates, and other factors not modeled in this exercise; as a result, wetlands with future inundation may remain as wetlands or may transition to open water or another type of wetland (forested to emergent wetlands, for example). Likewise, the future fate of inundated upland natural and agricultural habitats, whether they transition to a wetland state or to open water, depends on the depth of the inundation, rates of marsh migration, rooting zone saturation periods, salinity changes, habitat connectivity obstacles, rates of succession, etc.; therefore the specific future cover type was not determined.

Inundated developed areas will be increasingly prone to frequent flooding and may require heavy investment in engineered solutions to maintain current uses; otherwise some kind of rezoning or conversion to open space may need to be considered. Caution should be used when considering the effects of future inundation in areas that also have extensive current inundation due to possible habitat classification and/or elevation errors, particularly in areas not covered by higher resolution LiDAR source data.

Methods

Areas predicted to experience increased inundation due to future Sea Level Rise (SLR) were identified along the Atlantic and Long Island Sound coastlines of Long Island, New York City, Westchester County, and the NY shorelines of the Hudson River Estuary up to the dam at Troy. The amounts of future SLR inundation thought to best match the central range of models for the IPCC 2050 A2 + rapid ice melt (2m) climate change scenario, as identified in the NYS Sea Level Rise Task Force Report (2010) and the NYS 2100 Commission Report (2013) were selected to be:

a. 18” of SLR above Kingston on either side of the Hudson River
b. 24” of SLR below Kingston on either side of the Hudson River (down to the Ludlow Park area of Yonkers)
c. 26.3” of SLR for the Long Island Sound shorelines of NYC, Westchester County, and Long Island (Nassau and Suffolk Counties)
d. 21.7” of SLR for the lower Hudson and Atlantic shorelines of NYC, and Long Island (Nassau and Suffolk Counties)

The midriver point on the Hudson just above Kingston where this division occurs was chosen to be at 73.955145 W, 41.94135 N (NAD 1983 datum). This point was chosen as the closest to Kingston where both the east and west banks of the Hudson were steep with minimal shoreline that would be inundated under any scenario up to and including the 72” SLR scenario. In this way, no wetlands or floodplain terraces would be artificially bisected by the dividing line, which would otherwise create analysis artifacts. The dividing line runs east-west through this point in the projected coordinate system.

SLR inundation data for the Hudson River estuary at 1 m. resolution was obtained from Scenic Hudson (2014). The data shows a set of possible inundation zones due to SLR calculated for stepwise increments of SLR of 6 inches from 0 to 72 inches above current mean higher high water (MHHW). Any pixels in the 0”, 6”, 12”, or 18” inundation zone (or 24” south of Kingston) were categorized as being possibly inundated in the future (coded “1”) while any pixels within higher inundation zones or within 100m of the most upslope inundation zone were considered to not be inundated in the future (coded “0”). The inundation data was reprojected into our standard Albers projection and aligned with the grid cells of the current and future hybrid habitat classification maps.

SLR inundation data for eastern Long Island (Suffolk County) and for NYC, Westchester and Nassau Counties (here referred to collectively as the NYC data) were obtained from TNC’s Coastal Resilience program for New York (http://maps.coastalresilience.org/newyork/; methods: Gilmer and Ferdana 2012). The elevation data upon which the future inundated area estimates were based was of a much finer resolution (5 ft.) with a correspondingly much lower vertical uncertainty (0.4265 ft.) than that of the pre-LiDAR USGS National Elevation Dataset (NED) used for NYC (9.86 m. resolution, 4.9 ft. vertical uncertainty). As a result, the Coastal Resilience data from different source regions were processed separately. The north-south dividing line for NYC and Long Island matches the division in the Coastal Resilience data from TNC.

The Coastal Resilience elevation data was adjusted to be relative to the mean high water (MHW) datum using interpolated grids based on NOAA’s VDatum conversion program. The tidally-corrected Digital Elevation Models (DEMS) were reprojected into our standard Albers projection and resampled to 1.5 m. and 10.0 m. resolutions to facilitate upscaling to 30 m. to exactly align with the grid cells of the current and future hybrid habitat classification maps. Pixels with elevations equal to or below the future inundation thresholds (above) were categorized as being possibly inundated in the future (coded “1”) while any pixels with elevations above the future inundation thresholds were considered to not be inundated in the future (coded “0”).

All future SLR inundation data for the Hudson, NYC, and eastern Long Island was aggregated (or “up-scaled”) using a 30 m. neighborhood/block filter and a majority decision rule. Each 30 m. pixel was preliminarily classified as inundated if a majority (50%) or more of the 1 m. pixels with the 30 m. block were classified as inundated.

In order to detect discrepancies between the current NETWHC upland terrestrial habitat classification and what the Scenic Hudson and Coastal Resilience SLR data show to be currently inundated (at or below 0 MHHHW or 0 MHW, repectively), the current extent of inundation was also determined using the exact same methodology described above but only for pixels in the 0” inundation zone of the Scenic Hudson data or those at or below 0 MHW in the coastal Resilience datasets. Additionally, the proportion of 1 m. subpixels that were inundated in each 30 m. pixel was calculated and the proportional change between the current and future climate scenario was determined.

If a 30 m. pixel was majority inundated under future conditions, the pixel was reclassified as an inundated LULC class (Inundated Developed, Inundated Upland [ag or natural], or Inundated Wetland) in the FUTURE habitat classification. Because of the variable depth of future inundation within the 30 m. pixels, uncertain amount of future development intensification prior to inundation on current or newly developed lands, and the uncertain fate of uplands potentially converting to wetlands and of various wetland types being able to migrate landward and/or accrete vertically and so perhaps persist despite the projected future inundation, no finer division of future inundation habitat types was attempted and no future inundated areas were reclassified to open water.

If a 30 m. pixel was majority inundated under both current and future conditions, and the proportion of inundation did not change, the pixel was reclassified as an inundated LULC class (Inundated Developed or Inundated Upland) in the CURRENT habitat classification data, excluding wetlands, which were not reclassified because they can currently exist and persist when inundated at high tide by current inundation depths. This allows areas with steep near-vertical shorelines, where the increased vertical inundation will not be expected to translate to a lateral increase in inundated land, to reflect no change. It also allows for a conservative estimation of areas of potential future impact under SLR by excluding areas of open water that were misclassified in the NETWHC dataset.

Due to the finer level of habitat class differentiation for areas beyond the SLR inundation mask compared to those within it, both a pre-SLR and a final post-SLR habitat classification map for both the current (2011) and future (2050) scenarios has been provided to aid in subsequent analyses.

This layer itself represents just those resulting areas from the future (2050) hybrid LULC habitat classification within NY State that were classified into one of three SLR-related inundation classes.

Raster Value (LULC code)	LULC code description
15	Inundated Developed
16	Inundated Upland
17	Inundated Wetland (future only)

Attributes

Raster Value: hybrid LULC code

Descrip: hybrid LULC code description

Citations

Developing a Framework for Assessing Coastal Vulnerability to Sea Level Rise in Southern New England, USA. Gilmer, B. and Z. Ferdaña. in K. Otto-Zimmermann (ed.), Resilient Cities 2: Cities and Adaptation to Climate Change Proceedings of the Global Forum 2011, Local Sustainability 2, © Springer Science+Business Media B.V. (2012).

Scenic Hudson, 2013 (see http://www.scenichudson.org/slr for the interactive sea level rise web mapper)

NYS Sea Level Rise Task Force Report. 2010. http://www.dec.ny.gov/energy/67778.html

NYS 2100 Commission Report: http://www.governor.ny.gov/sites/governor.ny.gov/files/archive/assets/documents/NYS2100.pdf

ECOSYSTEM FUNCTIONS

Ecosystem Functions\Carbon Storage\Predicted future above-ground carbon storage

Summary

Carbon sequestration is an important ecosystem service that may partially offset greenhouse gas emissions and reduce climate change impacts. We assessed the net storage of carbon on the landscape by 2050, in order to understand the impact of predicted land use changes, and identify areas that have the biggest potential for storage, or are under the biggest threat of carbon loss. This analysis is potentially useful for land use planning and assessing the potential value of lands on the carbon market.

Methods

Since above-ground biomass is in most cases the largest component of biomass, and is the pool currently available for carbon credits, we decided to limit our analysis to this carbon pool. Below-ground biomass is generally estimated as a fixed propotion of above-ground pools, and litter and soil are assumed to be at equilibrium or 0 for most cover types.

All estimates based on forest growth were derived from regional standards published by the US Forest Service (Smith et al 2006). Estimates of carbon stocks in various pools are provided for afforestation of forest types in 10 year increments. Since the USFS forest types do not crosswalk directly to the NETWHC macrogroups, we used spatial concurrence and descriptions of composition to assign them as follows:

NETWHC Macrogroup	USFS Forest Type Group
Boreal Upland Forest	Spruce-Balsam Fir*
Central Oak-Pine Forest	Oak-Hickory
Northern Hardwood-Conifer	Maple-Beech-Birch
Northeastern Floodplain Forest	Maple-Beech-Birch**

*Based on spatial concurrence, the Boreal Upland Forest aligns with the Aspen/Birch group. However the species composition for that classification is most similar to the Spruce-Balsam Fir group
**Northeastern Floodplains align best with the Elm/Ash/Cottonwood group, but carbon stock data were not available

For each forest type, annual live tree carbon stocks were linearly extrapolated from the 10-yr interval data. The USFS data were limited to stands up to 125 in age, which is or will be exceeded by some New York forests by 2050. In those cases the last growth rate available (based on 115-125 years) was extrapolated to 182 years (the oldest age needed for this assessment). It should be noted that this likely overestimates the carbon storage of the oldest forests, which are expected to slow their sequestration rate over time. All values were multiplied by 0.09 to convert from tonnes C per hectare to per pixel values.

Each land use transition was modeled separately using different methods, as detailed below:

Agriculture to Forest

This transition is assumed to accumulate carbon at a rate specific to each forest type, starting from 0 above-ground biomass at the year of transition. All change codes were selected from the raster 'lulc_change_matrix' with FROM 81 or 82 and TO 600 (Central Oak-Pine), 1600 (Northern Hardwood-Conifer), or 1800 (Ruderal Shrubland/Grassland). These were merged with the year of transition for each cell, which were subtracted from 2050 to get final forest age. Total storage by age was derived for each forest type from the estimates in Smith et al (2006) as described above, and joined to the raster.

Agriculture to Wetland

Agricultural classes transitioned to Wet Meadow/Shrub Marsh (3170 and 3270) were assumed to reach an equilibrium state by 2050, and were assigned a total C storage of 4.14 tC/pixel based on the average for this class in the NBCD (calculated by zonal statistics).

Agriculture/Natural to Developed

Developed land is estimated to accrue carbon at a rate of 2.9 tonnes C per hectare of crown cover (IPCC). We used zonal statistics on the 2011 NLCD tree canopy raster (within NY) to estimate mean crown cover by development class, and then converted those values to an annual sequestration rate per pixel as follows:

LAND_COVER	MEAN_perc_cover	ha_cover_pixel	tC_yr_pixel
Developed, Open Space	40.92966823940	0.036836701	0.106826434
Developed, Low Intensity	23.29563656980	0.020966073	0.060801611
Developed, Medium Intensity	13.62253794360	0.012260284	0.035554824
Developed, High Intensity	4.59862155489	0.004138759	0.012002402

Years of growth were calculated as 2050-transition year, and were multiplied by the annual sequestration to get estimated total storage for each dev class/transition year combination.

All ag and natural classes with a TO code of 21, 22, 23, or 24 were extracted from the lulc_change raster to map all new development. This raster was merged with the transition years and joined to the carbon storage estimates.

Forest remaining Forest

Growth rates for forests depend on the forest type, age of the stand, management practices, site productivity, and climate. We did not have sufficient data on the latter three factors to incorporate them into this statewide model, but were able to use a map of predicted stand age provided by the US Forest Service (Wilson, Barry, pers. comm. 3/10/2015) to refine our regional estimates.

We selected all pixels from the lulc_change map with either no change in forest type, or Ruderal Shrubland/Grassland converting to forest (5656 Central Oak-Pine; 5959 Boreal Upland Forest; 6464 Northeastern Floodplain Forest; 6666 Northern Hardwood-Conifer; 6856 RSG to COP; and 6866 RSG to NHC). [Succession of ruderal lands was included here because much of the ruderal land outside of the Long Island and Great Lakes regions were already classed as forest in the NETWHC, so doing so would give them more consistent treatment across the state. It was assumed that these lands would have a young stand age reflecting their successional status.] Since the stand age data are available at 250m resolution, so they were first resampled to 30 m and then merged with the selected land cover pixels.

Since the stand age data were based on 2009 forest inventory, but carbon storage needed to be compared to a 2000 baseline, sequestration calculations were based on an adjusted starting age of stand age – 9. All stand ages less than 9 (due to ruderal land abandoned after 2000, or variance in the stand age model) were given a starting age of 0. Carbon storage in 2050 was then calculated as 50 years of growth from the 2000 starting age. Carbon storage in 2000 was also calculated based on the 2000 starting age and subtracted from 2050 storage to obtain a net carbon sequestration. This was then added to the baseline AG carbon in the NBCD to obtain total storage in 2050. [We did not simply use the initially calculated 2050 storage because, due to variance in the stand age estimates and variation in actual growth rates compared to the regional estimates, in some cases the modeled future C storage was less than the 2000 NBCD and resulted in net negative growth. Subtracting the modeled baseline and adding the net change to the NBCD ensured all forest growth would be positive.]

Developed land remaining Developed

Lands that were classed as developed (21, 22, 23,or 24) in the 2011 NLCD may have been developed in 2000, or they may have been natural in 2000 in which case the NBCD baseline would reflect a natural cover type. Because of this we could not simply add net sequestration to the NBCD to obtain 2050 storage for all cases. To identify which developed pixels were likely natural in 2000, we compared the hybrid lulc class to the NETWHC, which is based on 2001 NLCD. All pixels that were Developed in the hybrid lulc that were NOT developed in the NETWHC were assumed to have a baseline C storage of 0 (all stored C lost in conversion) and assigned 40 years (since assumed to have been developed by 2010) of sequestration according to the development type (see previous table under Ag/Nat to Dev). All other developed pixels were assigned a baseline from the NBCD to which we added 50 years of sequestration based on development type. The resulting two rasters represent the 2050 C storage in 'old' (pre2000) and 'new' (2000-2010) existing development.

Future Agriculture and Future Water

Since active agriculture and open water do not store any above ground carbon, these classes were assigned a 2050 C storage of 0, regardless of starting class. This included all pixels with the following TO codes: 11 (Water), 15/16/17 (Inundated), 30 (new ag), 31 (pasture/hay) and 32 (cultivated).

No change

Unforested natural areas (e.g. grass/shrubland, wetlands, rocky/bare) experiencing no change in the future land cover model were assumed to be in a steady state and not sequestering additional above-ground carbon (IPCC). This assumption is most reliable for habitats dominated by annual vegetation (grasslands, emergent marsh). Woody wetlands and shrub/savannah classes are more likely to be storing AG biomass but we did not have good estimates for sequestration rates. Some habitats like Alpine, Cliff/Talus, and Summit Scrub have C storage in the NBCD comparable to the surrounding forest types. This likely reflects the small scale and steep slopes of these habitat types compared to the spatial accuracy of the nbcd data. Productivity of these habitats is expected to be low and sequestration may still be very small, but it is possible we are underestimating future C storage for these types. This group also included ruderal shrubland on protected lands, assumed to be managed to maintain grass/shrub character.

Pixels with the lulc_change codes: 5252, 5454, 5757, 5858, 6060, 6161, 6262, 6363, 6565, 6767, 6868, 6969, 7070, 7171, 7272 were assigned the current C storage values in the NBCD.

A final 2050 C storage map was created by combining the above component rasters into a single map using nested con statements in raster calculator. Values are the modeled 2050 aboveground storage in tonnes C per pixel.

Limitations:

All sequestration rates applied are based on regional averages and may not reflect local conditions. The NBCD, NETWHC, and land use change model all include their own assumptions and uncertainties that could affect our results. We did not attempt to incorporate estimates of loss due to timber harvest, pests, disease, fire, etc. due to the high uncertainty of predicting the spatial distribution these disturbances. Additional assumptions and limitations are detailed in the subsections above.

Ecosystem Functions\Carbon Storage\Predicted above-ground carbon sequestration (2000-2050)

Carbon sequestration is an important ecosystem service that may partially offset greenhouse gas emissions and reduce climate change impacts. We assessed the net storage of carbon on the landscape by 2050, in order to understand the impact of predicted land use changes, and identify areas that have the biggest potential for storage, or are under the biggest threat of carbon loss. This analysis is potentially useful for land use planning and assessing the potential value of lands on the carbon market.

Methods

The current above-ground storage from NBCD (converted to tonnes C per pixel) was subtracted from the future carbon storage model (described above) to obtain a net change raster from 2000-2050.

Values are estimated net change in aboveground storage from 2000-2050 in tonnes C per pixel.

Limitations

All sequestration rates applied are based on regional averages and may not reflect local conditions. The NBCD, NETWHC, and land use change model all include their own assumptions and uncertainties that could affect our results. We did not attempt to incorporate estimates of loss due to timber harvest, pests, disease, fire, etc. due to the high uncertainty of predicting the spatial distribution these disturbances. Additional assumptions and limitations are detailed in the subsections above.

Ecosystem Functions\Carbon Storage\Observed current above-ground carbon storage

Summary

Data from the National Biomass and Carbon Dataset (NBCD), developed by the NASA Terrestrial Ecology Program. The data set provides a high-resolution (30 m) map of year- 2000 estimates of basal area-weighted canopy height, above-ground, live, dry biomass, and standing carbon stock for the conterminous United States.

Citation

Kellndorfer, J., W. Walker, K. Kirsch, G. Fiske, J. Bishop, L. LaPoint, M. Hoppus, and J. Westfall. 2013. NACP Aboveground Biomass and Carbon Baseline Data, V. 2 (NBCD 2000), U.S.A., 2000. ORNL DAAC, Oak Ridge, Tennessee, USA. http://dx.doi.org/10.3334/ORNLDAAC/1161

Ecosystem Functions\Carbon Storage\Estimated terrestrial carbon storage (all sinks)

Summary

Using the Natural Capital Project InVEST toolkit we assessed the amount of carbon sequestered naturally in soils, dead plant material and above- and below-ground live vegetation.

Methods

The InVEST model inputs include: land cover, soil order and carbon pool data. For land cover classification we used the Terrestrial Habitats based on macrogroups from the Northeastern Terrestrial Wildlife Habitat Classification (please also find the meta-data and an attribute description above). For the purposes of this analysis floodplain forests were added to the land cover for their role as forest habitat, but other wetland types were excluded.

The Soil Orders were derived from a STATSGO raster dataset obtained from USDA and SSURGO data obtained from the Soil Data Mart (www.soildatamart.nrcs.usda.gov). We generated a table from SSURGO by using the soils database with relationships built in for the STATSGO dataset. We then queried for the major component of each mapunit and its taxonomic name and joined the resulting table to the SSURGO shapefile. The taxonomic name is listed both in whole and in parts. With help from USDA Service Center soil scientist, we used the Soil data viewer 6.1 (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053619) to generate a list of taxonomic names by major component. There were several blanks for map units that had Urban land, so we manually populated those with the Second named component or Entisols (based on guidance from USDA).

Habitat macrogroups and soil orders were combined to create a single raster of unique carbon units for input to InVest.

Carbon storage values were applied to each habitat type for above and below ground and dead litter pools and for each soil order for the soil carbon pool. Carbon storage for above-ground pools were based on the remotely-sensed biomass data in the National Biomass and Carbon Dataset (2000), which we summarized to the habitat types by raster calculation and converted to carbon using biomass:carbon ratios for each habitat type from the IPCC (2006). Below-ground pools were calculated from the above-ground values using root:shoot ratios based on either the IPCC or the Carbon Dioxide Information Analysis Center. The dead litter pool was assumed to be 0 for most non-forest habitat types, although we applied a default IPCC estimate for some shrub/scrub habitats and for floodplain forests. For the forested habitats we used an estimate of total dead carbon pools (down dead, standing dead, and litter) for comparable habitats from the FIA database. FIA carbon data were also used to verify the above and below ground values for the forested habitats. Soil pool values were based on general guidance provided by the IPCC (2006).

Attributes

Raster value represents Mg of carbon per 30x30m grid cell (900 sq. meters).

Limitations

The InVEST model returns a simplified carbon cycle. Carbon storage values may vary considerably within a habitat type and we provide an estimate only. This analysis excluded wetland habitats, which may contribute substantial carbon storage in organic soils. It also did not take into account forest age, management history, or other local variables. The output is only as detailed and reliable as the land use classes and carbon pool data that are input.

Citations

IPCC. 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Kellndorfer, J., W. Walker, K. Kirsch, G. Fiske, J. Bishop, L. LaPoint, M. Hoppus, and J. Westfall. 2013. NACP Aboveground Biomass and Carbon Baseline Data, V. 2 (NBCD 2000), U.S.A., 2000. Data set. Available on-line [http://daac.ornl.gov] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/1161

Ruesch, Aaron, and Holly K. Gibbs. 2008. New IPCC Tier1 Global Biomass Carbon Map For the Year 2000. Available online from the Carbon Dioxide Information Analysis Center *[http://cdiac.ornl.gov]*, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Ecosystem Functions\Nutrient Retention\Predicted Future Percent Change in Phosphorus Retention and Export to Streams

Summary

Nutrient retention by vegetation and soils is an important ecosystem service that may become even more important with climate change, as extreme precipitation events become more frequent and more severe, and the consequences of nutrient pollution within streams become more severe due to warming temperatures. We assessed the net export and overall retention of phosphorus on the landscape in both current day and 2050, in order to understand the impact of predicted land use changes, and identify areas that have the biggest potential for retention, or are under the biggest threat of loss of nutrient retention services. We selected phosphorus because it is the primary limiting nutrient in freshwater systems and the overall adaptation toolkit is designed to address terrestrial and freshwater systems, but not Great Lakes coastal, estuarine, or marine coastal systems. The same tool could be used to predict nitrogen retention as well if there is interest in the future.

Methods

We used Natural Capital Project's InVEST modeling tool (http://data.naturalcapitalproject.org/nightly-build/invest-users-guide/html/waterpurification.html) to model phosphorus export and retention within each HUC 8 in the freshwater project boundary for both current day and 2050. Results are reported here as average values for each HUC, but pixel level export and retention are available and can be used, in conjunction with the flow paths, to summarize for any unit.

Key Processing Steps:

1) Project area boundary
    a. Download and process most current Watershed Boundary Dataset (WBD) HUC8 boundaries
    b. Project to NAD83 Albers
2) 10 m DEM:
    a. Download 10 m National Elevation Dataset (NED) state tiles for full project area: CT, MA, NJ, NY, PA, OH, RI, and VT
    b. Merge NED tiles
    c. Project to NAD1983 Albers
    d. Check for NoData areas
    e. Process DEM using ArcHydro
        i. Derive stream networks to test grid
        ii. Agree DEM
        iii. Fill DEM
3) SSURGO county level soils data
    a. Downloaded SSURGO data by county for all states
    b. Processed by subset using Soil Data Viewer

    c. Project to NAD1983 Albers
        i. Depth
            1. Convert cm to mm (*10)
            2. Convert to 10 m grid, snap to DEM
        ii. Available water capacity
            1. Convert to 10 m grid, snap to DEM
4) STATSGO2 state soil data (to fill in missing SSURGO areas)
    a. Soil Data Viewer to process
        i. Depth
            1. Convert cm to mm (*10)
            2. Convert to 10 m grid, snap to DEM
        ii. Available water capacity
            1. Convert to 10 m grid, snap to DEM
            2. Fill in missing data (assign to 0), convert to numeric
    b. Merge STATSGO data underneath SSURGO data
5) Current hybrid land use layer
    a. Clip to project area
    b. Project to NAD83 Albers and resample to 10-m
    c. Burn in CAFO points (see below)
6) CAFOs
    a. NY Point data obtained from NYS Division of Water
        i. Unable to locate point data for areas outside NY state but know that adjacent PA counties do have fair amount of CAFOs
    b. Determine which SPARROW loading data (field) to use for MRB1 and MRB3
    c. For SPARROW Atlantic data
        i. Select catchments that intersect Atlantic flowlines
        ii. Join flowlines to catchments by COMID
        iii. Run identity with catchments and CAFO points
        iv. In R, distribute nutrient data to CAFO points
            1. If more than one CAFO in a catchment, distribute nutrient proportionally based on area
    d. For SPARROW Great Lakes data
        i. Select HUC12 watersheds that intersect MRB flowlines
        ii. Identity between MRB flowlines and HUC12
        iii. Identity between part ii identity and CAFO points
    e. Convert loads to g/yr from kg/yr
    f. Create unique LULC ID for each CAFO (>= 2300)
    g. Convert CAFO points to grid
    h. Add to LULC using unique value to reflect CAFO loading
    i. Update the InVEST biophysical table with the CAFO points
7) NPDES Point sources
    a. Download DMR nutrient modeling data for Phosphorus from EPA for all 8 states that intersect the project area
    b. In R, select desired columns, merge all states
        i. Convert P units from lbs/yr to kg/yr (0.45359237)
    c. Create point shapefile from the merged csv
    d. Clip points by project area
    e. Run spatial join to sum total NPDES P for each HUC8 watershed
8) Future hybrid
    a. File = “hybrid_LULC_2050_final2”
    b. Resample to 10 m; snap to current land cover
    c. Add current CAFO points to LULC using unique value to reflect CAFO loading
    d. Merge current LULC underneath for areas outside NY state
    e. Convert all potential sea level rise pixels (i.e., values 15, 16, 17) to open water (i.e., worst case scenario approach)
9) Climate variables:
    a. Current:

i. Precipitation:
1. Download project's Climate Wizard extraction
2. Clip to project area
3. Reproject to Albers
4. Resample to 10 m, snap to DEM

ii. PET:
1. Download global PET (Hargreaves)
2. Reproject to Albers
3. Resample to 10 m, snap to DEM

b. Future:

i. Precipitation
1. Download project's Climate Wizard extraction
2. Clip to project area
3. Reproject to Albers
4. Resample to 10 m, snap to DEM
5. Fill in NoData holes (two locations, in lake areas) and expand edges
   a. Focal mean for NoData area: 1500 x 1500
   b. Merge in focal mean values underneath

ii. PET:
1. Clip to project area
2. Reproject to Albers
3. Resample to 10 m, snap to DEM
4. Fill in NoData holes (two locations, in lake areas) and expand edges
   a. Focal mean for NoData area: 1500 x 1500
   b. Merge in focal mean values underneath

10) The seasonality constant was determined to be 3
   a. Same as was used for the CT River InVEST model which was determined by running the InVEST Water Yield and comparing the results for each subwatershed (mean water yield in mm/yr) to the average runoff values from GAGES II database (mm/year) until the difference across watersheds was minimized.

11) Threshold flow accumulation value used in InVEST: 1000
   a. This value was determined based on calibration and testing with the SPARROW nutrient loads and flow line derivation

12) InVEST Biophysical Table (see details below and on following pages)
   a. Current
      i. The P coefficient values (p_load) and P removal efficiencies (eff_p) for each land cover were initially based on literature review (see details on following pages). The values for some key land uses such as agriculture and pasture were further adjusted using calibration with USGS SPARROW model outputs (Moore et al. 2011). This was done through the use of multiple InVEST runs for a handful of watersheds with varying land cover composition and located in different parts of the project area until the InVEST nutrient estimates for those watersheds were very similar to those estimated by the SPARROW models.
   b. Future
      i. The same parameter values as those in the Current scenario were used except for a new land use category called Future Ag (value = 80). As it was not possible to distinguish pasture pixels from row crop pixels in the future land cover grid, we adjusted the root_depth, Kc, and load_p values in the biophysical table based on the proportion of row crops and pasture in each HUC8 watershed. An R script was written to create a unique biophysical table for each watershed (n=59) based on a weighted average of the row crops and pasture values from the current land use parameters, using the proportion of row crops and pasture in the watershed. The eff_p value was not updated because this value was the same for row crops and pasture in the current scenario (i.e., eff_p was equal to 0 for both row crops and pasture).

Input Data Sources:

- Elevation data for determining water flow over land: 10 m DEM for NY from GIS clearinghouse, and remaining areas used the 10 m National Elevation Dataset (NED)
- Soils: We used SSURGO county level soils data where available and STATSGO 2 state soil data to fill in missing SSURGO areas for soil depth and available water capacity.
- Land use: We used the future hybrid land use layer within NY (see 8a above), and 2011 NLCD data for the remainder of the project boundary, resampled to 10 m to match the DEM. Pixels projected to be inundated by sea level rise were converted to water. *Note that this is a worst case scenario-if wetlands are able to migrate upland/inland, and current wetlands become future emergent or submergent wetlands, they will still provide nutrient retention value.*
- Concentrated Animal Feeding Operations: NY point dataset from NYS Division of Water, unable to locate point data for areas outside of NYS
- SPARROW Atlantic and Great Lakes data: from USGS, http://cida.usgs.gov/sparrow/#region=NY
- NPDES Point sources: Download DMR nutrient modeling data for Phosphorus from EPA for all 8 states that intersect the project area
- Future hybrid: described in A.3. above.
- Climate variables for current and future scenarios: from Climate Wizard extraction and global PET (Hargreaves)

Biophysical Table Parameters:

A .csv table of land use/land cover (LULC) classes, containing data on water quality coefficients used in InVEST was created for each land cover type in the project area. This table is included with the packaged data and is linked to the metadata for the online tool. A description of each field in the biophysical table follows:

1. lucode (Land use code): Unique integer for each LULC class that must match the LULC raster above.
2. LULC_desc: Descriptive name of land use/land cover class
3. root_depth: The maximum root depth for vegetated land use classes, given in integer millimeters. Non-vegetated LULCs are given a value of 1. Root depth values were based on literature review for the main species in each land cover type as follows. Values were obtained for the key species as outlined for each land cover type. A weighted average was then used to calculate an average root depth for each land cover type. Values from Canadell et al. (1996) and Schenk & Jackson (2002) were used for more general land cover types. *See complete metadata document attached to the output dataset for details on how root depth values were determined for the NY project area.*
4. Kc: The plant evapotranspiration coefficient for each LULC class, used to obtain potential evapotranspiration by using plant physiological characteristics to modify the reference evapotranspiration, which is based on alfalfa. The evapotranspiration coefficient is usually a decimal value in the range of 0 to 1.5. Values greater than 1 can occur in some very wet tropical regions and where water is always available. *See complete metadata document attached to the output dataset for details on how Kc values were determined for the NY project area.*
5. load_p: The phosphorus nutrient loading for each land use. The potential for terrestrial loading of water quality impairing constituents is based on nutrient export coefficients. The nutrient loading values are given as decimal values and have units of kg. Ha^{-1} yr^{-1}. The following sources, coupled with many InVEST calibration runs using SPARROW model data from Moore et al. (2011), were used to determine the P loading coefficients for the different land uses in the NY project area. *See complete metadata document attached to the output dataset for a complete reference list.*
6. eff_p: The vegetation filtering value per pixel size for each LULC class, as an integer percent between zero and 1. This field identifies the capacity of vegetation to retain nutrient, as a percentage of the amount of nutrient flowing into a cell from upslope. For example if the user has data describing that wetland of 5000 m2 retains 82% of nitrogen, then the retention efficiency that the he should input into this field for eff_n is equal to (82/5000 * (cell size)2). In the simplest case, when data for each LULC

type are not available, high values (0.6 to 0.8) may be assigned to all natural vegetation types (such as forests, natural pastures, wetlands, or prairie), indicating that 60-80% of nutrient is retained. An intermediary value also may be assigned to features such as contour buffers. All LULC classes that have no filtering capacity, such as pavement, are assigned a value of zero. Initial phosphorous removal efficiencies for general land cover categories (i.e., developed, ag, pasture) came from Kris Johnson, Ecosystem Services Scientist for TNC North America (Johnson et al. 2012), and were used in a recent CT River ecosystem services analysis. All removal efficiencies were recalculated for a 10 m pixel size. *See complete metadata document attached to the output dataset for a complete reference list* used to inform development of the P removal efficiencies for the more specific land covers available in the NY current land use grid.

Key References:

Canadell, J, RB Jackson, JR Ehleringer, HA Mooney, OE Sala, E-D Schulze. 1996. Maximum rooting depth of vegetation types at the global scale. Oecologia 108: 583-595.

Johnson, K.A., Polasky, S., Nelson, E., Pennington, D., 2012. Uncertainty in ecosystem services valuation and implications for assessing land use tradeoffs: an agricultural case study in the Minnesota River Basin. Ecological Economics 79, 71-79.

Moore, R. B., Johnston, C. M., Smith, R. A. and Milstead, B. 2011. Source and Delivery of Nutrients to Receiving Waters in the Northeastern and Mid-Atlantic Regions of the United States. JAWRA Journal of the American Water Resources Association, 47: 965–990.

Schenk, HJ, RB Jackson. 2002. Rooting depths, lateral root spreads, and belowground/aboveground allometries of plants in water limited ecosystems. *Journal of Ecology* 90: 480-494.

Attributes

HUC8	Watershed Boundary Dataset (WBD) HUC8 code (leading 0 removed)
HUC8 TEXT	Watershed Boundary Dataset (WBD) HUC8 code (leading 0 included)
NPDES Points	Total number of NPDES points in the watershed.
WS ID	Unique watershed ID required for use in InVEST model
NPDES P(kgyr)	Sum of NPDES P loadings by HUC8 watershed
InVEST Model	Version of InVEST model that was used
Current Mean Runoff Index	InVEST nutrient model output: mean runoff index per watershed under the current land cover scenario
Current P (kg/ha) Available	InVEST Nutrient model output: Total amount of (p)hosporous available per watershed under the current land cover scenario
Current P (kg/wshed) Retained	InVEST Nutrient model output: Total amount of (p)hosporous/(n)itrogen retained by the landscape on the watershed under the current land cover scenario.

Current P (kg/wshed) Exported	InVEST Nutrient model output: Total amount of nutrient exported to the stream in the watershed under the current land cover scenario
Future Mean Runoff Index	InVEST nutrient model output: mean runoff index per watershed under the future land cover scenario
Future P (kg/ha) Available	InVEST Nutrient model output: Total amount of (p)hosporous available per watershed under the future land cover scenario
Future P (kg/wshed) Retained	InVEST Nutrient model output: Total amount of (p)hosporous/(n)itrogen retained by the landscape on the watershed under the future land cover scenario.
Future P (kg/wshed) Exported	InVEST Nutrient model output: Total amount of nutrient exported to the stream in the watershed under the future land cover scenario
P Retained % Change	% change comparing current P retained to future: ((future - current) / current) * 100
P Export % Changed	% change comparing current P exported to future: ((future - current) / current) * 100

Limitations

In general, there is a high likelihood that P loads could be underestimated in the future scenarios for the following reasons:

1. For the non-NY portion of the project area, current land use was used and while outside NY's domain, the amount of area that contributes to the nutrient estimates isn't trivial.
2. Use of row crops/pasture ratios for the P coefficients. We used our best option given the issues with distinguishing between pasture and row crops in the future land cover. However, because the location of a pixel matters in how a row crop or pasture pixel is intercepted by a potential downstream sink pixel, a lower P coefficient for a crop pixel based on the crop/pasture ratio in a HUC8 could underestimate P loads and could also overestimate (i.e., where pasture was given a higher P coefficient). Hopefully the two are close to balancing each other out but it ultimately depends on the spatial configuration of the key land uses and their relationship with downstream flowpaths which will be unique and varied in each watershed.

NPDES P loads were not included in the final P export values because we don't have good information on trying to project these forward for the future scenario. We encourage users to focus on % change from current to future rather than on the actual P values as these P estimates should not be interpreted as predictions of actual current or future values but to provide information on relative changes from current to future for many reasons including: 1) these are estimates based on a model, 2) the future land cover is a model, 3) the use of crop/pasture ratios for future P loading coefficients, and 4) outputs vary slightly depending on the InVEST version used (the same version was used for all HUC8s and for both the current and future scenarios).

FRESHWATER FLOODING

Datasets appearing in the Freshwater Flooding section not described below are copies of data also displayed in Streams, and their metadata may be found under the corresponding entries in that section.

Freshwater Flooding: Current Condition\Number of Flood Disaster Declarations

Summary

New York State Department of Homeland Security and Emergency Services (DHSES) Mitigation staff researched several data sources for historical flood records including NYSOEM archives, FEMA statistics, disaster declaration data, Spatial Hazard Events and Losses Databases for the United States (SHELDUS), and NOAA's National Climatic Data Center (NCDC) storm event database. According to FEMA, 52 major flood events resulting in Presidential disaster declarations occurred from 1954 to 2013. For descriptions of disaster declaration types and the process for declaration, please visit the following website: https://www.fema.gov/disaster-process-disaster-aid-programs.

Methods

Data obtained from sources listed above were attributed to county.

Attributes

No_FldDisasterDecs: Number of disaster declarations due to flood by county. Ra values were symbolized.

Citation

Permission for use and distribution provided by New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Current Condition\Number of Flood Events

Summary

New York State Department of Homeland Security and Emergency Services (DHSES) Mitigation staff researched several data sources for historical flood records including DHSES archives, FEMA statistics, disaster declaration data, Spatial Hazard Events and Losses Databases for the United States (SHELDUS), and NOAA's National Climatic Data Center (NCDC) storm event database. The results of their search are presented in table 3.9a and 3.9b of the 2014 State Hazard Mitigation Plan (SHMP).

Methods

Data were obtained by DHSES from the Spatial Hazard Events and Losses Database for the United States (SHELDUS™). SHELDUS is a county-level hazard data set for the U.S. for 18 different natural hazard event types such thunderstorms, hurricanes, floods, and tornados. For each event, the database includes the beginning date, location (county and state), property losses, crop losses, injuries, and fatalities that affected each county. The data derives from the national data source, National Climatic Data Center's monthly Storm Data publications. Using the release of SHELDUS™ 12.0, the database includes every loss-causing and/or deadly event between 1960 and 1992 and from 1995 onward. Between 1993 and 1995, SHELDUS™ reflects only events that caused at least one fatality or more than $50,000 in property or crop damages. These data were supplemented with flood records from DHSES archives and FEMA statistics.

Attributes

Events_19602012: Number of flood events by county

FLO_NoFldEv: Value ranges for map symbology

Citation

These data were obtained from the 2014 New York State Hazard Mitigation Plan, Table 3.9c.

Division of Homeland Security and Emergency Services. 2014. New York State Hazard Mitigation Plan, p. 1205.

Freshwater Flooding: Current Condition\Number of Residential Parcels in the 100-yr Floodplain

Summary

Total number of residential parcels within the 100-year flood zone were calculated by DHSES and were based on available DFIRMs and Q3 data. Residential parcels were specifically analyzed because they comprise the greatest number and total value of property within floodplains and because damage to residences has the greatest impact on citizens (SHMP).

Methods

Number of residential parcels in 100-yr flood zone – calculations completed by Dan O'Brien with DHSES and were updated for our request.

Isolated residential parcels. Generated center points for each parcel. Selected those parcels with center points that intersected FEMA mapped 100-year floodplains. Summed data by municipality. Center points were used rather than parcel polygons to exclude parcels with only a small portion of the parcel in the floodplain. DFIRMs were used where available. Q3 data were used elsewhere. Counties without digital maps of some kind were excluded from the analysis.

Limitations

Ideally this analysis would have used parcel points placed on the residential structure, but unfortunately these data are not available. Therefore, center points were used. This means that in some cases a parcel may have been counted in the floodplain when the residential structure may actually be well out of the floodplain, and parcels may have not been counted when the residential structure did indeed fall within the floodplain.

Due to limited coverage across the state of FEMA mapped floodplains, many areas were excluded from this analysis.

This method could under or overestimate properties and should be used in conjunction with local knowledge.

Attributes

ResPar100y: Number of residential properties estimated to lie within the Special Flood Hazard Area or 100-year floodplain

FLO_ResPropsSFHA: Value ranges for map symbology

Citation

Permission for use and distribution provided by New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Sensitivity\# NFIP Policies per 100-Yr Residential Property

Summary

Estimated number of residential properties within a 100-year flood zone is based on a GIS intersection of property parcel centroids with Digital Flood Insurance Rate Map (DFIRM) or Q3 100-year flood zones (only where DFIRM or Q3 data are available). This method could under or over estimate properties and should be used in conjunction with local knowledge. The ratio of the number of NFIP policies within a community to the number of estimated residential properties within a 100-year floodplain is also provided. NYC, Nassau, Suffolk counties and municipalities where either the total # of policies or the # of SFHA properties was 0 were excluded. NYS municipal layer assigned with associated National Flood Insurance Program (NFIP) community statistics as of May 2015.

Methods

Number of residential parcels in 100-yr flood zone – calculations completed by Dan O'Brien with DHSES and were updated for our request.

Isolated residential parcels. Generated center points for each parcel. Selected those parcels with center points that intersected FEMA mapped 100-year floodplains. Summed data by municipality. Center points were used rather than parcel polygons to exclude parcels with only a small portion of the parcel in the floodplain. DFIRMs were used where available. Q3 data were used elsewhere. Counties without digital maps of some kind were excluded from the analysis.

Ideally this analysis would have used parcel points placed on the residential structure, but unfortunately these data are not available. Therefore, center points were used. This means that in some cases a parcel may have been counted in the floodplain when the residential structure may actually be well out of the floodplain, and parcels may have not been counted when the residential structure did indeed fall within the floodplain.

The Field Calculator was used to divide the number of NFIP policies by the number of estimated residential properties within the FEMA 100-year floodplains.

Attributes

TotalPolEstResProps: Estimated number of policies per residential property in the 100-year floodplain

FLO_TotalPol100ResProps: Value ranges for map symbology

Citation

These data were obtained from New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Sensitivity\# Repetitive Losses per Repetitive Loss Property

Summary

Number of repetitive losses per repetitive loss property. A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP. Repetitive loss data indicate those municipalities with the highest flooding threat and vulnerability. They can be used as an indicator of the location of flood prone areas. NYS municipal layer assigned with associated National Flood Insurance Program (NFIP) community statistics as of May 2015.

Methods

Raw data were provided to New York State Department of Homeland Security and Emergency Services by William Nechamen, Chief Floodplain Management Section, Bureau of Flood Protection and Dam Safety, New York State Department of Environmental Conservation. Field Calculator was used to divide the number of repetitive loss property claims by the number of repetitive loss properties.

Attributes

RL_LossestoProps: The number of repetitive loss property claims per repetitive loss property

FLO_LossestoProps: Value ranges for map symbology

Limitations

Repetitive Loss Properties cannot be shown by location but instead must be summed by municipal jurisdiction.

Citation

These data were obtained from New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Sensitivity\Number of NFIP Policies

Summary

Number of National Flood Insurance Program policies by township. NYS municipal layer assigned with associated National Flood Insurance Program (NFIP) community statistics as of May 2015.

Methods

Data were provided to New York State Department of Homeland Security and Emergency Services by William Nechamen, Chief Floodplain Management Section, Bureau of Flood Protection and Dam Safety, New York State Department of Environmental Conservation.

Attributes

INS_TotPol: Total number of NFIP policies by township

FLO_TotPol: Value ranges for map symbology

Citation

These data were obtained from New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Sensitivity\Number of Repetitive Loss Properties

Summary

The number of repetitive loss properties by township. A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP. Repetitive loss data indicate those municipalities with the highest flooding threat and vulnerability. They can be used as an indicator of the location of flood prone areas. NYS municipal layer assigned with associated National Flood Insurance Program (NFIP) community statistics as of May 2015.

Methods

Data were provided to New York State Department of Homeland Security and Emergency Services by William Nechamen, Chief Floodplain Management Section, Bureau of Flood Protection and Dam Safety, New York State Department of Environmental Conservation.

Attributes

RL_Propert: Number of repetitive loss properties by township

FLO_Total RLPs: Value ranges for map symbology

Limitations

Repetitive Loss Properties cannot be shown by location but instead must be summed by municipal jurisdiction.

Citation

These data were obtained from New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Sensitivity\Paid NFIP Claims

Summary

Amount paid in National Flood Insurance Program Claims. NYS municipal layer assigned with associated National Flood Insurance Program (NFIP) community statistics as of May 2015.

Methods

Data were provided to New York State Department of Homeland Security and Emergency Services by William Nechamen, Chief Floodplain Management Section, Bureau of Flood Protection and Dam Safety, New York State Department of Environmental Conservation.

Attributes

INS_Paid: Amount paid in NFIP claims

FLO_Claims_Paid: Value ranges for map symbology

Citation

These data were obtained from New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Sensitivity\Paid Repetitive Loss Property Claims

Summary

Amount paid in National Flood Insurance Program claims to repetitive loss properties. A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP. Repetitive loss data indicate those municipalities with the highest flooding threat and vulnerability. They can be used as an indicator of the location of flood prone areas. NYS municipal layer assigned with associated National Flood Insurance Program (NFIP) community statistics as of May 2015.

Methods

Data were provided to New York State Department of Homeland Security and Emergency Services by William Nechamen, Chief Floodplain Management Section, Bureau of Flood Protection and Dam Safety, New York State Department of Environmental Conservation.

Attributes

RL_TotalPa: Total amount paid in claims to repetitive loss properties

FLO_RLPTotalPaid: Value ranges for map symbology

Limitations

Repetitive Loss Properties cannot be shown by location but instead must be summed by municipal jurisdiction.

Citation

These data were obtained from New York State Department of Homeland Security and Emergency Services. Contact: Dan O'Brien, Daniel.obrien@dhses.ny.gov.

Freshwater Flooding: Supporting Data\FEMA DFIRM/Q3 Floodplains

Summary

Areas of New York State covered by either FEMA's DFIRM or Q3 digital floodplain maps are shown and the location of areas designated as 100-year and 500-year floodplains, as well as areas determined to lie above the 500-year floodplain, within the mapped regions are indicated.

The Federal Emergency Management Agency produces Flood Insurance Rate Maps (FIRMs) as part of the National Flood Insurance Program. These FIRMs exist in geospatial form in two ways: DFIRMS and Q3.

DFIRMs are the digital, geospatial version of the flood hazard information shown on the published paper FIRMs. The FIRM Database depicts flood risk information and supporting data used to develop the risk data. The primary risk classifications used are the 1-percent-annual-chance flood event, the 0.2-percent-annual-chance flood event, and areas of minimal flood risk. The FIRM Database is derived from Flood Insurance Studies (FISs), previously published FIRMs, flood hazard analyses performed in support of the FISs and FIRMs, and new mapping data, where available. The FISs and FIRMs are published by FEMA. The NFHL is available as State or US Territory data sets. Each State or Territory data set consists of all FIRM Databases and corresponding LOMRs available on the publication date of the data set. The specification for the horizontal control of FIRM Databases is consistent with those required for mapping at a scale of 1:12,000. This file is georeferenced to the Earth's surface using the Geographic Coordinate System (GCS) and North American Datum of 1983.

The Q3 Flood Data are developed by electronically scanning the current effective map panels of existing paper FIRMs. Certain key features are digitally captured and then converted into area features (floodplain boundaries, flood insurance zones, political boundaries).

FIRM data displayed in the Natural Resource Navigator are a combination of DFIRM and Q3 data where they exist. Absence of DFIRM/Q3 data for some regions of New York State should not be taken to imply that FEMA has not mapped floodplains in these regions nor that FIRM maps for these regions have not been published, only that this data is not currently available from FEMA in a digital format.

Methods

FEMA DFIRM (NFHL) and Q3 data were combined into a single set of polygons with a simplified set of classification attributes, based on the primary risk classifications (the 1-percent-annual-chance flood event [including areas susceptible to coastal wave impacts], the 0.2-percent-annual-chance flood event, and areas of minimal flood risk).   DFIRM data was preferentially used where there was data coverage; otherwiseQ3 data was used.

NRN Floodplain class (FPclass)	DFIRM Flood Zones (FLD_ZONE) and subtypes (ZONE_SUBTY)	Q3 Flood Zones (Q3_ZONE)
Open Water	Open Water	UNDES
100-year Floodplain	A, AE, AE (floodway), AH, AO	A, AE, AH, AO, FWA, FWIC
100-year Floodplain with coastal wave impacts	V, VE	VE
500-year Floodplain	X (0.2 pct annual chance flood hazard), X (0.2 pct annual chance flood hazard contained in channel)	X500, 500IC
Above Floodplain	X (area of minimal flood hazard)	X
Undetermined		D
(set to no data)	area not included	ANI

Attributes

FPclass: Floodplain class, simplified flood plain class consistent across DFIRM and Q3 datasets. See table above for descriptions.

SOURCE: original data source (DFIRM or Q3).
FLD_ZONE: FEMA Special Flood Hazard Area (SFHA) Flood Zone category from DFIRM data. NULL for Q3 data. See the FEMA FIRM Database Technical Reference for code explanations.
ZONE_SUBTY: FEMA DFIRM Special Flood Hazard Area (SFHA) zone subtlety designation Subtype, (example: "floodway", "0.2 pct annual chance flood hazard", etc.) from DFIRM data. See the FEMA FIRM Database Technical Reference for code explanations. Includes additional info like if area is a floodway or in the 500-year floodplain.
Q3_ZONE: Q3 Special Flood Hazard Area (SFHA) zone designation. NULL for DFIRM data.
FLOODWAY: Q3 floodway designation.

Limitations

DFIRM: The hardcopy FIRM and FIRM Database and the accompanying FIS are the official designation of SFHAs and Base Flood Elevations (BFEs) for the NFIP. For the purposes of the NFIP, changes to the flood risk information published by FEMA may only be performed by FEMA and through the mechanisms established in the NFIP regulations (44 CFR Parts 59-78). These digital data are produced in conjunction with the hardcopy FIRMs and generally match the hardcopy map exactly. Acknowledgement of FEMA would be appreciated in products derived from these data.

No warranty expressed or implied is made by FEMA regarding the utility of the data on any other system nor shall the act of distribution constitute any such warranty.

Q3: The FEMA Digital Q3 Flood Data is developed by scanning the existing Flood Insurance Rate Map (FIRM) hardcopy and capturing a thematic overlay of flood risks. Digital Q3 Flood Data files contain only certain features from the FIRM hardcopy in effect at the time of scanning and do not replace the existing FIRM hardcopy maps. The maps displayed on this site should be considered an advisory tool for general hazard awareness, education, and flood plain management. The flood hazard maps displayed on this site are not the legal document to be used when making a single site flood hazard determination.

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Absence of DFIRM/Q3 data for some regions of New York State should not be taken to imply that FEMA has not mapped floodplains in these regions nor that FIRM maps for these regions have not been published, only that this data is not currently available from FEMA in a digital format.

Citation

FEMA National Flood Hazard Layer (NFHL,) version 1.1.1.0(2015-03-03). (NY Statewide download available at: http://msc.fema.gov/portal).

FEMA Digital Q3 Flood Zone Data (available from the NYS GIS Clearinghouse at http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=246).

FEMA Flood Insurance Rate Map (FIRM) Database Technical Reference (Nov 2015) (available in the FEMA Library at http://www.fema.gov/media-library/assets/documents/34519).

LANDUSE/LANDCOVER

Landuse/Landcover (LULC)\Future (2050) NYS LULC: Changes Only

Summary

This layer shows the Future (2050) NYS LULC data described below, but shows only the change cells (those differing from their current LULC class), symbolized by the future land use class.

Methods

See below.

Landuse/Landcover (LULC)\Future (2050) NYS LULC

Summary

In order to represent likely changes in habitat extent and distribution, we created a map of modeled future land use/land cover for 2050. As a current day basemap we created a 'hybrid' map that combined the natural cover classes from the NETWHC with the development and agriculture classes from the 2011 NLCD. Habitat classifications were adjusted in to correct misclassification of open forest as wetland in three areas based on local habitat maps: Saratoga Sandplains, Albany Pine Bush, and Shawangunk Ridge. Upland areas that were predicted to be currently under water in the sea level rise models were assigned to an inundated class in order to avoid overpredicting future inundation.

Land use transitions predicted by SUNY-ESF - succession of agriculture to natural cover, development of agriculture or natural lands, and conversion of natural cover to agriculture – were applied to the baseline map, in addition to succession of ruderal shrubland to forest and inundation due to sea level rise. Areas currently designated as ruderal shrubland were assumed to be currently transitioning from agriculture to forest and were assigned to either northern hardwood or oak-pine forest based on the dominant surrounding forest types. Abandoned agriculture was given a variety of endpoints based on date of abandonment, with earlier transitions converting to the same two forest types, and later transitions converting to ruderal shrubland. All abandoned agriculture on hydric soils with flat topography was transitioned to Wet Meadow. Future development was assigned to one of the four NLCD development classes based on the current surrounding development types. We did not attempt to predict transitions among development types for current developed lands. Future agriculture was assigned to a generic New Ag class; prediction of spatial variation within future agriculture classes was not possible, as it is dependent on future market dynamics that we could not forecast. Existing sea level rise models for Long Island, NYC, and the Hudson River were applied to predict areas at risk of inundation. Other types of flooding or changes in lake levels were not incorporated. All transitions other than sea level rise were excluded on protected lands, since these lands are protected from conversion and likely to be managed to maintain their current cover types.

Methods

Adjustments to SUNY-ESF predicted future LULC transitions (due to change in baseline from 2006 to 2011)

Predicted future landuse transitions from SUNY-ESF, based on 2006 NLCD input data, were combined for the different individually modeled regions of NY and updated where needed to reflect the base 2011 conditions used in the final hybrid habitat classification. SUNY-ESF data was reprojected from UTM zone 18 to NAD 1983 Contiguous USA Albers (EPSG SRS#5070) to match and align with our Hybrid Habitat raster data, and the following areas were excluded from the future change layer: all areas currently in protection (according to Task 4 deliverable); areas that transitioned from Natural or Ag to Ag or Natural or Developed that had already become Developed by 2011; areas that transitioned from Natural to Ag that had already become Ag by 2011; and areas that transitioned from Ag to Natural that had already become Natural by 2011. Year of predicted transition was retained for those areas not excluded by the above rules.

Predicted future landuse transitions from SUNY-ESF were refined by landuse type based on the following rules:

- New development was assigned to the closest current (2011) development intensity class based on the standard Inverse Distance Weighting (IDW) algorithm in ArcGIS;
- New agricultural land was not assigned to an existing class (i.e. row crops or pasture/hay) but retained in a separate “new ag” landuse class;
- New natural LULC classes were determined based on the initial ag class, the expected time (# years) since conversion as determined in 2050, proximity to the nearest dominant non-wetland forest type, and soil type.
    - All conversion to natural occurring on hydric flats (areas with hydric soils as definied in the USDA STATSGO soils database that were also identified as flats in the NETWHC geomorphic classification) were assumed to convert to “Wet Meadow/Shrub Marsh” wetlands;
    - Conversion from Ag to Natural that was in natural <10 years for “Pasture/Hay” or <20 years for “Cultivated Crops” was assumed to have converted to “Ruderal Shrubland/Grassland” with insufficient time having lapsed for succession into forest to have progressed fully; otherwise
    - Conversion from Ag to Natural that was in natural >=10 years for “Pasture/Hay” or >=20 years for “Cultivated Crops” was assigned to the nearest current (2011) dominant non-wetland forest type (“Central Oak-Pine” or “Northern Hardwood-Conifer”) based on the IDW algorithm.

Adjustments to Current and Future Habitat to Account for Predicted Sea Level Rise:

Areas predicted to experience increased inundation due to future Sea Level Rise (SLR) were identified along the Atlantic and Long Island Sound coastlines of Long Island, New York City, Westchester County, and the NY shorelines of the Hudson River Estuary up to the dam at Troy.

If a 30 m. pixel was majority inundated under future conditions, the pixel was reclassified as an inundated LULC class (Inundated Developed, Inundated Upland [ag or natural], or Inundated Wetland) in the FUTURE habitat classification. Because of the variable depth of future inundation within the 30 m. pixels, uncertain amount of future development intensification prior to inundation on current or newly developed lands, and the uncertain fate of uplands potentially converting to wetlands and of various wetland types being able to migrate landward and/or accrete vertically and so perhaps persist despite the projected future inundation, no finer division of future inundation habitat types was attempted and no future inundated areas were reclassified to open water.

Citations

Developing a Framework for Assessing Coastal Vulnerability to Sea Level Rise in Southern New England, USA. Gilmer, B. and Z. Ferdaña. in K. Otto-Zimmermann (ed.), Resilient Cities 2: Cities and Adaptation to Climate Change Proceedings of the Global Forum 2011, Local Sustainability 2, © Springer Science+Business Media B.V. (2012).

Scenic Hudson, 2013 (see http://www.scenichudson.org/slr for the interactive web mapper)

NYS Sea Level Rise Task Force Report. 2010. http://www.dec.ny.gov/energy/67778.html

NYS 2100 Commission Report: http://www.governor.ny.gov/sites/governor.ny.gov/files/archive/assets/documents/NYS2100.pdf

Attributes

CID: short numeric code for habitat class, added for computational efficiency

CODE and DESCRIP: habitat code and descriptions from hybrid NETWHC/NLCD classification

"From" and "To" land use codes are assigned to identify each conversion type, as well as a "FromTo" 4-digit combined code based on CID for each permutation (ex. from "Pasture/Hay" to "Central Oak-Pine" yields "3156".

CID	CODE	DESCRIP
11	11	"Water"
15	15	"Inundated Developed"
16	16	"Inundated Uplands"
17	17	"Inundated Wetlands"
21	21	"Open Space Developed"
22	22	"Low Intensity Developed"
23	23	"Medium Intensity Developed"
24	24	"High Intensity Developed"
30	80	"New Agriculture"
31	81	"Pasture/Hay"
32	82	"Cultivated Crops"
52	200	"Outcrop/Summit Scrub"
54	400	"Coastal Grassland/Shrubland"
56	600	"Central Oak-Pine"
57	700	"Coastal Plain Swamp"
58	800	"Salt Marsh"
59	900	"Boreal Upland Forest"
60	1000	"Alpine"
61	1100	"Cliff/Talus"
62	1200	"Rocky Coast"
63	1300	"Northern Peatland"
64	1400	"Northeastern Floodplain Forest"
65	1500	"Glade and Savanna"
66	1600	"Northern Hardwood-Conifer"
67	1700	"Central Hardwood Swamp"
68	1800	"Ruderal Shrubland/Grassland"

69	1900	"Northern Swamp"
70	2000	"Wet Meadow/Shrub Marsh"
71	2100	"Emergent Marsh"
72	2200	"Coastal Plain Peatland"

Limitations

While the future land cover was modeled at a 30m pixel scale, the actual trajectory of land cover transition may differ from the model for any particular pixel. These data are best used in aggregate to examine general trends at the parcel scale or larger. Each transition has its own assumptions detailed below:

The baseline hybrid land use/land cover map is subject to the classification errors inherent in the NETWHC and NLCD source data. Where extensive classification errors were observed in the NETWHC in conservation areas for which we had independent habitat maps, we attempted to correct the classification, however there are likely to be similar errors in other places for which we did not have access to local data.

For transitions modeled by SUNY-ESF (new agriculture, new development, abandoned agriculture), the location and amount of transition are founded on the assumption that past regional trends will continue into the future. It is unknown what impact future economic or cultural changes, or local laws, may have on whether and where development occurs. We also cannot predict the possibility of rare stochastic development events, such as a casino. The probability of transition depends on the spatial accuracy of the predictive variables; the degree to which the predictive variables capture the observed patterns is described in the technical report previously delivered. Since the models were run within ClimAID regions, there may be artificial changes in transition patterns along regional boundaries, and sub-regional variation in transition drivers may not be adequately captured.

In assigning future natural cover types for abandoned agriculture, we assumed that the future forest type would be consistent with the dominant forest type in the surrounding landscape, and that it would take 10 years (for Pasture/Hay) to 20 years (for Cultivated Crops) for forest to establish. We also assumed that all hydric flats would become wetlands, and that Wet Meadow was the most likely wetland type in all such circumstances, regardless of soils, hydrology, or surrounding vegetation.

We assumed that current development and non-abandoned agriculture classes would remain static, in absence of reliable data on which to base an alternative projection. It is probable that these lands will remain in their general class but it is possible that their subclass may change in the future due to economic and other factors. Because new development was assigned a subclass based on the surrounding development type, and most new development occurred on the fringes of existing development, this may have resulted in an overestimate of open space and low intensity development, and an associated underestimate of medium and high intensity development in the future.

The uncertainty in the sea level rise models depends on both the precision of the elevation data, and the accuracy of the climate projections used (Gilmer and Ferdaña 2012). In particular, the pre-LiDAR 10m NED elevation data available in the New York City region upon which the Coastal Resilience SLR model predictions are based have a high large vertical uncertainty, which in combination with very shallow slopes results in very large areas of potential inundation in the southwestern portion of Long Island. Our data may underestimate future inundation by designating many of these areas as currently under water. In addition many barrier islands and coastal marsh habitats in Long Island were not mapped in the NETWHC and so appear as water in both current and future maps. We likely underestimate future coastal wetlands by not incorporating accretion of wetland sediments or migration of wetlands upland in response to inundation. We also did not attempt to predict the construction of seawalls, levees, dune stabilization, or any other human responses that might reduce the impact of inundation.

We assumed that lands under some form of legal protection or public ownership would not experience any changes in land cover other than sea level rise. In some cases, protected land can experience development (such as recreational infrastructure), cultivation or timber harvest, or could be sold out of public ownership. Some protected lands will experience no active management, while others will be managed to maintain current habitats. Without reliable methodology to predict these activities, 'no change' was selected as a conservative default. We also did not attempt to predict which properties would be additionally protected in the future.

In consultation with the New York Natural Heritage Program, we examined the likelihood of shifts in natural habitat types due to climate change, independent of other transitions. Due to the long lifespan and slow migration times for trees and other foundational vegetation it did not seem realistic to predict wholesale replacement of habitat types within the timeframe of this assessment. In addition, many of the habitat types in the NETWHC are based on underlying geology or hydrology, which is not likely to change. As a result, we did not forecast any habitat shifts due to climate change. However, we do expect that growth, reproduction, and mortality rates of individual plant species will be variably affected by climate change, and the species composition of these habitats will be likely to change.

Landuse/Landcover (LULC)\Current (2011) NYS LULC

Summary

As a current day basemap we created a 'hybrid' map that combined the natural cover classes from the NETWHC with the development and agriculture classes from the 2011 NLCD. Habitat classifications were adjusted in to correct misclassification of open forest as wetland in three areas based on local habitat maps: Saratoga Sandplains, Albany Pine Bush, and Shawangunk Ridge. Upland areas that were predicted to be currently under water in the sea level rise models were assigned to an inundated class in order to avoid overpredicting future inundation.

Methods

Creation of hybrid land cover map

- Projected and snapped NETWHC map to match NLCD 2011 (Albers)
- Reclassed the NETWHC by macrogroups, adding 00 to end of each ID code.
- Run raster calculator CON statement to use values from the NLCD for water (11), urban (21,22,23,24) or ag (81 or 82) classes. Otherwise, the NETWHC macrogroup code was used.
- Since NETWHC sometimes mapped non-natural habitat in places the NLCD did not, these were retained but were reclassed to be consistent with the NLCD codes: reclassed 100 (Blank) to 11 (water); 300 (Urban) to 22 (low dens development) and 500 (agriculture) to 81 (pasture). The latter assumptions are based on the fact that these are areas the NLCD classed as natural, so we selected the lower intensity NLCD option for each type.

Corrections to Current Hybrid Habitat Classification Map (Northern Swamp misclassifications)

Current (2011) hybrid habitat classifications were partially modified to correct a NETWHC/NLCD/CCAP classification error that resulted in the overestimation of "Northern Swamp"

(Palustrine forest in the CCAP classification) within protected areas of the Saratoga Sandplains, Albany Pine Bush, and Shawangunk Ridge. This misclassification issue had previously been identified in the CCAP data by NY Natural Heritage staff for the Albany Pine Bush, and Shawangunk Ridge regions. Additional inspection within natural areas across New York, in particular within the Rome Sand Plains and along the Neversink River, determined the misclassification to not be a problem for most other areas.

To correct the misclassification, areas identified as "Northern Swamp" by NETWHC and as wetlands in local habitat maps were retained as "Northern Swamp" (sources were the NY Natural Heritage modified 2011 CCAP product, TNC 2008 and Natural Heritage 2013 Communities Element Occurrence maps of Shawangunk Ridge, the 2011 Edinger NY Heritage Program vegetation map for Wilton, and a 2009 smoothed landcover raster of the Albany Pine Bush created by Kirstin Seleen of TNC). In the case of the Albany Pine Bush, in addition to CCAP areas identified by NYNHP to retain as forested wetland, pixilated noise was removed from the smoothed 2009 landcover raster and edges classified by eliminating wetland patches smaller than 28.8 sq. meters (five 2.4 m. pixels) then upscaling the data so that any 30m pixel partially containing a wetland patch was classified as wetland and retained as Northern Swamp. In the case of Shawangunk Ridge, only areas identified and mapped by NTNHP or TNC staff as wetlands were retained as Northern Swamp. In the case of Wilton Wildlife Park and Preserve, areas of Northern Swamp mapped as wetlands were retained as Northern Swamp but were otherwise recoded as either "Central Oak-Pine" or "Northern Hardwood-Conifer" based on the locally mapped habitat classification. For the Albany Pine Bush and Shawangunk Ridge, the remaining areas of "Northern Swamp" were converted to the nearest dominant upland forest type ("Central Oak-Pine" or "Northern Hardwood-Conifer") based on the standard Inverse Distance Weighting (IDW) algorithm in ArcGIS.

Adjustment of inundation baseline

In order to detect discrepancies between the current NETWHC upland terrestrial habitat classification and what the Scenic Hudson and Coastal Resilience SLR data show to be currently inundated (at or below 0 MHHHW or 0 MHW, repectively), the current extent of inundation was determined using the exact same methodology described above for Future Sea Level Rise but only for pixels in the 0" inundation zone of the Scenic Hudson data or those at or below 0 MHW in the Coastal Resilience datasets. Additionally, the proportion of 1 m. subpixels that were inundated in each 30 m. pixel was calculated and the proportional change between the current and future climate scenario was determined.

If a 30 m. pixel was majority inundated under both current and future conditions, and the proportion of inundation did not change, the pixel was reclassified as an inundated LULC class (Inundated Developed or Inundated Upland) in the CURRENT habitat classification data, excluding wetlands, which were not reclassified because they can currently exist and persist when inundated at high tide by current inundation depths. This allows areas with steep near-vertical shorelines, where the increased vertical inundation will not be expected to translate to a lateral increase in inundated land, to reflect no change. It also allows for a conservative estimation of areas of potential future impact under SLR by excluding areas of open water that were misclassified in the NETWHC dataset.

Limitations

The baseline hybrid land use/land cover map is subject to the classification errors inherent in the NETWHC and NLCD source data. Where extensive classification errors were observed in the NETWHC in conservation areas for which we had independent habitat maps, we attempted to correct the classification, however there are likely to be similar errors in other places for which we did not have access to local data.

Landuse/Landcover (LULC)\Current (2011) Regional LULC

Summary

The Current Regional LULC 'hybrid' map is the same as the Current NYS LULC 'hybrid' map with the following exceptions:

- The landcover data covers the full region within the freshwater study boundary; and
- The inundation-modified cover classes related to sea level rise (SLR) were not included. Instead, those areas are shown with their pre-SLR LULC class.

This was done so that the classes would be comparable between areas inside NYS and those areas outside of NYS for which SLR was not modelled and where no future landuse models were developed. It also allows users to see greater detail about the kinds of wetland, upland, and developed LULC is locally included inside of the SLR-related inundation areas.

Landuse/Landcover (LULC)\Future (2050) NYS Impervious Cover

Summary

NLCD 2011 impervious cover, clipped to the larger freshwater boundary area envelope extent, and within which any cells coded as NoData (values greater than 100, usually 127) were turned to NoData. Only changes that occurred within New York State were considered, because the future habitat and future land cover change models are limited to New York. Areas of new future development (natural or agricultural lands to developed) were assigned an average impervious value according to their predicted development class based on the current statewide average % impervious for that class:

NLCD Class	NLCD Definition	2011 NY Average
Class 21	Open space (<20% impervious)	8 %
Class 22	Low Intensity (20-49%)	26 %
Class 23	Med. Intensity (50-79%)	61 %
Class 24	High Intensity (80-100%)	88 %

These values are based on the average current impervious for each development class of the current (2011) hybrid habitat model (for more details, please see methods for future 2050 base habitat map in this document). The greater of the current or future average impervious was applied to each cell of future development to produce the final estimate of future impervious. For areas beyond NYS, future impervious always equals current impervious. In order to use the NHD Plus accumulation tool, all raster data was shifted to align with the national grid for NLCD and NHD catchment data.

Landuse/Landcover (LULC)\Current (2011) Regional Impervious Cover

NLCD 2011 percent impervious cover across the full freshwater study region.

ADDITIONAL FACILITATING LAYERS

NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk

Summary

Stream reaches (source: NHD Plus Version 2) that contain both the Version2 and Version 1 COMID unique ID codes, as well as an ID for the V2 catchments.

To facilitate the transfer of stream reach attribute data from the Northeast Aquatic Habitats Condition Assessment dataset of Anderson et al. (2013a), which is based on stream reach flowlines from USGS NHD Plus Version 1 data, to the stream reach flowlines of the updated and more comprehensive USGS NHD Plus Version 2 dataset (used as the base data set of streams for all of our freshwater analyses), we conducted a multi-step crosswalk to identify which (if any) V1 stream reach was associated with each V2 stream reach. The result is a set of stream segments containing all of the V2 stream reaches within our study area and the reach ID of the matching V1 reach.

Methods

Most stream reaches were unaltered between NHD Plus versions and retained their original COMID. However, some unaltered segments received new COMIDs, some segments were extended or shortened, some were split/merged following the addition/removal of intersecting side tributary streams, and some V1 lines were whole deleted while many headwater V2 lines were added in some portions of the study area. Therefore there is no perfect one-to-one relationship between the V1 and V2 IDs. Instead, we took a spatial approach to solve the assignment problem.

We used as sources the NHD PlusV2 lines downloaded directly from USGS, the V1 lines from the Northeast Aquatic Habitats Condition Assessment dataset of Anderson et al. (2013a), and the NHD PlusV2 catchment polygons also from USGS. All analyses were performed with ArcGIS 10.2.2 and made use of the Spatial Analyst extension.

The catchments were given a shorter unique ID used for this project ("V2CATZONE") and converted to 30m raster grids aligned with our hybrid LULC habitat rasters. Then the V2 and V1 were compared or else assigned to a V2 catchment as described in the steps below.

Step 1. Match identical lines (spatially).

Select based on location "identical" lines from NHDPlus V2 and NAHCS (based on NHDPlus V1)

- Export each "same1" set of lines,
- Create centroids for each,
- Spatially join the centroids (joining v1 to the v2 centroids),
- Tabular join of the joined centroids attribute table to the V2 same1 line subset,
- Export final result: "nhdv2_same1_w_nahcsv1" lines.

Step 2. Match near-identical lines (spatially).

Lines not included in the two "same1" identical subset become next starting point = "leftover1" lines.

- Same initial process as above, export each "leftover1" set of lines,
- Create centroids for each,
- Spatially join the centroids (joining v1 to the v2 centroids),
- Tabular join of the joined centroids attribute table to the V2 same1 line subset.
- This time, further separate based on distance between centroids: Assume the same line if distance is <= 1m. and assume different lines if greater than this (>1m. to 21 km.)

- Select based on attributes (below or above 1m. distance threshold) and export subset:
    - Near-identical final result = “nhdv2_lo1_w_nahcsv1” lines
    - Remaining = “nhdv2_leftover2” lines
- Same tabular join to NAHCS V1 lines to select the over 1m remainder leftover2 lines.

Step 3. Assign majority V1 line (by length) to V2 catchment then to V2 lines of the catchment (spatially).

Remaining lines may be coincident but of different lengths due to merging and splitting, may be different due to reshaping between stream nodes, or may be entirely new additions or deletions between versions. Generally speaking, there is a one to one relationship between a stream segment and its catchment, so transferring the main V1 Id and properties to a V2 line via its catchment should be reasonable. In cases of small <30m “connecting” segments that are there to correct original digitizing errors or breaks between source quad map lines, these should get the characteristics of the larger segment in the catchment anyways instead of unknown.

- Convert NAHCS V1 leftover2 lines to gridcells based on V1COMID and snapped to the 30m gridded catchments.
- Use zonal statistics (as a table) to assign the majority (thus longest segment’s) V1 COMID to the V2 catchments.
- Tabular join the result of the zonal statistics to the leftover2 NHDV2 lines.
- Export the resulting lines with a successful NAHCS_V1COMID joined based on V2CATZONE = “nhdv2_lo2cat_w_nahcsv1” lines
- REPEAT iteratively catch small segments <60 m. that may not have had their V1 comids assigned to a single grid cell if they shared all of the grid cell through which they pass with longer reaches (which by defult then are assigned to that cell). Repeat the above steps until no further V1 segments overlap with V2 catchments.
- Export the remainder (with NULL V1 COMIDS) as “nhdv2_leftover3”. These represent V2 lines whose catchments do not overlap with V1 lines, thus these are all NEW lines in NHD V2. Assign them all a default nodata NAHCS_V1COMID value of -9999.

The result is that V1 COMIDS were assigned to V2 segments 86691 times (98%) in Step One, 773 times (0.9%) in Step Two, 559 times (0.6%) in Step Three, with only 464 lines (0.5%) remaining unassigned at the end of Step Three.

Step 4. Merge the four sets of resulting lines into a FINAL fully crosswalked set of lines containing both the V2 COMIDs and Catchment Zone IDs as well as the matching NAHCS V1 COMIDs.

Attributes

V2COMID: Original unique reach COMID from the source NHD Plus V2 data.

V2CATZONE: unique ID for each V2 catchment (see “Boundaries & Reference/Catchments” layer at the top of this document).

NAHCS_V1COMID: matching V1 COMID from the Northeast Aquatic Habitat Condition Assessment dataset. -9999 for V2 reaches with no matching V1 segments.

XWALKSTEP: step during which the V1 COMID was assigned (1, 2, 3, or 4).

Citation

Anderson, M.G., M. Clark, C.E. Ferree, A. Jospe, and A. Olivero Sheldon. 2013a. Condition of the Northeast Terrestrial and Aquatic Habitats: a geospatial analysis and tool set. The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. http://nature.ly/GeoCondition

NHD Plus Version 2 to USGS FishVIS/Aqua GAP Reach IDs Crosswalk

Summary:

Stream reaches (source: NHD Plus Version 2) that contain the NHD Plus Version2 COMID unique ID code, Version 1 COMID from the Northeast Aquatic Habitat Condition Assessment dataset, Version 1 COMID from the USGS FishVIS dataset (kept separate in case of mid-version ID changes or updates), unique IDs associated with the pre-NHD Plus streams in the USGS Aquatic GAP dataset, and an ID for the V2 catchments.

To facilitate the transfer of stream reach attribute data from the predicted suitable habitat by stream reach data for fish from two USGS source models (FishVIS and Aqua GAP), we again conducted a multi-step crosswalk to identify which (if any) Aqua GAP stream reach was associated with each V2 stream reach. FishVIS reaches were able matched entirely using the NAHCS_V1COMID crosswalk results from the earlier crosswalk.

The result is a set of stream segments containing all of the attributes from the earlier “NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk” as well as the matching reach IDs from the two fish species distribution datasets.

Methods:

FishVIS reach V1 COMIDs were matched using the NAHCS_V1COMIDs previously crosswalked, with no reaches unaccounted for.

Aqua GAP reaches were assigned to NHDPlus V2 reaches using the same methodology as used to assign V1 to V2 reaches, except that in this case the “PU_GAP” id was used instead of a nonexistent COMID. Because PU_GAP was a text string, and unique numerical temporary ID was also created for each PU_GAP ID for easier ID comparisons. The assignment step was kept track of as before.

Attributes:

All of the attributes of the earlier the earlier “NHD Plus Version 2 to NEAHC NHD Plus Version 1 Reach ID Crosswalk” were retained as well as the following additional attributes:

MCK_PU_GAP: Original unique reach ID from the source Aqua GAP data.

MCK_TMP_ID: new unique numerical ID for each MCK_PU_GAP.

MCK_XWSTEP: step during which the MCK_PU_GAP ID was assigned (1, 2, 3, or 4).

FV_V1COMID: matching V1 COMID from FishVIS as well as the Northeast Aquatic Habitat Condition Assessment dataset. -9999 for V2 reaches with no matching V1 segments.

Citation:

Stewart, J.S., Covert, S.A., Estes, N.J., Westenbroek, S.M., Krueger, Damon, Wieferich, D.J., Slattery, M.T., Lyons, J.D., McKenna, J.E., Jr., Infante, D.M., and Bruce, J.L., 2016, FishVis, A regional decision support tool for identifying vulnerabilities of riverine habitat and fishes to climate change in the Great Lakes Region: U.S. Geological Survey Scientific Investigations Report 2016–5124, 15 p., with appendixes, http://dx.doi.org/10.3133/sir20165124.

McKenna, J.E., J.E. Ruggirello, and J.H. Johnson. 2012. A landscape-based distribution model for fallfish (Semotilus corporalis) in the Great Lakes drainage of New York. Journal of Great Lakes Research 38:413-417.

NHD Plus Version 2 to FW Resilience FCN BATNET IDs Crosswalk

Summary:

Stream reaches (source: NHD Plus Version 2) that contain the NHD Plus Version2 COMID unique ID code and the Functionally Connected Network BATNETID (of the network to which each sub-reach segment belongs). Networks can contain as few as one but usually many more stream reaches. Individual V2 stream reaches (each with one COMID) may belong to multiple networks if a dam(s) occurs partway along the reach. These FCN-split V2 stream reaches are required when combining the climate sensitivity indicator scores with unsplit reach attributes to come up with combined Condition, Threat, Sensitivity, and Exposure scores and to turn these into a set of freshwater stream strategy recommendations.

New or previously excluded small headwater stream reaches that connect to a functionally connected network (FCN) from the analysis of Anderson *et al.* (2013b) without an intervening dam between them were assigned to the adjacent FCN and given its attributes when estimating various network-based indicators (this study). New or previously unassigned networks separated in space or across dams from the FCNs of Anderson *et al.* (2013b) were assigned new FCN IDs (with negative values) but no new network analysis was undertaken to assign network attribute values. See descriptions of individual climate sensitivity network-based indicators for the reasoning and decision rules that were applied.

To facilitate the transfer of data associated with the functionally connected stream networks from the Northeast Freshwater Resilience Analysis dataset of Anderson et al. (2013b), which is based on stream reach flowlines from USGS NHD Plus Version 1 data but additionally breaks stream reaches into sub reaches if interrupted by a dam or other natural obstruction, to the stream reach flowlines of the updated and more comprehensive USGS NHD Plus Version 2 dataset (used as the base data set of streams for all of our freshwater analyses), we split the V2 segments at the same snapped breakpoints (dams and obstructions), crosswalked matching unbroken stream reaches, and then “walked” the networks outward along unassigned reaches until the end of the network was reached (the stream head or mouth, a dam, or another existing network now connected due to a new stream reach or side channel that bypasses a dam or crosses what otherwise would be a divide).

Methods:

Snapped dam locations (point file) used to create the Functional Connected Networks (FCNs) and the FCN network steam lines themselves were obtained from The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. The FCN streams included small networks (with IDs) that were identified and their drainage area calculated but which were later dropped from the FCN analysis because they did not meet the minimum size threshold for the regional analysis.

Dam locations were cross-checked against FCN stream segment nodes (reach/subreach endpoints that connect to one or more other reaches/subreaches belonging to different FCN networks [different

BATNETIDs]). Subreaches were dissolved back to original reaches based on COMID and the number of subreaches per COMID tabulated. Within reaches thus identified as containing breaks, ones where the dissolved FCN reach is identical to the NHD V2 reaches (5909 out of 6265 reaches with breaks) were replaced with the FCN segments keeping the FCN BATNETIDs but assigned the V2 COMIDs. Those not identical differed for a variety of reasons: some were different because V1 reaches were subdivided (or merged) when new tributaries were added (removed), but otherwise have the same linear shape and are coincident but for coordinate precision. Others (only a few if any) were different because of the stream reaches being reshaped/rerouted. For these non-identical reaches, the “internal” subreach endpoints beyond 1 m. from a dissolved reach endpoint were extracted and duplicate coincident points dropped (resulting in 310 breakpoints). These breakpoints and their coincident dam points from the point file were manually inspected and compared to the latest NYS orthoimagery and then used to split the V2 reaches.

The following steps were then used to assign FCN BATNETIDs to the split V2 reaches and subreaches, which had been assigned new unique segment IDs (“SPLITID”):

Step 1. Match identical unsplit lines – no FCN splits.

Select based on location “identical” lines from NHDPlus V2 and FCN dataset

- Export each “same1” set of lines,
- Create centroids for each,
- Spatially join the centroids (joining FCN to the V2 centroids),
- Tabular join of the joined centroids attribute table to the V2 same1 line subset,
- Export attributed subset.

Step 2. Match near-identical unsplit lines.

Like with the V1 to V2 crosswalk, repeat step 1 but allow up to 1m separation between centroids.

Step 3. Match split but otherwise coincident/identical lines.

Repeat step 1 on split but otherwise coincident lines except:

- Spatially join the V2 line (and COMID) to the nearest FCN centroid.

Step 4. Split remaining V2 lines using the ArcGIS SplitLineAtPoint tool if a remaining line is within 2 m. of a snapped dam locations.

Step 5. Iteratively determine if remaining (possibly split) no-BATNETID “unassigned” lines share one or both endpoints with one or many stream segments already assigned a BATNET-ID during steps one to three (or an earlier iteration of this step). Spatially join the endpoints with the dam points if the dam point is within 1 m. and use to determine if the adjacent segment is beyond a dam or not.

Based on these determinations, assign to an iteration result code (ITCODE) based on the following rules where SBATNETID and EBATNETID refer to the BATNETID from already assigned V2 segments joined to the starting and ending nodes, respectively, of unassigned segments if assigned segments are within 1 m. of said nodes, and similarly SDAM_UNIQUE_ID and EDAM_UNIQUE_ID refer to dam attributes joined to said nodes:

- #0 : SBATNETID is NULL and EBATNETID is NULL -> not (yet) adjacent to assigned, do not assign.
- #1 : SBATNETID not NULL and EBATNETID is NULL and SDAM_UNIQUE_ID not NULL --> adjacent at one end but across dam, do not assign.
- #2 : SBATNETID is NULL and EBATNETID not NULL and EDAM_UNIQUE_ID not NULL --> adjacent at one end but across dam, do not assign.
- #3 : SBATNETID not NULL and EBATNETID is NULL and SDAM_UNIQUE_ID is NULL --> adjacent at one end and no dam, assign to start.
- #4 : SBATNETID is NULL and EBATNETID not NULL and EDAM_UNIQUE_ID is NULL --> adjacent at one end and no dam, assign to end.
- #5 : SBATNETID not NULL and EBATNETID not NULL and SDAM_UNIQUE_ID not NULL and EDAM_UNIQUE_ID is NULL --> spans 2 networks, but startnode at a dam, assign to end.
- #6 : SBATNETID not NULL and EBATNETID not NULL and SDAM_UNIQUE_ID is NULL and EDAM_UNIQUE_ID not NULL --> spans 2 networks, but endnode at a dam, assign to start.
- #7 : SBATNETID not NULL and EBATNETID not NULL and SDAM_UNIQUE_ID not NULL and EDAM_UNIQUE_ID not NULL --> spans 2 networks, both nodes at a dam, assign to unknown.
- #8 : SBATNETID not NULL and EBATNETID not NULL and SDAM_UNIQUE_ID is NULL and EDAM_UNIQUE_ID is NULL --> spans 2 networks, neither node at a dam, assign to unknown.
- #9 : special case of #8 for internal segments when the BATNETID is identical up and downstream --> assign to either (so end).
- #10 : spatial match (centroids within 2m) of original FCN centroids for data not assigned by above rules during first set of iterations (then process repeated again).

Run iterations until no further unassigned segments are assigned BATNET-IDs. The process will have “walked” out each sequence of connected segments to the externt possible.

Step 6. For remaining unassigned segments, determine which groups form a connected network:

- buffer unassigned by 5m, dissolve, multi- to single-part, spatial join to the unassigned lines and new batnetids = -100 – objected.

Combine all now assigned lines into a single new FCN stream reach/subreach dataset based on NHD Plus V2 stream lines. End.

Attributes:

V2COMID: Original unique reach COMID from the source NHD Plus V2 data.

V2FCN_ID: new unique ID for each stream reach or subreach segment assigned after all splitting of V2 segments at dam points has occurred and subsequently COMID is no longer unique. This is the new unique Identifier for the dataset.

ITCODE: iteration rule used to assign the BATNETID (or rule that explaines the situations were no existing BATNETID could be assigned and a new one was created).

BATNETID: ID for the Functionally Connected stream Network (FCN), which can be related to stream network resiliency metrics.

LAKE_FLAG: 0 if not a flowline through a lake or reservoir, 1 if it is (from FCN data).

BATNET_per_COMID: number of distinct networks the NHD V2 stream reach is a part of.

FCN_V1COMID: V1 COMID from FCN data.

FCN_UNIQUEID: previously ID from FCN data (original attribute name in FCN data is "UNIQUEID").

DAM_Unique_ID: identifier string for dam (if present) at one end of the segment. If both ends have dams, only one is listed. From FCN dam point file.

DAM_NAME: Name of the above dam. From FCN dam point file.

Citation:

Anderson, Mark, Arlene Olivero Sheldon, Colin Apse, Alison A. Bowden, Analie R. Barnett, Braven Beaty, Catherine Burns, Darran Crabtree, Doug Bechtel, Jonathan Higgins, Josh Royte, Judy Dunscomb, and Paul Marangelo. 2013b. Assessing Freshwater Ecosystems for their Resilience to Climate Change (a.k.a. the Northeast Freshwater Resilience Analysis report). The Nature Conservancy, Eastern Conservation Science, Eastern Regional Office. Boston, MA. https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/fwresilience/Pages/default.aspx

SPECIES

NYNHP Element Distribution Models

Summary

NY Natural Heritage developed predictive current day species distribution models for a 383 species, 338 of which passed model validation and may be included in the toolkit. Species distribution models (SDMs) match known locations of plants and animals to environmental conditions and map places with similar environmental conditions. They use a variety of statistical routines to determine the affiliations of the species of interest and predict the suitability of habitat elsewhere. Models cannot predict species presence with certainty for many reasons, including important local factors or other species that are typically not mapped at the spatial scale of interest (such as presence of seeps, large logs, host plants, or predators), statistical uncertainty, and some randomness in the distribution of plants and animals across the landscape. These models are GIS-based, meaning that they assess habitat suitability based purely on statewide geospatial data that are available electronically. Many other factors influence whether a species is present at any given location.

Two kinds of spatial products are derived from these distribution models:

1) Simple predictions of "suitable habitat present" and "suitable habitat absent". Each species' data is presented as a binary surface, with zero (0) representing 'suitable habitat predicted to be absent here' and one (1) representing 'suitable habitat predicted to be present here.' The value for the cutoff used to determine the suitable/unsuitable threshold varied with each model and was determined programmatically using the approach described in the metadata file for each species (F-measure with alpha=0.01).

2) Not included in NRN: Full probability surfaces. Note that it may be inappropriate to consider the same probability value among species to be equivalent and thus creating merged or summary surfaces using these raw raster may be misleading. A description and the relative performance of each model are provided in the metadata file for each species.

Methods

Species distribution modeling was achieved through five steps: 1) documentation of known locations (typically points) and establishment of a set of background points; 2) attribution of all points with environmental variables; 3) applying modeling algorithms; 4) model validation; and 5) prediction (extrapolation) to the entire landscape of interest. This method follows well-documented approaches in extensive use throughout the research community (e.g., Guisan and Zimmerman 2000, Elith *et al.* 2006, Lawrence *et al.* 2006, Prasad *et al.* 2006, Vincenzi *et al.* 2011). Full methods for each of these steps are described in Howard and Schlesinger (2012) (http://nynhp.org/files/pways/NYNHP_2012_PATHWAYS_final_report.pdf), pages 4-8, and the parameters for each individual model are detailed in the metadata for that model.

We created models of 2050 distribution by altering two sets of environmental variables: climate and land cover. Climate variables for 2050 were derived from Climate Wizard (Girvetz et al. 2009) and downscaled to 30-m resolution followed Howard and Schlesinger (2012, 2013). We created a 2050 version of our land cover dataset by 1) projecting 2050 urban development (Hall and Weng 2013) and replacing undeveloped pixels with developed pixels, and 2) mimicking ecological succession (**methods). We used this 2050 C-CAP layer to model a 2050 impervious surfaces layer and a 2050 canopy cover layer, which were used as model inputs as per Howard and Schlesinger (2012, 2013).

Attributes

For attribute descriptions and detailed metadata please see Appendix 4 of Howard, T.G. and M.D. Schlesinger. 2012. PATHWAYS: Wildlife habitat connectivity in the changing climate of the Hudson Valley. New York Natural Heritage Program, Albany, New York. Created on 15 Jun 2012. http://nynhp.org/files/pways/NYNHP_2012_PATHWAYS_final_report.pdf

Limitations

These data are subject to our license agreement with NY Natural Heritage, and once we get closer to completing the final toolkit, we will work with them to determine what can be publicly distributed and how to word the limitations.

Please cite the metadata documents and the associated EDM as: New York Natural Heritage Program 2012. Element distribution model, model validation, and environmental variable importance for *Genus species*. Albany, NY. Created on 15 Jun 2012.

NYNHP CCVI-S

Summary

Vulnerability to climate change is often assessed at large scales, such as states and entire species ranges. For some applications, however, it may be desirable to identify specific locations in which species are especially vulnerable, and even to prioritize conservation actions among locations and species simultaneously. We built a fine-scale model of climate change vulnerability for 50 at-risk species in New York State by modifying spatially explicit distribution and habitat suitability information with nonspatial sensitivity factors. Specifically, our model for each species incorporated 1) a change in suitability from the current day to 2050, weighted by the adaptive potential of the species; 2) current-day and future landscape resistance in the surrounding area, weighted by the species' dispersal potential; and 3) the amount of 2050 suitable habitat near current-day habitat, weighted by additional sensitivity factors. The result is a species-specific, location-specific climate change vulnerability model that will help managers prioritize conservation actions both among species at particular locations and among locations for particular species.

Methods

Species selection

We selected 50 animal species for the assessment. Because having an up-to-date, fine-scale map of each species distribution was important to our methodology, we selected only species for which we had modeled current-day distributions in other projects (Schlesinger and Howard in preparation, Howard and Schlesinger 2012, 2013). Additionally, we wanted our assessment of climate change sensitivity to be based on a standard methodology, so we selected species whose statewide climate change vulnerability we had assessed for an earlier project (Schlesinger et al. 2011). There were 59 species that met both criteria; we winnowed this down to 50 species by balancing across taxonomic groups, life histories, and statewide climate change vulnerability rankings. We selected 5 amphibians, 10 birds, 7 fish, 13 insects, 8 mollusks, 1 mammal, and 6 reptiles. Thirteen species had been rated as "Extremely Vulnerable" statewide, 2 as "Highly Vulnerable," 16 as "Moderately Vulnerable," and 19 as "Presumed Stable" by Schlesinger et al. (2011).

CCVI

We obtained our sensitivity ratings from an earlier assessment of species vulnerability (Schlesinger et al. 2011) that used NatureServe's Climate Change Vulnerability Index (CCVI; Young et al. 2010). We grouped sensitivity attributes (see Young et al. 2010 for definitions) into three categories: 1) Adaptability—the ability to adapt to predicted changes in climate (Historical Thermal Niche, Physiological Thermal Niche, Historical Hydrological Niche, Physiological Hydrological Niche, Genetic Variability, and Past Genetic Bottlenecks); 2) Dispersal ability—the ability to reach future habitat (Dispersal Ability and Dependence on Other Species for Dispersal), and 3) Survivability—the ability to survive in new locations, beyond the factors considered in distribution modeling (Dependence on Disturbance, Dependence on Ice and Snow Cover, Dependence on Unique Geological Features, Dependence on Other Species for Habitat Dependence on Other Species for Diet, and Other Interspecific Interactions).

Each factor was rated according to its likely effect on climate-change vulnerability: Decrease, Slightly Decrease, Neutral, Slightly Increase, Increase, Greatly Increase, and Unknown. Some factors were rated using a subset of these values. Combination ratings were possible (e.g., Slightly Increase – Increase) to account for uncertainty in the ratings. We converted the ratings to numbers, where Decrease = -2, Slightly Decrease = -1, Neutral = 0, Slightly Increase = 1, Increase = 2, and Greatly Increase = 3. We calculated both a Low and High version to accommodate combination ratings, and then created Low and High versions of each of three "sensitivity multipliers" by adding the values of factors in each sensitivity category (Adaptability, Dispersal ability, and Survivability) and rescaling so that all values were positive. Factors with a decreasing effect on vulnerability ranged from 0 to 1, those with a neutral effect had a value of 1, and those with an increasing effect were greater than 1. "Unknown" values were ignored.

Spatially explicit exposure and sensitivity factors

This group of factors included those that may be important for distinguishing vulnerability among species but also across space within species. We included three factors derived from NYNHP Element Distribution Models:

Change in habitat suitability: Using the current and future EDMs, we subtracted 2050 % habitat suitability from current-day suitability and rescaled from 1 to 3.

Resistance to dispersal outside of current patches: Resistance to dispersal was calculated for each cell as the inverse of habitat suitability within a defined radius, weighted by distance from the focal cell. Two radii were used: 500 m for species with limited mobility (mussels, fish, amphibians, some reptiles) and 1000 m for species with greater mobility (birds, flying insects, mammals, other reptiles). This metric was averaged for current-day and 2050 and rescaled from 1-3. Steps: 1) Create two kernel files (grids of numbers) to represent circles with decreasing weighting farther from the focal cell - one for a 500-m radius and one for 1000 m. 2) Invert the current-day and 2050 distribution models so that greater values indicate greater resistance to movement. 3) Calculate mean resistance throughout the state with a neighborhood ("roving window") analysis using the kernel file to indicate decreasing weight with increasing distance using the appropriate radius. 4) Calculate average distance-weighted resistance for current-day and 2050 and rescale from 1-3.

Future unsuitability of nearby habitat: We calculated this as the inverse of the amount of 2050 habitat in 1 ha or greater patches above the current-day presence/absence cutoff within the same radius used for the Resistance factor. Steps: 1) Apply current-day cutoff to 2050 suitability model. 2) Reclass to a 1/NoData raster. 3) Perform a RegionGroup to associate all touching cells, including those touching diagonally, to the same "patch." 4) Convert to polygon. 5) Dissolve on the ID field that associates all grouped cells. 5) Calculate area of each polygon and remove patches < 1 ha. 6) Convert back to raster, ensuring statewide extent and snapping to distribution models. 7) Perform neighborhood analysis to sum on the Value field within 500 or 1000 m. 8) Convert to floating-point raster format. 9) Divide by 901 for species for which 500 m was used and 3409 for species for which 1000 m was used to convert to proportion. 10) Invert and convert from 1-3 such that greater numbers indicate less available suitable habitat surrounding each cell 2050.

Species-specific sensitivity factors that are nonspatial, coarsely spatial, or unmodelable

This group of factors included those from the CCVI that could not be depicted and analyzed at a fine scale but that may be important for distinguishing vulnerability among species. Each corresponded to one of the spatially explicit factors above and was calculated by assigning numerical scores to the categorical scores, with greater numbers indicating a greater category of vulnerability. When a range (e.g., Neutral to Greatly Increase) was supplied we took the higher value to arrive at a conservative estimate of vulnerability. We also calculated the score based on the lower bounds, which we used in our uncertainty calculations (below). All nonspatial factors were scored such that values from 0 to 1 indicated a reduction in vulnerability and values from 1 to 2 indicated an increase in vulnerability.

Because a change in habitat suitability may not matter if a species can adapt to that change within a suitable timeline, we calculated an Adaptation Difficulty score from a subset of CCVI factors: Historical thermal niche, Physiological thermal niche, Historical hydrological niche, Physiological hydrological niche, Measured genetic variation, Occurrence of bottlenecks in recent evolutionary history, Dietary versatility, and Documented phonological response to changing seasonal temperature and precipitation dynamics. We weighted the continuous raster representing change in habitat suitability by Adaptability by multiplying it with the Adaptation score.

We calculated a score for Dispersal Difficulty to reflect differential mobility among species using two CCVI factors: Dispersal and movement capability and Dependence on other species for propagule dispersal. We weighted the raster representing resistance to dispersal outside of current patches by Dispersal Difficulty by multiplying the two.

Finally, we calculated a Survival Difficulty score to reflect the ability to survive in new locations, encompassing factors not included in our distribution models: Dependence on a specific disturbance regime likely to be impacted by climate change, Dependence on ice, ice-edge, or snow-cover habitats;

Dependence on other species to generate habitat; Restriction to uncommon geological features or derivatives; and Other interspecific interactions. We weighted the raster representing Future Unsuitability of Nearby Habitat by Survival Difficulty by multiplying the two.

Final index

We calculated the final index, which we call the CCVI Spatial (CCVIS) as the sum of the three weighted factors, each of which could range from below 1 to 6. The combined index could range from 1.55 to 18.00 in theory, with greater values for any given species in a given location indicating greater vulnerability in that location than in other locations, and greater values in a given location for one species indicating greater vulnerability for that species in that location than for other species in that location.

Attribute Description

Raster values are final CCVIS index values

Limitations

For each species, we provide several measures of uncertainty to guide users of the models. We calculated the True Skill Statistic (Allouche et al. 2006) of each distribution model as a measure of accuracy. In addition, we quantified the uncertainty of the three groups of nonspatial life-history factors by subtracting the score if the lower bounds of scores were used from the score if the upper bounds of scores were used. We also noted whether the scores spanned the point at which species were assessed to have life-history characteristics yielding decreased vs. increased vulnerability. Finally, we counted the number of life-history characteristics for which the value was recorded as "Unknown."

NYNHP Migration Pathways

Summar:

When species distribution models show a movement of suitable habitat from one area to another over time, the question is often asked whether it is possible for the species to move between the habitat patches, and what areas in the intervening landscape are most important to protect to maintain that ability. Without modeling numerous time increments to track the shift in range, this proves to be a difficult question to answer. In this product, we piloted methods to address the issue using just the current and future suitability models, and appling the least cost path modeling approach also applied to forest matrix blocks. With these data we can identify critical linkages for the modeled species, look for common trends among them, and refine a methodology that may be applied to additional species of interest in the future.

Method:

To develop current-day to future connectivity zones we first identified appropriate current-day habitat patches and future habitat patches. These patches consisted generally of the largest patches modeled as suitable habitat in the species distribution model (SDM) developed for the species. Patches were chosen in clusters with current and future patches within the same cluster. If no future patch was relatively nearby a current-day patch, it was excluded from the set. Since the goal was to model a few key corridors from current to future, we generally excluded very long connections or many connections among patches within the same time period.

From each current-day and future SDM we created a resistance surface by inverting the grid with the simple formula: absolute value (SDM value - 1). We then used these resistance surfaces to model the least-cost paths between each patch (following Howard and Schlesinger 2012), creating a set of least cost paths based on current-day resistance and another set based on future resistance. From these two sets of least-cost paths, we then chose a subset of paths for which to model connectivity zones, or Continuous Minimum Transit Costs (CMTC, Pinto and Keitt 2009). We set the CMTC to include paths 10% greater or less than the cost of the least-cost path for each patch to patch connection. We converted the lines making up each CMTC to polygons by extracting the triangles from the TIN the lines originated from, while keeping the path densities for the CMTC paths (each CMTC path differs overall but many line segments might be reused if that segment has low resistance).

We then merged the current-day connectivity zone with the modeled future connectivity zone by simply finding and keeping the portions of the zones where the two zones overlap. Within this overlap zone, we attributed zone sections with a standardized measure of line density from both time periods.

The final connectivity zone depicts the areas of highest permeability between current-day and future habitat patches. Large polygons of a single shading indicate relatively equivalent permeability throughout which narrow bands of shading indicate potential areas for bottlenecks.

For display within a single layer, the current and future habitat patches for select species was combined with the union of the TIN triangles of the Least Cost Path analyses (+ or – 1-% of the least cost path) under current and under future conditions (rather than just the overlap, i.e. the intersection where connectivity exists under both current and future conditions). This allowed us to prioritize the areas of connection in terms of being persistent under both sets of conditions (lowest uncertainty and risk) to connected only under current connections (moderate uncertainty and risk) to connected only under future conditions (highest uncertainty and risk). Within each group, the data was further categorized as more or less connected based on whether the number of paths through the triangle (current and future paths added together) was above or below the median number of current plus future paths. Triangles in similar bins were dissolved to speed display and combined with the patches for these following classes:

Label Order	Class	Connection Rank, risk
1	current predicted habitat patch	-
2	future predicted habitat patch	-
3	persistent conditions - more connected	1 (high rank, lowest risk)
4	persistent conditions - less connected	2
5	current only - more connected	3
6	current only - less connected	4
7	future only - more connected	5
8	future only - less connected	6 (low rank, highest risk)

Limitations

Limitations of the species distribution models and least cost path models would apply.

Citations

Howard, T. G., and M. D. Schlesinger. 2013. Wildlife habitat connectivity in the changing climate of New York's Hudson Valley. Annals of the New York Academy of Sciences 1298:103–109.

Pinto, N., and T. H. Keitt. 2009. Beyond the least-cost path: evaluating corridor redundancy using a graph-theoretic approach. Landscape Ecology 24:253–266.

Predicted number of rare species

Summary

This is a package of nine rasters (ArcGIS GRIDS of all rare species models, all animal models, bat hibernacula models, birds, federally listed species, flying insects, invertebrates, plants, state listed species, and vertebrates), each of which depict the predicted richness (number) of up to 379 rare species in various categories. The probability of the existence of suitable habitat for each species was modeled and converted to a presence or absence of suitable habitat; we then summed across all species in each category (i.e., created model "stacks") to yield the number of species for which suitable habitat was predicted to be present in each cell. Location data come primarily from NY Natural Heritage element occurrence databases. Other sources of known locations, and sources of environmental variables, are noted in Howard and Schlesinger (2012). Methods and which models were included in which stack are detailed in the full metadata document, which is included in the Task 5 deliverable description (and also saved in O:\GIS_Project_Data\AdaptationToolkit\New Order\Task 5 Current Species\EDMs from Heritage\Stacks\Metadata_StackedEDMs).

Methods

1. Species were selected to represent a range of habitat preferences, niche breadth, and spatial distribution within New York State. Species known to predominantly occupy habitats within streams or lakes were generally excluded from this study in recognition of the additional (catchment and basin-level) landscape metrics needed to adequately model distributions. We selected 243 plant and 136 animal species to be modeled. The number of known locations for each species varied from 2 to 200 (mean = 11) among species. Twenty-six of the animals were modeled for a separate project (Howard and Schlesinger 2012) and included here. The two rare bats were modeled using a modified approach (see 8).

2. We attributed each 30-m cell with 44 environmental variables (see Howard and Schlesinger [2012]).

3. We compared the environmental characteristics of cells with known presence and 10,000 randomly distributed background points using Random Forest analysis.

4. We used the results of this model to predict the probability of suitable habitat for each species.

5. We computed validation statistics for each model and retained models with TSS (Allouche et al. 2006) greater than or equal to 0.5.

6. To convert each model value to a predicted presence (1) or absence (0) of suitable habitat, we used the F-measure (Van Rijsbergen 1979, Sing et al. 2005) with alpha = 0.01 to find a balance of precision and recall weighted conservatively towards higher recall (more land area represented as suitable).

7. For each of the 10 categories, we summed the 0/1 values for each species to arrive at the number of species predicted to have suitable habitat in each cell.

8. Bat data came from statewide 2009 and 2010 acoustic surveys from 49 fifteen-mile road transects and mist-net surveys (318 points) from various targeted projects 2003-2010. For hibernacula models,

we used locations from the NY Natural Heritage database. We modeled summer distribution of two rare species for inclusion in model stacks.

Attributes

There are 9 rasters:

- Allrarespp = all rare species models
- animals = all animal models
- bathiber = bat hibernacula models
- birds = all bird models
- fedlisted = all federally listed species
- flyinginsects = all flying insects
- inverts = all invertebrates
- plants = all plant models
- state listed = all state listed species
- verts = all vertebrates

Limitations

These data are subject to our license agreement with NY Natural Heritage, and once we get closer to building the final toolkit, we will work with them to determine what can be publicly distributed and how to word the limitations.

Overall predicted species richness by hexagon is a straight count of the number of species with habitat recorded as present (current and/or future, by any source model) within the hexagon. The maximum number of species for all species combines is 685. Species richness was also broken out by taxa based on the following groupings of the TAXON class from the species list table:

Species Richness Taxon Group	Species List Taxa
Birds	Bird
Mammals	Mammal
Reptiles/Amphibians	Reptile, Amphibian
Freshwater Fish	Fish
Rare Insects	Beetle, Butterfly/Moth, Mayfly, Odonate
Rare Aquatic Invertebrates	Crustacean, Mollusk
Trees	Tree
Rare Vascular/Nonvascular Plants	Vascular Plant, Nonvascular Plants

Note that categories labeled as “rare” only have species habitat models available from NYNHP which only modeled rare species they track and no habitat models for the entire taxon group were available from other sources.

Predicted species richness stacks for rare species, separately provided for current and future periods as well as the net change in number, are also provided at a finer 30 m. resolution based solely on data provided by NYNHP.

The predicted species richness of just those species listed as Species of Greatest Conservation Need (SGCN) in the NYS Comprehensive Wildlife Conservation Strategy (http://www.dec.ny.gov/animals/9406.html) was also determined at the hexagon scale. Subsets of SGCN species were selected based on nonspatial condition and threat information to show richness of SGCN species that represent either a high potential benefit from restoration or threat reduction actions, or a high risk and high investment need in order to be maintained.

SGCN richness group	Condition_C	Threat_C
Restoration opportunities	Low or Moderate	Low
Reduce threat opportunities	High	High or Moderate
High risk / high investment	Low or Moderate, ELSE Low	High, ELSE High or Moderate

USFS TreeAtlas

More info at http://www.fs.fed.us/nrs/atlas/. Data available from USFS upon request. ... BECKY – what do we say for that the underlying individual tree spp data was provided to TNC by USFS?

"The results of [the USFS CCTA] modelling effort give potential habitat distributions for future General Circulation Model (GCM)scenarios (2100) for 134 tree species. [USFS] used the data for two emission scenarios: the A1fi (high emissions - which assume that the current emission trends continue into the future without modification) and the B1 (significant conservation and reduction of CO_2 emissions). These two emissions scenarios bracket most of the future emissions as outlined by the Intergovernmental Panel on Climate Change's evaluation of emission scenarios, and end the century at roughly double (550 ppm-B1) and triple (970 ppm-A1fi) the pre-industrial levels for CO_2. We also averaged the three models for each emission scenario to yield an average high and average low emission set of climate predictors."

We used the 3-GCM-model averaged high emission scenario results because that scenario best matched the emissions scenario used throughout the Natural Resource Navigator project.

Following guidance from USFS (M. Peters, pers. comm.) we defined presence as having an importance value greater than three (IV >= 4) and absence as less than or equal to three (IV <= 3). To determine if a large enough portion of original USFS square grid cells (20x20 km.) with species present fell within our analysis hexagon (216.5 sq. km.) to be included as present in our analysis, the data was resampled to 30m resolution and the area of the hexagon with the species present had to exceed ten percent of the area of the hexagon (or that portion of the hexagon covered by USFS data in the case of edge cells). This follows the methodology of the USFS (for example, see Appendix 4 in Handler et al 2014) for similarly determining regional presence absence.

Citations (2):

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USGS Terrestrial GAP

More info at http://gapanalysis.usgs.gov/ . Nationwide predicted species habitat DISTRIBUTION data was downloaded as 30m resolution rasters for all species found within New York and surrounding states but only retained if at least some predicted species habitat fell within our freshwater study region. Any cell with predicted year-round or seasonal habitat (summer or winter, for migrating birds or marine animals) was counted as presence of suitable habitat.

USGS Aquatic GAP

These are predicted distributions within NY for 115 fish species from the USGS (McKenna, pers. comm.; see also McKenna and Johnson 2011, McKenna et al. 2012, and McKenna et al. in prep). These predictions are based on models that incorporate enduring landscape values (e.g., stream temperature, climate, geology, etc.) with little anthropogenic input (e.g., point source pollution), except for land use. Note that while these models incorporate data on land use, they use slightly different current land use data than our other species models, and the future models, only available for 13 of the species through the USGS FishVIS project, do not incorporate predicted changes in land use, just predicted changes in climate variables. Importantly, these models do not take into consideration whether a certain species has had the opportunity to colonize an area (i.e., darters found in only the Allegheny watershed can be predicted elsewhere, for example). Thus, these model predictions are of a stream's best potential to support a given species, whether or not that species has had access to the stream, or if it is anthropogenically degraded (with the exception of the model's inclusion of current day land use). This dataset contains both the continuous variable of predicted abundance and a categorical presence variable (0=not predicted present or predicted present at <1 individual for that stream reach, 1= predicted present at low to moderate abundance and 5= predicted present at high abundance).

Methods

Summary methods for underlying predictive models from USGS pending. See references for details on the source data and neural network models used to create the predicted fish distributions. Aquatic GAP species data were obtained from USGS (Jim McKenna jemckenna@usgs.gov). Data cover all of NY State plus portions of PA and other states that drain into the Great Lakes or Lake Champlain and includes 115 species.

Source data shows predicted species abundances (number per mile) per stream reach in five abundance classes (code): absent (0); one (1); two to ten (5); eleven to one hundred (50); and greater than one hundred (500). These data were treated similar to USFS tree importance values and a threshold based on the maximum abundance class for the species observed within the dataset was used to delineate presence and absence of suitable habitat (see table). The distribution models were not deemed suitable for truly rare species (maximum predicted abundance of 1 fish per mile) and these species models were not included in our analysis, nor was an abundance class of one ever considered to indicate presence. Otherwise, the top two abundance classes were counted as the presence of suitable habitat and anything less counted as absence.

Max. abundance class	Present	Absent
500	500, 50	5, 1, 0
50	50, 5	1, 0
5	5	1, 0

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Attributes

COMID	NHDPlusv1 comid
GNIS_NAME	Original TNC field from shp file, flowlines_rev430_mckenna.shp
CLNEFL7634	Original TNC field from shp file, flowlines_rev430_mckenna.shp
LAKE_FLAG	Original TNC field from shp file, flowlines_rev430_mckenna.shp
MISSINGVAL	Original TNC field from shp file, flowlines_rev430_mckenna.shp
STATE	Original TNC field from shp file, flowlines_rev430_mckenna.shp
REV430	Original TNC field from shp file, flowlines_rev430_mckenna.shp
REV430NAME	Original TNC field from shp file, flowlines_rev430_mckenna.shp
OID_	GIS Field
COMID_1	comid for GIS join
PU_GAP	USGS GAP stream reach ID (gapcode)
REV1125	TNC earlier classes with headwaters & creeks combined
REV1125_NA	TNC earlier classes with headwaters & creeks combined
LENGTH	Length of stream reach
PU_CODE	GAP processing unit code
C_SHORE	Whether or not a shoreline arc, 1 = yes, 0 = no

STRAHLER	Stream order of reach
TEMP_CAT_N	USGS GAP stream temperature prediction, °C midpoint, 13 = cold, 19 = cool-cold trans, 22 = cool-warm trans, 26 = warm.
AEEL	Species predictions, see master_fish_codes.xls, each species has 2 columns, raw and categorized.
AEEL_C	Categorized species predictions. 0= not predicted present, or predicted at <1 individual per stream segment; 1= predicted present between 1-1.5 individuals per segment; 5=predicted present between 1.5-10 individuals per segment; 50=predicted present with >10 individuals per segment.

Citations

Please cite these data as James E. McKenna, personal communication.

The 14 species from the FishVIS dataset should be cited as:

DOI URL: http://dx.doi.org/10.5066/F74T6GGG

ScienceBase URL: https://www.sciencebase.gov/catalog/item/57c5cf93e4b0f2f0cebdaa9b

Stewart, J.S., Covert, S.A., Krueger, D., Slattery, M.T., Wieferich, D.J., Westenbroek, S.M., Infante, D.M., McKenna, J.E. Jr., and Lyons, J.D., 2016, FishVis, predicted occurrence and vulnerability for 13 fish species for current (1961 - 1990) and future (2046 - 2100) climate conditions in Great Lakes streams: U.S. Geological Survey data release, http://dx.doi.org/10.5066/F74T6GGG.

Species Richness by Hexagon (various)

For each species and each current and future source model, the presence of any suitable habitat within each hexagon was counted as presence in the hexagon, and the fraction of suitable habitat tallied (area of 30 m. cells or total length of streams.

Quintiles were used to assign qualitative habitat availability scores relative to the maximum current habitat for the species across all hexagons (in 20% blocks corresponding to lowest, low, moderate, high, and highest). If the maximum habitat availability across all models was within the bottom 40% of the distribution for that model (or if absent in the USFS CCTA data), the habitat availability was listed as “Low” and a filter was created to allow these records to be filtered out in the web tool at the user’s discretion.

Qualitative classes describing the amount of habitat change within the hexagon were assigned based on the ratio of the amount of future to current suitable habitat (see table) following the methodology of the USFS CCTA’s Regional Assessments. If a species only had modeled data for current conditions, the future hex future habitat change was listed as unknown. Because a single hexagon was roughly similar in area to the source grid cells of the USFS CCTA data and because it is not recommended to analyze change trends at scales smaller than roughly 4000 sq. km. (10 grid cells), a separate assessment of change direction was performed by ecoregion for all tree species in the USFS CCTA and this was used in place of the hexagon based change (and noted with an appended “(regional)” in the species details table).

Hex future habitat change	USFS change classes

Future exit	Extirpated (Complete loss of habitat in future)
Decrease	Large decrease (Future:Current ratio <0.5) Small decrease (Future:Current ratio >0.5 & <0.8)
No change	No change (Future:Current ratio >0.8 & <1.2)
Increase	Small increase (Future:Current ratio >1.2 & <2) Large increase (Future:Current ratio >2)
Future entry	New habitat: Suitable habitat is present in the future (currently does not exist)

A species list by hexagon using the sppcodes was compiled such that the species was included if it was listed as present by any current or future predicted habitat model or if the hexagon was modeled to contain a "future connection area" (see Migration Pathways above).

Only the hexagon future habitat change results of the preferred source model were retained within the hexagon species data tables. Source data from the NYNHP for rare species was always preferred if present for a species.

COMBINED PREDICTED SUITABLE HABITAT MAPS

Combined predicted suitable habitat rasters were created for each species by combining the predicted current and future (if modeled) habitat of the preferred source model plus showing where the habitat is absent in the preferred model but present in an alternate model (either present or future alternate presence).

When combining raster and linear vector sources (streams), data was always resampled to the resolution of the most detailed raster model available (30 m.), and stream reaches with suitable habitat presence were buffered (50 m.) before being converted to raster and combined with other raster data.

Presence was broken down for display into the following classes:

Combined Range Code	Description	Note
0	Absent	in all models
1	Currently present, future unknown	no future models available
2	Future extirpation (-)	within preferred model
3	Future new entry (+)	within preferred model
4	Persists into future	within preferred model
5	Present in alternate model	absent in preferred model, or beyond the extent of preferred model dataset