MichiganTech Research Institute

Evaluating the Impact of NRCS Programs: New Measures and Improved Communication

Report on the EQI Experts Meeting
September 17, 2007
Michigan NRCS building, East Lansing

Nancy French, Tyler Erickson, Robert Shuchman, Colin Brooks, Brian Thelen, Richard Powell, Ben Koziol, and Michelle Wienert

October 2007

USDA NRCS

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Michigan Tech Research Institute (MTRI)
3600 Green Court, Suite 100 • Ann Arbor, Michigan 48105 • (734) 913-6840

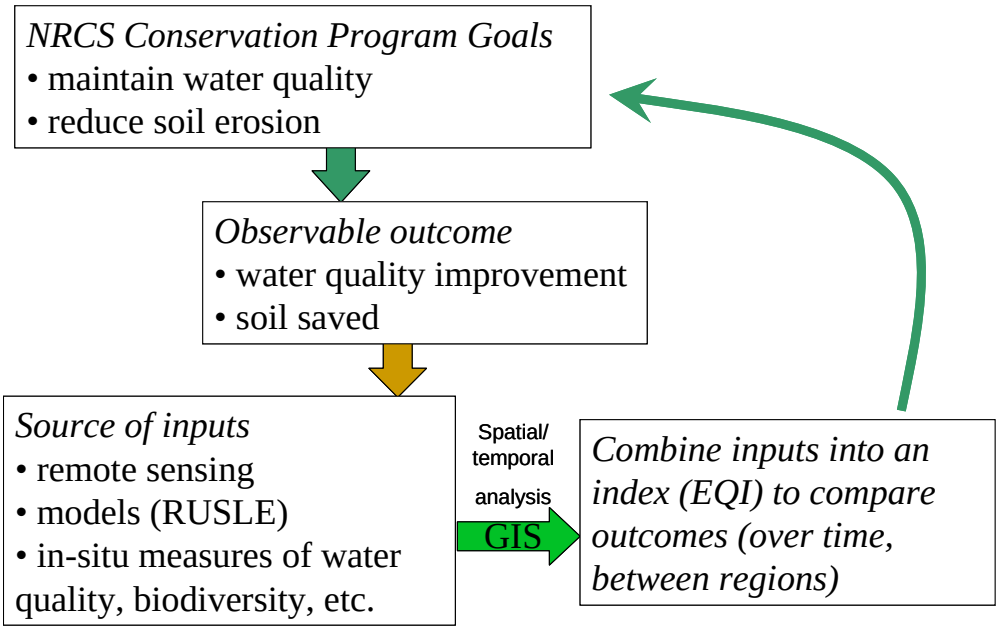
INTRODUCTION

The Michigan Tech Research Institute (MTRI) is working under a cooperative agreement with the Natural Resources Conservation Service (NRCS) in Michigan to support MI-NRCS in its management and administration of agricultural conservation programs. Entitled "Evaluating the Impact of NRCS Programs: New Measures and Improved Communication," this agreement includes efforts to assess the environmental impacts of NRCS programs and practices, with a significant focus on the development of an environmental metric that NRCS managers can use to evaluate program implementation effects. To develop this metric, named the Environmental Quality Index (EQI), MTRI staff has investigated the structure and calculation of existing environmental metrics and the availability of data needed for creating the EQI. An important part of the process to developing an EQI metric is inclusion of expert opinion for weighting the data used in the index. This report presents the process and results of an NRCS experts meeting and workshop held on 17 September 2007 to solicit expert opinion for inclusion in the metric.

BACKGROUND

In the first three years of the cooperative agreement, MTRI developed and demonstrated the mathematical feasibility of a stable and useful environmental quality index (EQI) for NRCS. The approach that has been developed begins by identifying resource concerns that NRCS programs address in their prescribed practices. The effects of these practices that are observable are then measured or modeled using a variety of information collection resources, which are described in the following section titled "Data for the EQI." These resources include remotely sensed imagery, Geographic Information System (GIS) data layers, and results from published models. The EQI is then used to combine these inputs into a metric that can be compared to the implementations made for a single or a set of resources concerns. Figure 1 summarizes this process. Details of this process are presented below, in the overview briefing presented at the meeting, and are included as Attachment A.

Figure 1. Overview of the process for development of the EQI



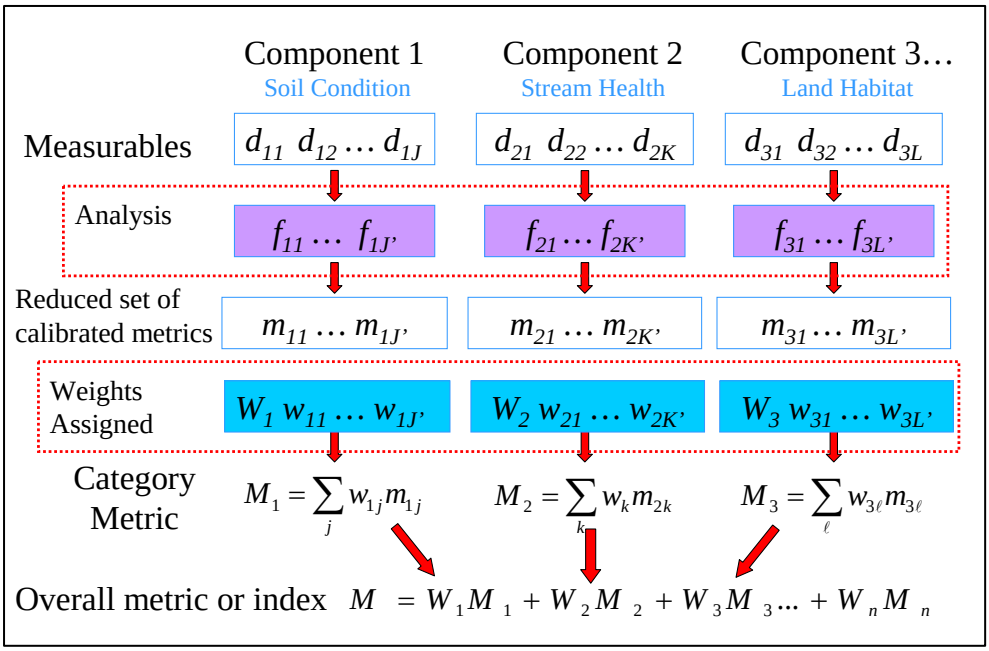
Calculating the Environmental Quality Index

MTRI has investigated promising methods of best calculating the EQI based on available and disparate data. From this analysis, we determined that statistical approaches rooted in factor analysis (e.g., principal components) are best suited for taking a set of input measures (indicators) in a variety of units and reducing these to a smaller set of calibrated metrics in a normalized unit. This method has been demonstrated in several applications in the scientific literature, including Esty, et al. 2005 and Burns, et al. 2004. As shown in Figure 2, this approach entails several steps mathematically and results in both an overall index or metric (the EQI) and component metrics that can serve to gauge outcomes within the domain of a single resource concern, such as soil condition.

The EQI as presented to the experts at the 17 September meeting employs five components within the overall EQI: soil condition, surface water health, land habitat health, air quality, and societal utility. Because these are not given equal weights in descriptions of NRCS program goals and objectives, as detailed within the agency and USDA as a whole, we foresee employing different weights for each when the category metrics are combined to form an overall EQI as defined by the expert panel. In addition to expert input for assigning weights of inputs and EQI components, the expert panel will help MTRI construct the transformation functions needed to translate the input data into a scale that allows combination with the other inputs. This requires that each input's units be mapped to a quality value via a transformation function.

A more detailed description of the calculation of the EQI is given in the briefing presented at the 17 September meeting and included here as Attachment A.

Figure 2: Approach for Calculation of EQI



Data for the EQI

In the four years of the cooperative agreement, the MTRI team has pursued independent sources of environmental quality data pertinent to assessment of agricultural programs and practice effectiveness. We have concentrated our efforts on remote sensing data sources and techniques and on other agencies and organizations that collect environmental data, such as the U.S. Environmental Protection Agency and the Conservation Technology Information Center (CTIC). These efforts build from MTRI's extensive experience with remote sensing and GIS, take advantage of existing well-documented data sources, and enable the EQI to eventually be applied for multiple time periods. In Figure 3, we list the chosen measures within each of the five envisioned components of the EQI that were selected with the help of the NRCS. These were defined considering NRCS resource concerns (the concerns that are targeted with conservation practice implementations) and discovering relevant and available information products, either measurements or model-based outputs (see Figure 1). More detail on the data sets planned to be used in the EQI are given in the briefing (Attachment A). A full list and description of each input was included on the information passed out at the meeting. The list and descriptions as presented at the meeting are included as Attachment B.

Figure 3. Components and inputs planned for use in the EQI (grey text indicates desired but not available input)

EQI =	**Soil condition index** +	**Water health index** +	**Land habitat index** +	**Air quality index** +	**Societal utility index**
	Soil erosion	*Lake Clarity*	*Habitat improvement*	*NH_3 emissions*	*Economic value*
	Residue cover/tillage practice	*In-situ stream quality*	*T&E&SC plants & wildlife*	*CH_4 emissions*	
	HEL treated				
	Carbon Sequestration	*Stream buffers*	*Biodiversity/ Fragmentation*	*Particulates*	

Components weighted using expert opinion and program goals

EQI EXPERTS MEETING GOALS, OBJECTIVES & PROCESS

The meeting goals, objectives, and process for achieving these goals are given below. The agenda for the meeting is included as Attachment C. The participant list is given in Attachment D.

Goals: Develop numerical weighting factors and transfer functions for the inputs to the Environmental Quality Index (EQI) calculation

Objectives:

- Educate NRCS experts on the EQI concept and needs
- Survey/solicit inputs from experts on the role of information products (inputs) in assessing NRCS conservation program effectiveness
- Gather advice on weighting factors for EQI
- Revise transform functions for each EQI input

Process:

- MTRI presentation on program evaluation activity including (Attachment A)
  - Background of MI-NRCS/MTRI cooperative agreement
  - EQI structure & approach for implementation
  - List of needs for EQI
- NRCS staff fill out initial questionnaire (Attachment E)
- Charge to breakout groups (Attachment F)
- Convene expert breakout groups to discuss EQI information products & finalize questionnaire responses based on consensus
- Meeting participants reconvene to report out breakout group discussions and results and to conduct final discussions

EQI EXPERTS MEETING RESULTS AND PRODUCTS

The meeting goals were fully met in the five-hour meeting time. Condensed notes from the breakout sessions are included in Attachment G. The consensus weightings for both EQI components (Soil, Surface water, Land habitat, and Air quality) and the individual EQI inputs are listed in Attachment H. Figure 4 below reviews these consensus weightings, and also includes the individual participant inputs that were used create the consensus values. These will be the default values in the EQI when an NRCS user sees the results.

Breakout group 1 suggested that crop rotation history be added as an input for the soil condition component of the EQI. This data should be available for all Michigan counties. A discussion on inclusion of a "Societal Utility" component in breakout group 1 led to the full panel deciding that economic and societal utility measures should not be included in the EQI, so this component will be dropped from the EQI structure. Based on NRCS interest, the Societal Utility component could be developed as a separate index.

The discussions conducted in the afternoon included a review of the consensus weightings, so that participants of both groups could comment on each input. Attachment H provides a breakdown of individual weightings, an average of these, and the consensus weightings arrived at following discussion of each component/input.

The majority of the time in the afternoon discussions centered on a review of the transformation functions for each input (see Attachment A briefing to review the need for the transformation functions). The final

transformation functions and associated notes are given in Attachment I for each input discusses. Changes to the transformation functions based on the consensus of the panel members discussed during the afternoon session will be made and used in the initial implementation of the EQI.

Figure 4: Consensus scores for the EQI components and input rankings developed by the NRCS EQI Experts Meeting Attendees.

EQI Component and Input Ranking Results

	Consensus	Participant ranks						Avg Rank
Component Rankings								
Soil Condition	**30**	30	35	25	X	X	30	30
Surface Water Quality	**30**	30	30	25	X	X	30	29
Land Habitat	**25**	20	25	25	X	X	30	25
Air Quality	**15**	20	10	25	X	5	10	14
Sum	**100**	100	100	100		5	100	
Input Rankings								
1 - Soil Condition Index								
Soil Erosion	**25**	30	20	25	30	X	X	26
HEL	**15**	10	25	5	20	X	X	15
Tillage	**20**	20	15	25	25	X	X	21
Carbon	**25**	25	25	30	10	X	X	23
Crop Rotation	**15**	15	15	15	15	X	X	15
	100	100	100	100	100			
2 - Surface Water Health Index								
Lake Clarity	**45**	50	40	50	40	X	40	44
Vegetative Riparian Buffers	**55**	50	60	50	60	X	60	56
	100	100	100	100	100		100	
3 - Land Habitat Index								
Habitat Improvement	**40**	X	X	X	X	X	40	40
T&E species counts	**20**	X	X	X	X	X	20	20
Biodiversity/fragmentation	**40**	X	X	X	X	X	40	40
	100						100	
4 - Air Quality Index								
Ammonia NH3 emissions	**20**	X	33	X	15	X	15	21
CH4 emissions	**20**	X	33	X	10	X	25	23
Particulate levels	**60**	X	34	X	75	X	60	56
	100		100		100		100	

CONCLUSION

The results of the experts meeting will be used in execution of the EQI by MTRI. Once the initial EQI results are available, MTRI will review the outputs with MI-NRCS staff to discuss any further changes needed. The success of the meeting has allowed the EQI metric to have great potential in demonstrating how an holistic assessment of program effectiveness can be made using expert opinion combined with relevant measurements and model-based information.

REFERENCES

Esty, D.C., M. Levy, T. Srebotnjak and A. de Sherbinin (2005). 2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship. New Haven: Yale Center for Environmental Law and Policy. http://www.yale.edu/esi/

Burns, J.W., T. Cors, B. Knight, and B. Thelen. 2004. "Evaluating Advanced Automotive Energy Technologies: A Multivariate Contribution Metric." *International Journal of Energy Technology and Policy*, 2(3): 262-271.

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The Environmental Quality Index (EQI):

Experts Meeting & Workshop

USDA-NRCS Michigan State Office, East Lansing, MI

September 17, 2007

USDA NRCS

www.mtri.org

Meeting Goals & Objectives

Goals: Develop numerical weighting factors and transfer functions for the inputs to the Environmental Quality Index (EQI) calculation

Objectives:

- Educate NRCS experts on the EQI concept and needs
- Survey/solicit inputs from experts on the role of information products (inputs) in assessing NRCS conservation program effectiveness
- Gather advice on weighting factors for EQI
- Revise transform functions for each EQI input

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Meeting Structure

- MTRI presentation on program evaluation activity including:
  - Background of MI-NRCS/MTRI cooperative agreement
  - EQI structure & approach for implementation
  - List of needs for EQI
- NRCS staff fill out initial questionnaire
- Charge to breakout groups
- Convene expert breakout groups to discuss EQI information products & finalize questionnaire responses based on consensus
- Meeting participants reconvene to report out breakout group discussions and results and to conduct final discussions

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Agenda

9:00 – 10:30	Workshop purpose, approach & expected outcome
10:30 – 10:45	NRCS participants fill out initial questionnaire
10:45 – 11:00	Breakout session assignments
11:00 – 12:00	Breakout sessions Group 1: Soil & Water quality discussions Group 2: Land habitat & Air quality discussions
12:00 – 1:00	Lunch (on your own)
1:00 – 2:15	Breakout sessions continue
2:15 – 2:30	Break
2:30 – 3:00	Report out (:15 per group)
3:00 – 3:30	Final discussions & wrap-up

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The Environmental Quality Index (EQI):

Overview and review of inputs and requirements

USDA-NRCS Michigan State Office, East Lansing, MI

September 17, 2007

USDA NRCS

www.mtri.org

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Briefing Outline

- Background of MI-NRCS/MTRI cooperative agreement
- Evaluation of NRCS programs and the EQI concept
- EQI structure & approach for implementation
- Needs for EQI & outcomes from workshop

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Overview of the MI-NRCS/MTRI Cooperative Agreement

- Develop and apply a method for evaluating the environmental effects of NRCS conservation programs at the State level
  - Develop environmental quality metric to assess impacts of NRCS practices on land, air, and water quality
  - Take a holistic look at how well the programs have achieved the goal of "conservation"
    - Retrospective analysis to assess program impacts since the beginning of Farm Bill programs
    - Metric or index to assess improvements to the environment from NRCS program practices
- Develop decision-support tools to:
  - Enable improved communication of conservation-related information within and outside NRCS
  - Assist MI-NRCS personnel with data handing and visualization to help them better manage conservation programs

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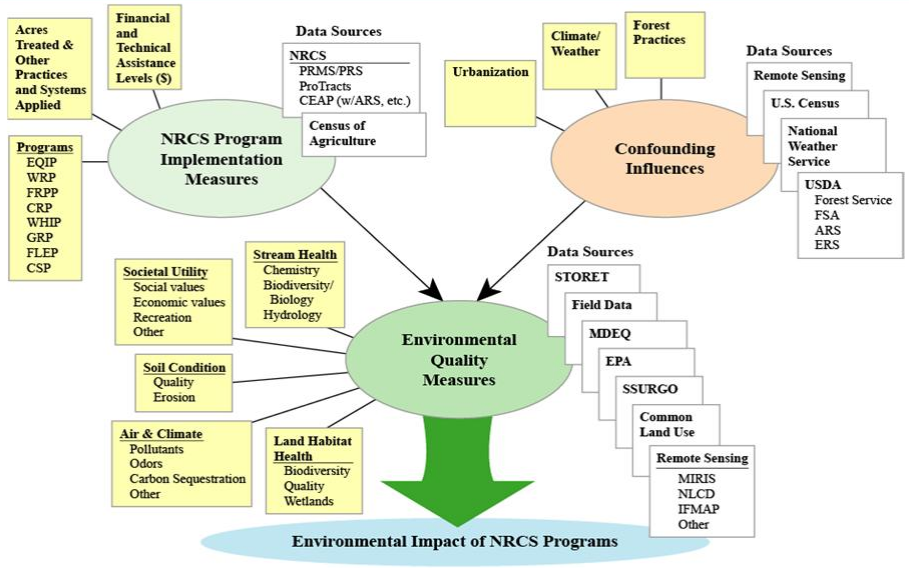
Program Evaluation Framework



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Development of the Environmental Quality Index (EQI)

Establish an index baseline for measuring change over time and/or monitoring differences in index scores across geographic units of interest (counties/districts, watersheds)

- Develop scaling system that accounts for good program outcomes (achieving program goals)
  - Based on measures of environmental quality over time
- Obtain data from inside and outside NRCS – based on program goals
  - ProTracts, PRS, etc.
  - Analysis of remote sensing (satellite imagery) & GIS data
  - EPA, USDA, other federal agencies
  - State agencies: MI-DNR, MI-DEQ, MDA
  - Correlations from literature or in-situ measurements
  - NGO's: Duck Unlimited, MNFI
- Use MTRI expertise in application of in-situ sampling data and remote sensing to extracting environmental information over large areas and over time
  - Moderate-resolution satellite imagery back to early 1970s (Landsat)

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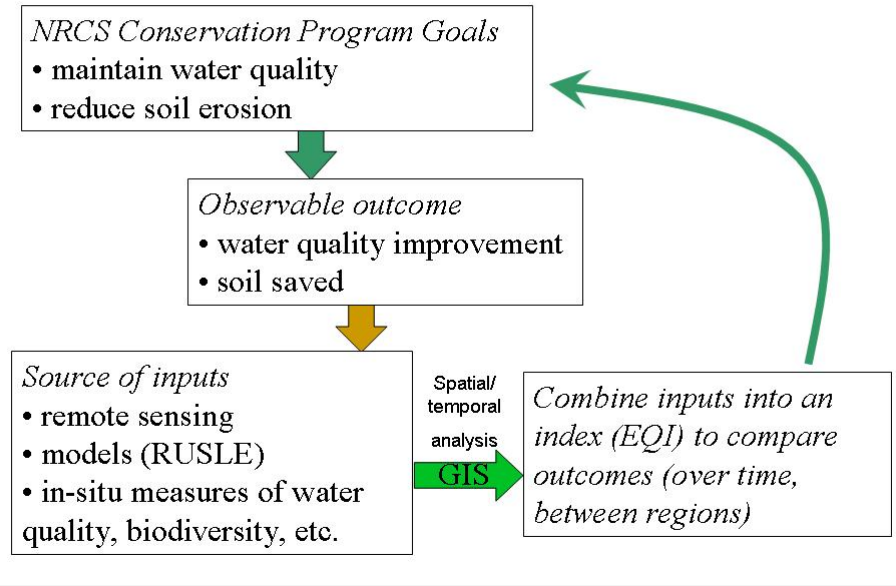
Process for Development of EQI



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Resource Concerns

EQI structure & inputs based on NRCS Resource Concerns

Group	Resource Concern	EQI Input
Air Quality	Particulate matter less than 2.5 micrometers in diameter (PM 2.5)	43 Particulates
	Ammonia (NH3)	41 Ammonia emissions
	Excessive Greenhouse Gas - CH4 (methane)	42 Methane emissions
Fish and Wildlife	Inadequate Cover/Shelter	31 Habitat improvement
	Inadequate Food	
	Inadequate Space	
	Threatened and Endangered Fish and Wildlife Species	32 T&E&SC counts
	Habitat Fragmentation	33 Fragmentation index
	T&E Species: Declining Species, Species of Concern	32 T&E&SC counts
Plant condition	Threatened and Endangered Plant Species	32 T&E&SC counts
	T&E Plant Species: Declining Species, Species of Concern	32 T&E&SC counts
Soil Condition	Organic Matter Depletion	15 Carbon sequestration
Soil Erosion	Classic Gully	12 HEL treated
	Ephemeral Gully	
	Mass Movement	
	Sheet and Rill	11 Soil erosion reduction
Water Quality	Excessive Suspended Sediment and Turbidity in Surface Water	21 Lake clarity

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Components of the EQI

EQI =	Soil condition index +	Water health index +	Land habitat index +	Air quality index +	Societal utility index
	Soil erosion	*Lake Clarity*	*Habitat improvement*	*NH_3 emissions*	*Economic value*
	Residue cover/tillage practice	*In-situ stream quality*	*T&E&SC plants & wildlife*	*CH_4 emissions*	
	HEL treated				
	Carbon Sequestration	*Stream buffers*	*Biodiversity/ Fragmentation*	*Particulates*	

Components weighted using expert opinion and program goals

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Input Characteristics

- Inputs are matched to resource concerns (or practice)
- Measurable at the county scale (a single value for each county in Michigan) *[may transition to watershed]*
- Measurable at several times (pre-1985, 1985-2000, present) to assess changes over time
- Need to assign the importance/strength of the input for the EQI based on expert opinion
  - Conveyed through weighting of input against other inputs
- Transformation function helps define input's relationship to "environmental quality"

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EQI Inputs

	Input	Units	Where from	Resource Concern or Practice	Notes
Soil condition index					
11	Soil erosion	tons	EPA STEPL model	Sheet & rill erosion	EPA STEPL model is being investigated - made for watershed assessment
12	HEL treated	% treated	MTRI developed	Gully erosion/mass movement	% HEL acres treated by county
13 & 14	Tillage practice	% conservation	CTIC (Purdue); MTRI developed	conservation tillage practices (329, 344,345,346)	Avail. up to 2002; This data no longer collected for all counties; Derived tillage practice from remote sensing; CSREES research
15	Carbon sequestration	tons	USDA-COMET VR output	Organic matter depletion	Implementation of COMET-VR is under development on the county scale See: http://www.cometvr.colostate.edu/
Surface water health index					
21 & 22	Lake clarity	index	USGS & MTRI developed	Turbid surface water	USGS has 2002 map of lake clarity (TSI); MTRI developing products for other years using remote sensing & in-situ data
23	Riparian buffers	% forested	MTRI developed	Riparian buffer practice (391)	GIS analysis of USGS land cover with stream networks
Land habitat index					
31	Habitat improvement	acres	MTRI developed	Inadequate cover/shelter/space	Land cover from USGS and State of Michigan analysis of change over time
32	T&E&SC species	count	MNFI	T&E species	Rawcounts of special concern animals and plants by county
33	Biodiversity/Fragmentation	index	MTRI developed	Habitat fragmentation	Patch size, shape and edge contrast using FRAGSTATS with USGS land cover
Air quality index					
41	NH3 emissions	kg	EPA- NEI	Ammonia	county-level ammonia emissions from animals and fertilizer is modeled for the National Emissions Inventory (NEI)
42	CH4 emissions	Tg CO2 equiv.	EPA - climate change group	Excessive greenhouse gas - CH4	EPA models CH4 from animal husbandry in its greenhouse gas emissions estimates
43	Particulate levels	density	MTRI developed	PM 2.5 level	MODIS-derived PM2.5 product compared with EPA in-situ measures
Societal utility index					
51	Economic value	dollars	Census of Agriculture		Question of yield or commodity value more valid for EQI

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Example of Input Description

EQI input name	Units of input	Index component
41. Ammonia Emissions	kg (month and year)	Air Quality Index

Origin of data for input measure

EPA National Emissions Inventory (NEI) using Carnegie Mellon University Ammonia Model. CMU, 2004.; USDA 2002 Census of Agriculture; and Association of American Plant Food Control Officials (AAPFCO) commercial fertilizer application data

Description of derivation of input

An ammonia emissions inventory model, developed at Carnegie Mellon University for EPA, is used to characterize the amount of ammonia (NH_3) emissions in each Michigan county from agricultural sources.
Agricultural sources consist of livestock (Dairy Cattle, Beef Cattle, Swine, Goats, Poultry, and Turkey) operations and fertilizer applications. Activity levels are derived from the Census of Agriculture for livestock operations and from the Association of American Plant Food Control Officials (AAPFCO) for fertilizer applications. The model output consists of county-level NH_3 emissions, expressed in kilograms, by month, or totaled for the year.
USDA, 2002. "2002 Census of Agriculture." http://www.agcensus.usda.gov/
Association of American Plant Food Control Officials (AAPFCO), 2002. Commercial Fertilizers 2002.

Transformation Function used in initial EQI analysis

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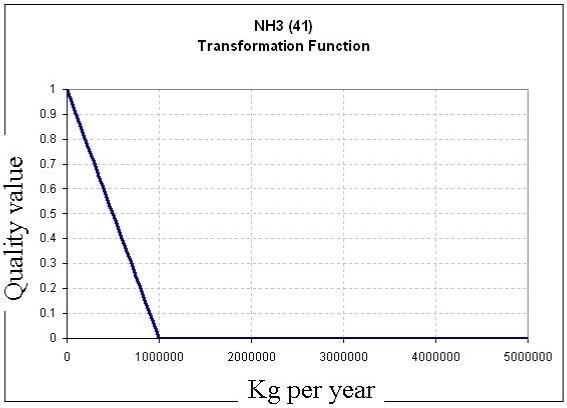
Example of Input Transformation Function



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Implementation of the EQI

USDA-NRCS Michigan State Office, East Lansing, MI

September 17, 2007

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Reasons for using an Index

- Difficult to see the big picture when faced with lots of measures of many discrete phenomenon
- Easier to track change over time along a single dimension (even if it is a virtual dimension, as with an index)
- Metrics/indices are much better at facilitating relative comparisons (across programs, across time, etc.) than they are at providing absolute measures of performance
- Easier to compare different cases when a single metric is used (such as, is the economy better in country X or Y, or is NRCS more effective in meeting environmental goals in Washtenaw or Hillsdale County?)
  - Must normalize data
  - Must account for external variables

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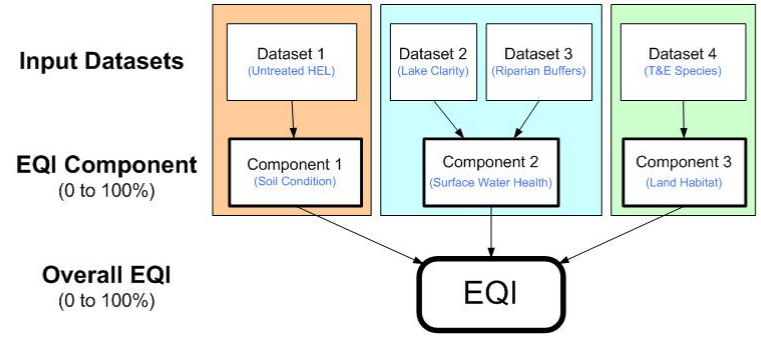
EQI Overview

- An index-based approach for characterizing various components that are important for environmental quality.



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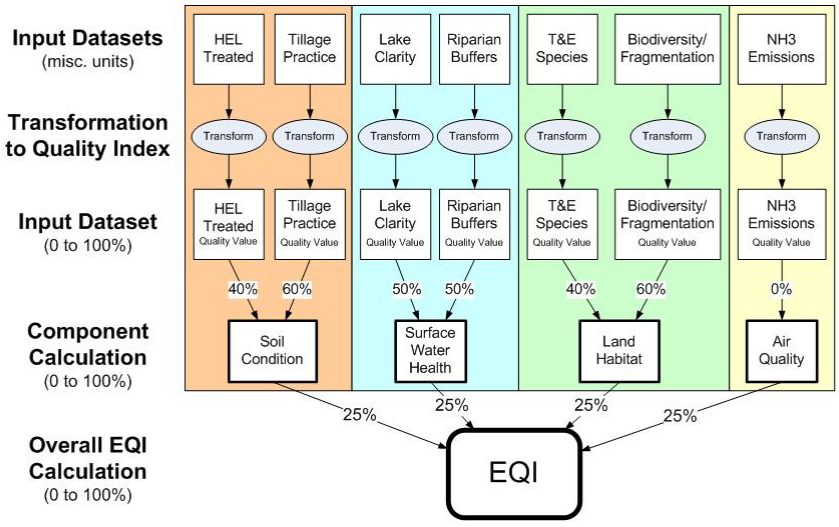
EQI Example



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Approach for Index Development

- Start with the interrelated input measures expressed in their own, "natural" units, divided into component (i.e., soil condition, surface water health, etc.)
- Find/develop transformation functions to express data in a common, normalized unit (i.e. the quality value)
- For each component, find/develop weights to combine normalized input datasets into a measure of environmental quality for that component (example: soil condition)
- Find/develop weights to combine environmental quality components into an overall measure of environmental quality (i.e. the overall EQI)

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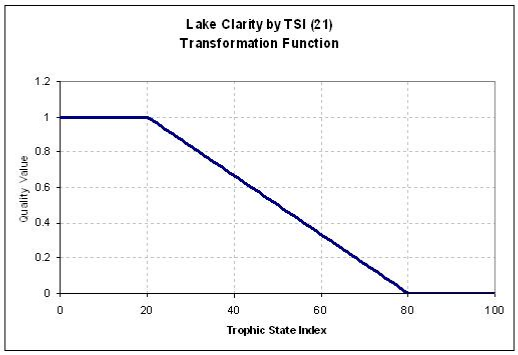
Transformation Function

- A transformation function converts an environmental measurement in its native units, to a "quality value" between 0 and 1.
- The graph shows an example transformation function for the trophic state index, a measure of water clarity.



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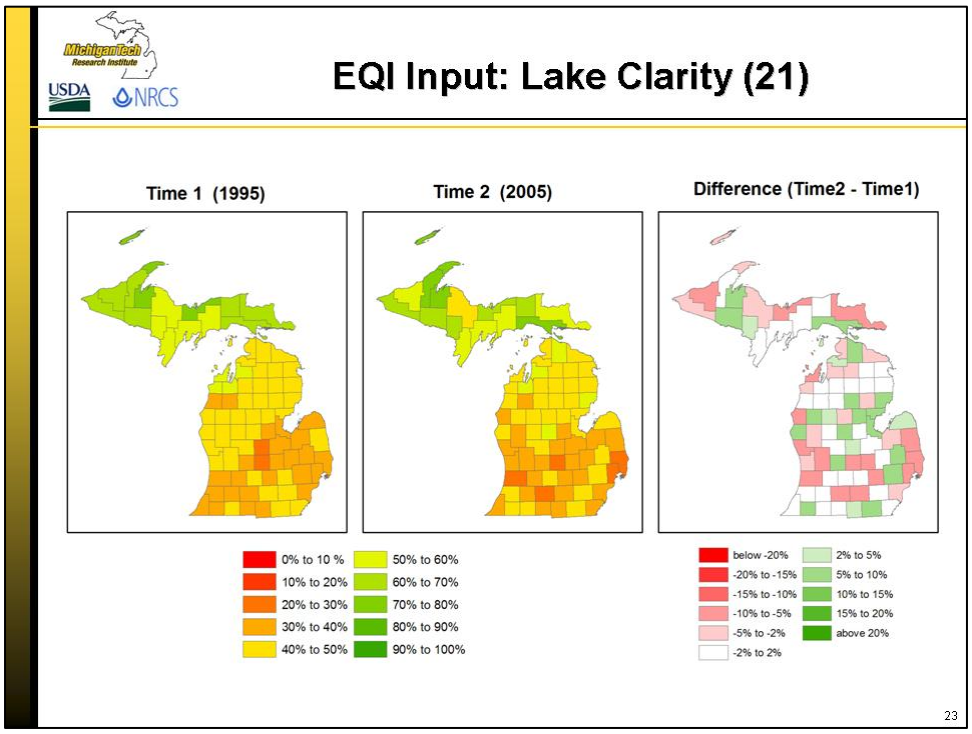
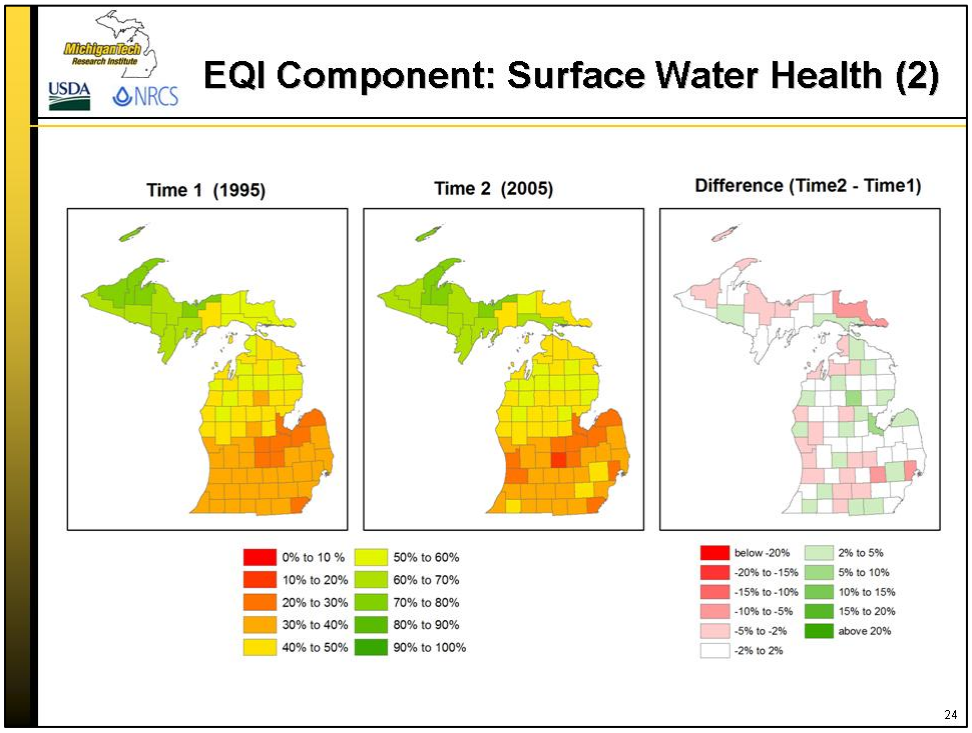
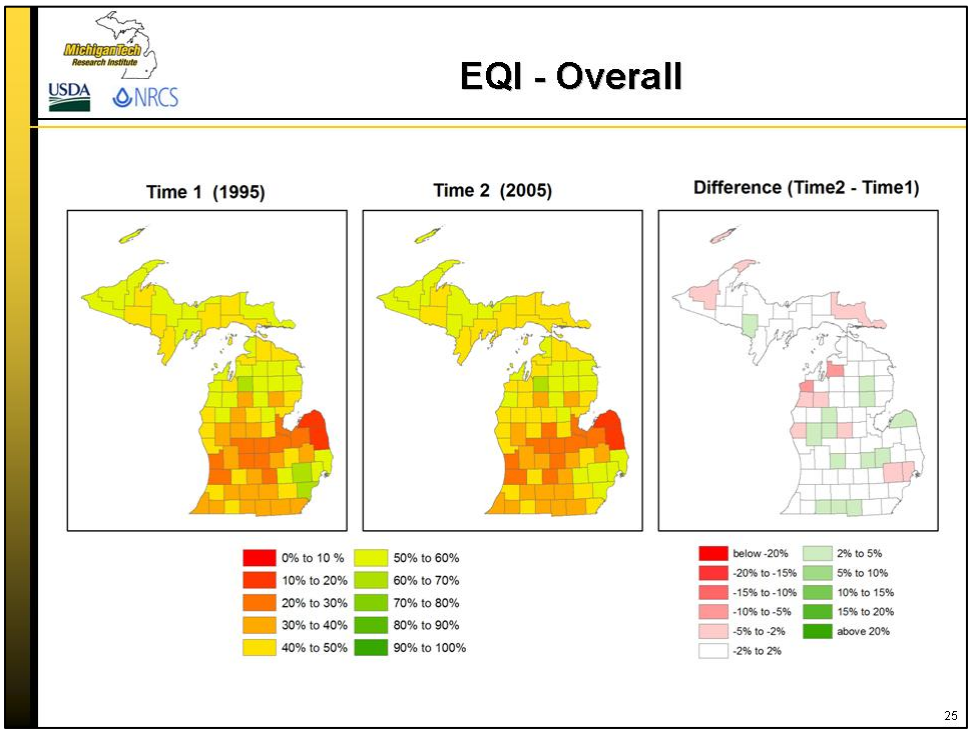
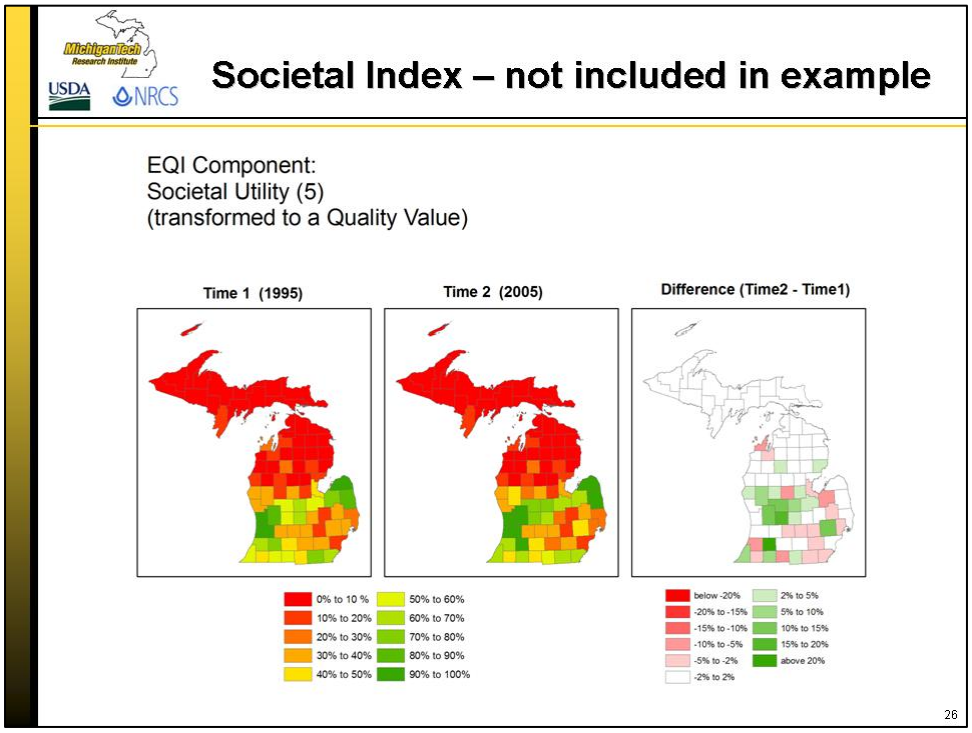

EQI Input: Lake Clarity (21)
Time 1 (1995)
Time 2 (2005)
Difference (Time2 - Time1)
0% to 10 %
10% to 20%
20% to 30%
30% to 40%
40% to 50%
50% to 60%
60% to 70%
70% to 80%
80% to 90%
90% to 100%
below -20%
-20% to -15%
-15% to -10%
-10% to -5%
-5% to -2%
-2% to 2%
2% to 5%
5% to 10%
10% to 15%
15% to 20%
above 20%
23


EQI Component: Surface Water Health (2)
Time 1 (1995)
Time 2 (2005)
Difference (Time2 - Time1)
0% to 10 %
10% to 20%
20% to 30%
30% to 40%
40% to 50%
50% to 60%
60% to 70%
70% to 80%
80% to 90%
90% to 100%
below -20%
-20% to -15%
-15% to -10%
-10% to -5%
-5% to -2%
-2% to 2%
2% to 5%
5% to 10%
10% to 15%
15% to 20%
above 20%
24


EQI - Overall
Time 1 (1995)
Time 2 (2005)
Difference (Time2 - Time1)
0% to 10 %
10% to 20%
20% to 30%
30% to 40%
40% to 50%
50% to 60%
60% to 70%
70% to 80%
80% to 90%
90% to 100%
below -20%
-20% to -15%
-15% to -10%
-10% to -5%
-5% to -2%
-2% to 2%
2% to 5%
5% to 10%
10% to 15%
15% to 20%
above 20%
25


Societal Index – not included in example
EQI Component:
Societal Utility (5)
(transformed to a Quality Value)
Time 1 (1995)
Time 2 (2005)
Difference (Time2 - Time1)
0% to 10 %
10% to 20%
20% to 30%
30% to 40%
40% to 50%
50% to 60%
60% to 70%
70% to 80%
80% to 90%
90% to 100%
below -20%
-20% to -15%
-15% to -10%
-10% to -5%
-5% to -2%
-2% to 2%
2% to 5%
5% to 10%
10% to 15%
15% to 20%
above 20%
26

MichiganTech Research Institute

The Environmental Quality Index (EQI)

Meeting Goals & Process

USDA-NRCS Michigan State Office, East Lansing, MI

September 17, 2007

USDA NRCS

www.mtri.org

MichiganTech Research Institute USDA NRCS

Meeting Goals & Objectives

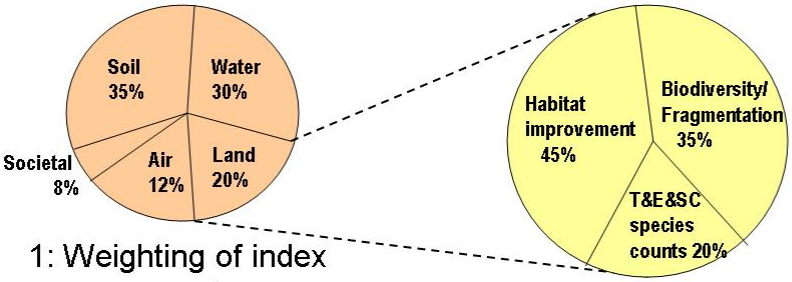
Goals: Develop numerical weighting factors and transfer functions for the inputs to the Environmental Quality Index (EQI) calculation

Objectives:

- Educate NRCS experts on the EQI concept and needs
- Survey/solicit inputs from experts on the potential role of each information product (input) in assessing NRCS conservation program effectiveness
- Advice on weighting factors for EQI at two levels
  - EQI components (soil, water, land, air)
  - EQI inputs with each component
- Revise transformation functions for each EQI input

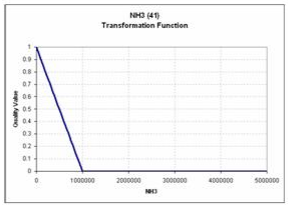
28

Requested Products from Meeting



1: Weighting of index components

2: Weights for index inputs for each component



3: Transformation function relating index input value to quality rating

29

EQI Expert Meeting Process

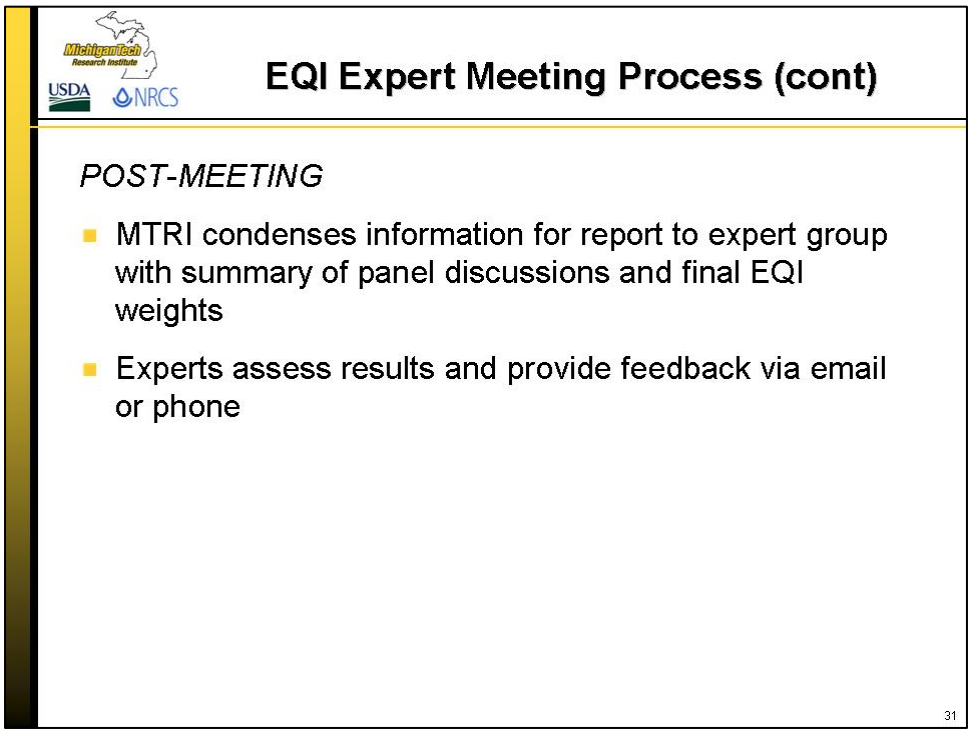
QUESTIONAIRE

- Provide your first thoughts on weighting of EQI components and inputs before breakout group discussions
- Use this to help in focus group discussions

BREAKOUT GROUPS

- Discuss EQI information products & finalize questionnaire responses based on consensus
- Meeting participant reconvene to report out focus group discussions and results and to conduct final discussions

30


MichiganTech
Research Institute
USDA
NRCS
EQI Expert Meeting Process (cont)
POST-MEETING
MTRI condenses information for report to expert group with summary of panel discussions and final EQI weights
Experts assess results and provide feedback via email or phone
31

INPUTS TO THE EQI

Summary list

Input		Units	Where from	Resource Concern or Practice	Notes
Soil condition Index					
11	Soil erosion	tons	EPA STEPL model	Sheet & rill erosion	EPA STEPL model is being investigated - made for watershed assessment
12	HEL treated	% treated	MTRI developed	Gully erosion/mass movement	% HEL acres treated by county
13 & 14	Tillage practice	% conservation	CTIC (Purdue); MTRI developed	conservation tillage practices (329, 344,345,346)	Avail. up to 2002; This data no longer collected for all counties; Derived tillage practice from remote sensing; CSREES research
15	Carbon sequestration	tons	USDA-COMET VR output	Organic matter depletion	Implementation of COMET-VR is under development on the county scale See: http://www.cometvr.colostate.edu/
Surface water health Index					
21 & 22	Lake clarity	index	USGS & MTRI developed	Turbid surface water	USGS has 2002 map of lake clartity (TSI); MTRI developing products for other years using remote sensing & in-situ data
23	Riparian buffers	% forested	MTRI developed	Riparian buffer practice (391)	GIS analysis of USGS land cover with stream networks
Land habitat index					
31	Habitat improvement	acres	MTRI developed	Inadequate cove/shelter/space	Land cover from USGS and State of Michigan analysis of change over time
32	T&E&SC species	count	MNFI	T&E species	Raw counts of special concern animals and plants by county
33	Biodiversity/Fragmentation	index	MTRI developed	Habitat fragmentation	Patch size, shape and edge contrast using FRAGSTATS with USGS land cover
Air quality index					
41	NH3 emissions	kg	EPA- NEI	Ammonia	county-level ammonia emissions from animals and fertilzer is modeled for the National Emissions Inventory (NEI)
42	CH4 emissions	Tg CO2 equiv.	EPA - climate change group	Excessive greenhouse gas - CH4	EPA models CH4 from animal husbandry in its greenhouse gas emissions estimates
43	Particulate levels	density	MTRI developed	PM 2.5 level	MODIS-derived PM2.5 product compared with EPA in-situ measures
Societal utility index					
51	Economic value	dollars	Census of Agriculture		Question of yield or commodity value more valid for EQI

EQI input name	Units of input	Index component
11. Soil erosion	tons	Soil condition index

Origin of data for input measure

STEPL (Spreadsheet Tool for Estimating Pollutant Load) model outputs – an EPA model for assessing sediment load by watershed

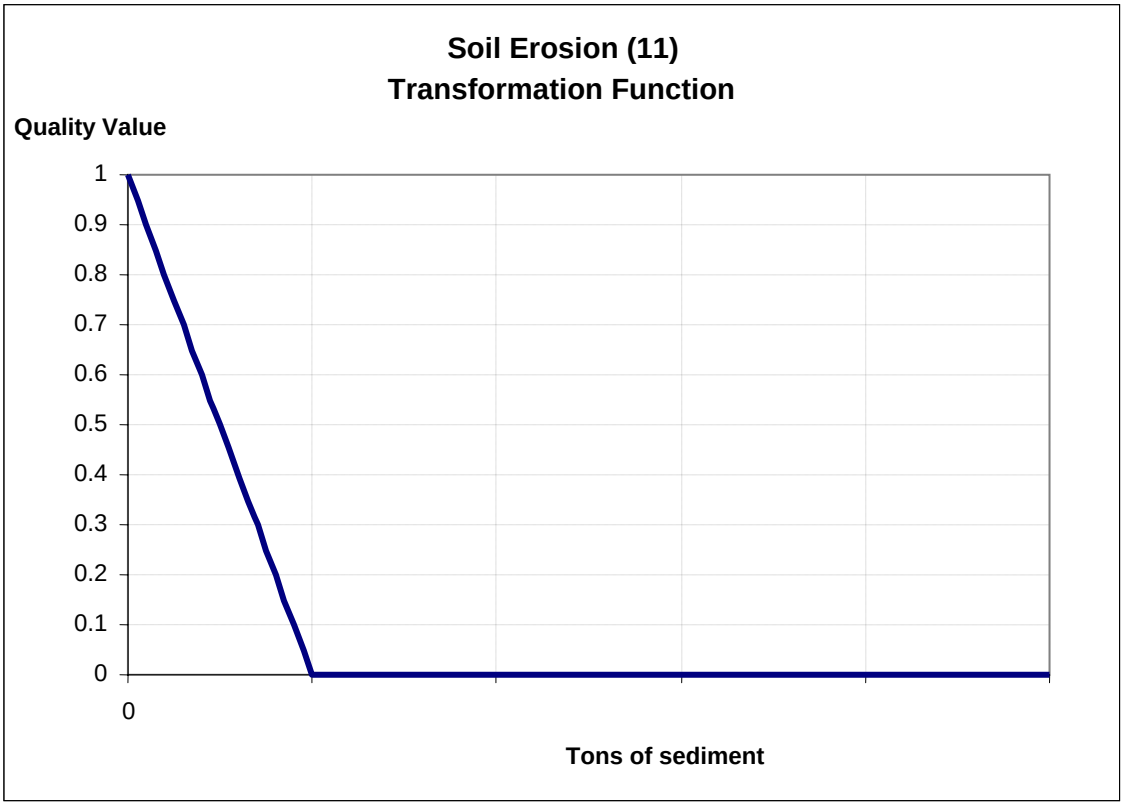
Description of derivation of input

Spreadsheet Tool for Estimating Pollutant Load (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various best management practices (BMPs). STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft (MS) Excel. It computes watershed surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biological oxygen demand (BOD5); and sediment delivery based on various land uses and management practices. For each watershed, the annual nutrient loading is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution and management practices. The annual sediment load (sheet and rill erosion only) is calculated from the Universal Soil Loss Equation (USLE) and the sediment delivery ratio. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using the known BMP efficiencies.

For the EQI, we use outputs of sediment loads from sheet and rill erosion by watershed that are then transformed by area weighting to county-level sediment load estimates.

http://it.tetratech-ffx.com/stepl/default.htm

Transformation Function used in initial EQI analysis



EQI input name	Units of input	Index component
12. HEL land	% treated	Soil condition index

Origin of data for input measure

- *2001 National Land Cover Data (NLCD) land cover map*
- *SSURGO with HEL table*
- *ProTracts data on practice implementations*

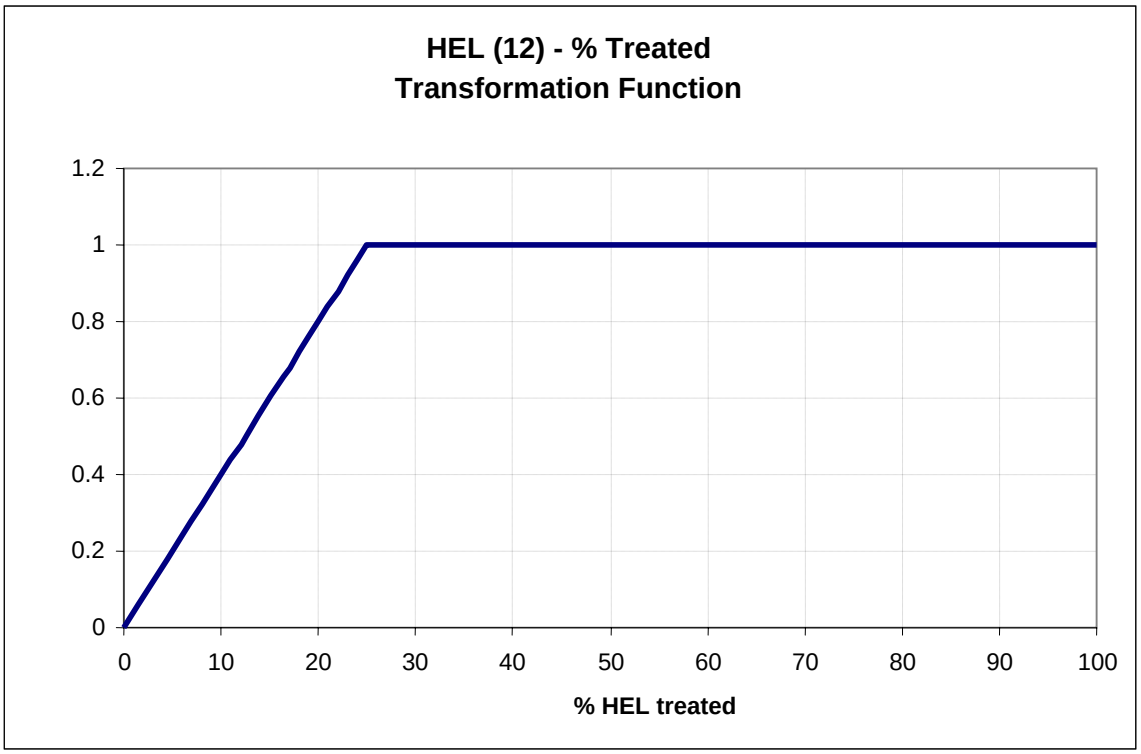
Description of derivation of input

Agricultural land is intersected with HEL and PEL designated soil polygons to assess agricultural areas with HEL/PEL.

Total area of agricultural HEL is compared with HEL erosion control practice data to produce % of HEL treated.

See Sept 2005 project report from the cooperative agreement for a more detailed description of treated HEL analysis and product

Transformation Function used in initial EQI analysis



EQI input name	Units of input	Index component
13. Tillage practice	Percent of conservation tillage	Soil Condition Index

Origin of data for input measure

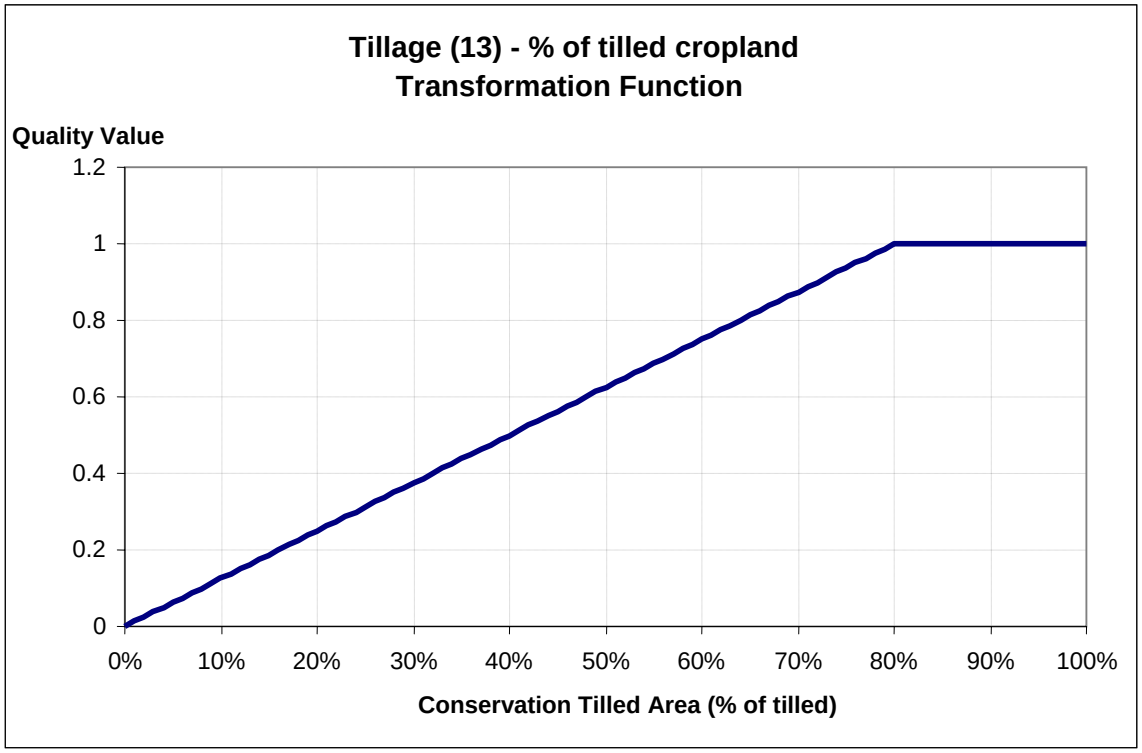
County-level tillage practice data from the Conservation Technology Information Center (CTIC) based at Purdue University (http://www.ctic.purdue.edu/).

Description of derivation of input

Field survey data collected by the Conservation Technology Information Center, capturing conservation (no-till, ridge-till, and mulch-till methods) and conventional (intensive and reduced tillage methods) tillage practices by county is linked within a GIS to county boundary data to model the distribution of tillage practices across the state.

Tillage practice is presented as a percentage of tilled acres using conservation tillage practice.

Transformation Function used in initial EQI analysis



EQI input name	Units of input	Index component
14. Tillage practice by mapped crop residue cover	% of conservation tillage	Soil Condition Index

Origin of data for input measure

MTRI-developed process of image analysis of Landsat, ASTER, and other remote sensing image data.

Description of derivation of input

Expanding upon methods described in the literature, MTRI uses multi-spectral remote sensing data and advanced statistical and image processing techniques to distinguish bare soils from crop residues to estimate and map crop residues and tillage practices.

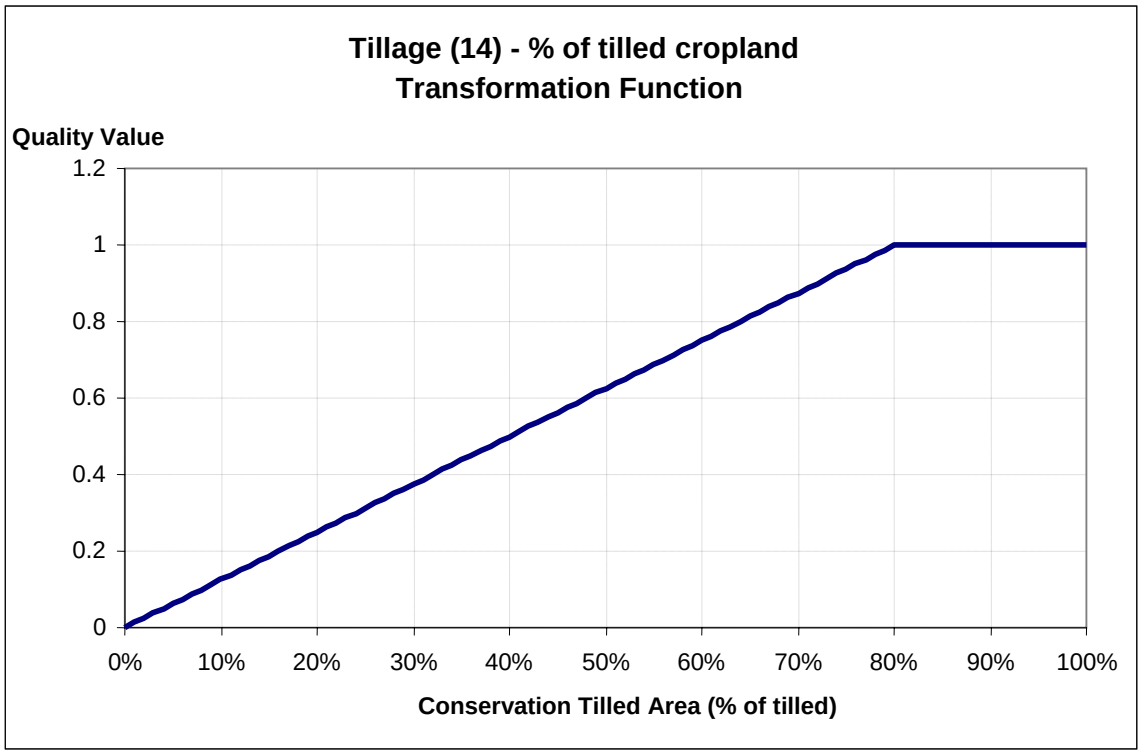
The output is percent of tilled acres in conservation tillage.

Bannari, A., D. Haboudane, H. McNairn, and F. Bonn. 2000. Modified Soil Adjusted Crop Residue Index (MSACRI): A new index for mapping crop residue. IGARSS 2000, 24-28 July, Honolulu, Hawaii, 2000:2936:2938.

Bannari, A, M Chevrier, K Staenz, H McNairn - 2003. Senescent vegetation and crop residue mapping in agricultural lands using artificial neutral networks and hyperspectral remote sensing. IGARSS 2003, 21-25 July 2003:4292:4294,

Vina, A., Peters, AJ., Lei Ji. 2003. Use Of Multispectral Ikonos Imagery For Discriminating Between Conventional And Conservation Agricultural Tillage Practices. Photogrammetric Engineering and Remote Sensing. Vol. 69, No. 5, May 2003:537:544

Transformation Function used in initial EQI analysis



EQI input name	*Units of input*	*Index component*
15. Carbon Sequestration	Tons	Soil condition index

Origin of data for input measure

COMET-VR model outputs – used to assess soil carbon sequestration/emissions

Description of derivation of input

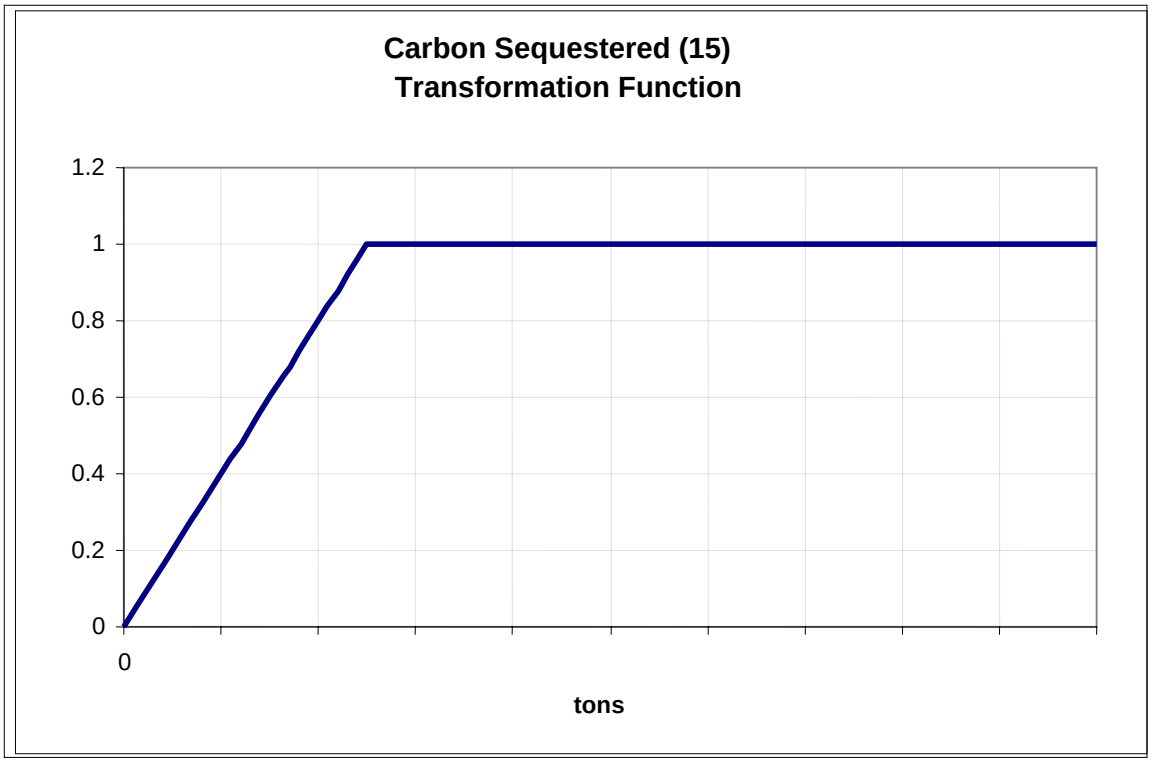
The **V**oluntary **R**eporting of Greenhouse Gases-**C**arb**O**n **M**anagement **E**valuation **T**ool (COMET-VR) tool is a decision support tool for agricultural producers, land managers, soil scientists and other agricultural interests.

COMET-VR provides an interface to a database containing land use data from the Carbon Sequestration Rural Appraisal (CSRA) and calculates in real time the annual carbon flux using a dynamic Century model simulation.

Users of COMET-VR specify a history of agricultural management practices on one or more parcels of land. The results are presented as ten year averages of soil carbon sequestration or emissions with associated statistical uncertainty values. Estimates can be used to construct a soil carbon inventory for the 1605(b) program.

See http://www.cometvr.colostate.edu/

Transformation Function used in initial EQI analysis



EQI input name	Units of input	Index component
21. Lake Clarity	index	Surface Water Health

Origin of data for input measure

- *In-situ water quality measurements from EPA, USGS, MDEQ, and volunteer networks*
- *Landsat TM/ETM+ remote sensing image data analysis*

Description of derivation of input

Using methods developed by the University of Wisconsin and implemented by the USGS in the Upper Midwest, a regression model and image processing algorithm is used to relate *in-situ* turbidity and chlorophyll-*a* measurements to large (> 20 acre) lakes in the Landsat imagery and calculate an index value representing the trophic state of a water body at the time the image was collected.

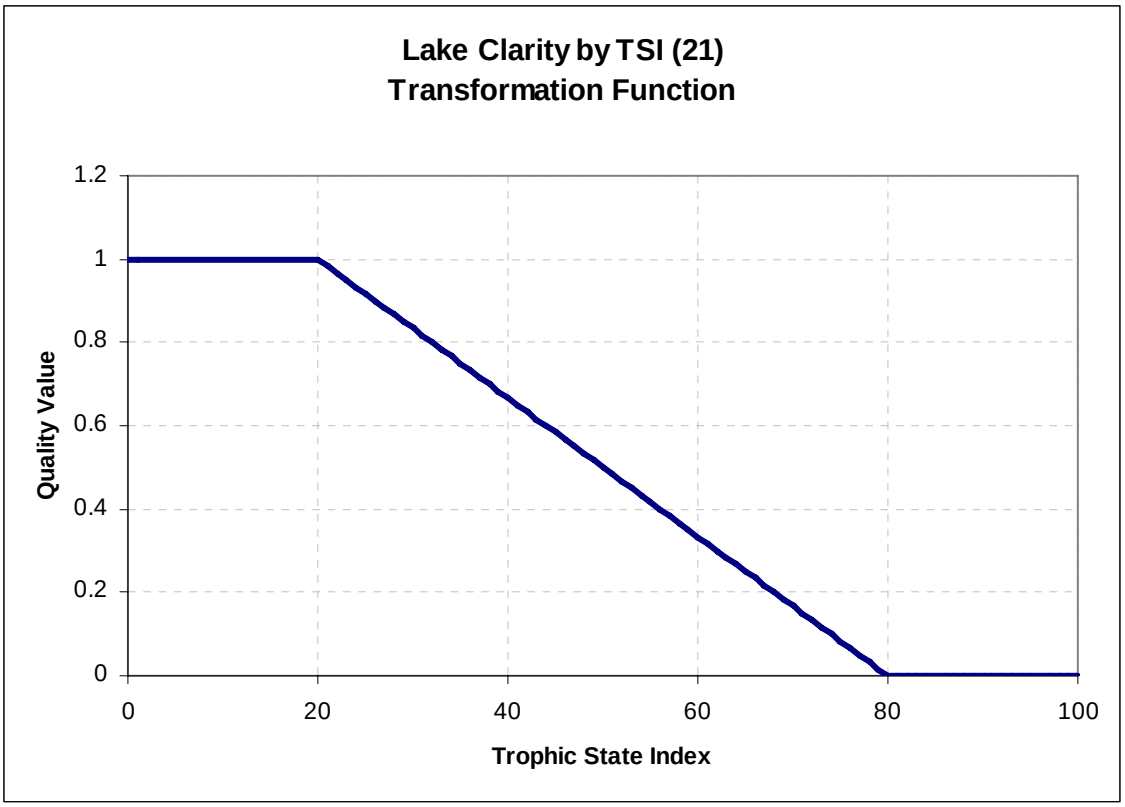
Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. 22:361-369.

Fuller, L.M, S.S. Aichele, and R.J. Minnerick, 2004, Predicting Water Quality by Relating Secchi-Disk Transparency and Chlorophyll a Measurements to Satellite Imagery for Michigan Inland Lakes, August 2002, U.S. Geological Survey Scientific Investigations Report 2004-5086 http://pubs.usgs.gov/sir/2004/5086/

Kloiber, S.M., Brezonik, P.L., Olmanson, L.G., and Bauer, M.E., 2002, A procedure for regional lake water clarity assessment using Landsat multispectral data: Remote Sensing of Environment, v. 82, p. 38–47.

Lillesand, T.M., Johnson, W.L., Deuell, R.L., Lindstrom, O.M., and Meisner, D.E., 1983, Use of Landsat data to predict the trophic state of Minnesota lakes: Photogrammetric Engineering and Remote Sensing, v. 49, no. 2, p. 219–229.

Transfer Function used in initial EQI analysis



EQI input name	Units of input	Index component
23. Riparian buffers	% forested	Surface Water Health

Origin of data for input measure

- *1995 and 2001 land cover maps from NOAA Coastal Change Analysis Program (C-CAP)*
- *2007 National Hydrography Dataset (NHD)*

Description of derivation of input

NHD high-resolution stream lines were buffered by 100 meters on each side to capture a reasonable extent of riparian vegetation. Areas of forest (and wetland) were calculated using ESRI GIS software by intersecting the buffered streams with the 1995 and 2001 C-CAP land cover data created with Landsat satellite imagery and field work.. The total amounts of forest with 100-m of each side of the streams were summarized by county, and were converted into a percent of the total buffered area adjacent to streams.

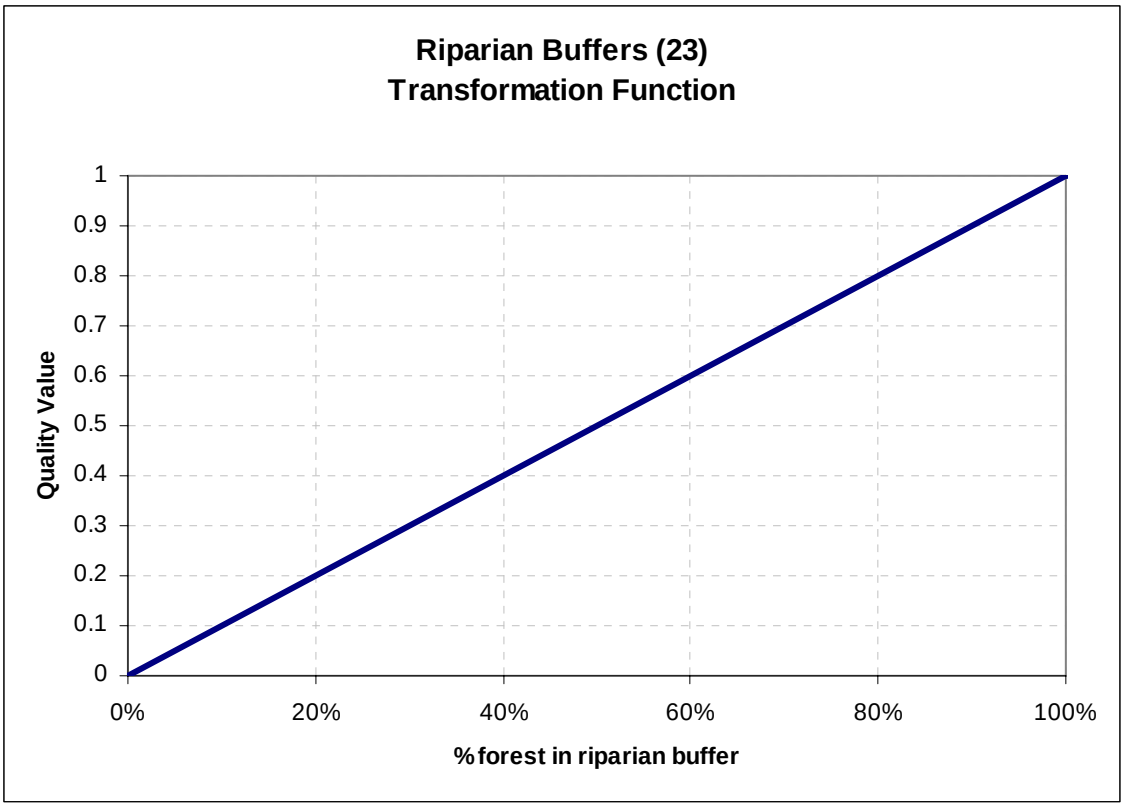
This analysis method answers the question of how much forest cover is adjacent to streams, and can be tracked over time and calculated historically using standardized land cover maps and satellite imagery analysis.

Abel, R. and J.D.Allan. 2002. Riparian shade and stream temperatures in an agricultural catchment, Michigan, USA. Verh. Internat. Verein. Limnol. Vol. 28, pgs. 232-237.

Environment Canada. 2004. "How Much Habitat is Enough" 2nd Edition, Great Lakes Fact Sheet. www.on.ec.gc.ca/wildlife

Goetz, S.J. 2006. Remote sensing of riparian buffers: Past progress and future prospects. Journal of the American Water Resources Association, February 2006, pgs. 133-143.

Transfer Function used in initial EQI analysis



EQI input name	Units of input	Index component
31. Habitat improvement	% of area improved	Land habitat index

Origin of data for input measure

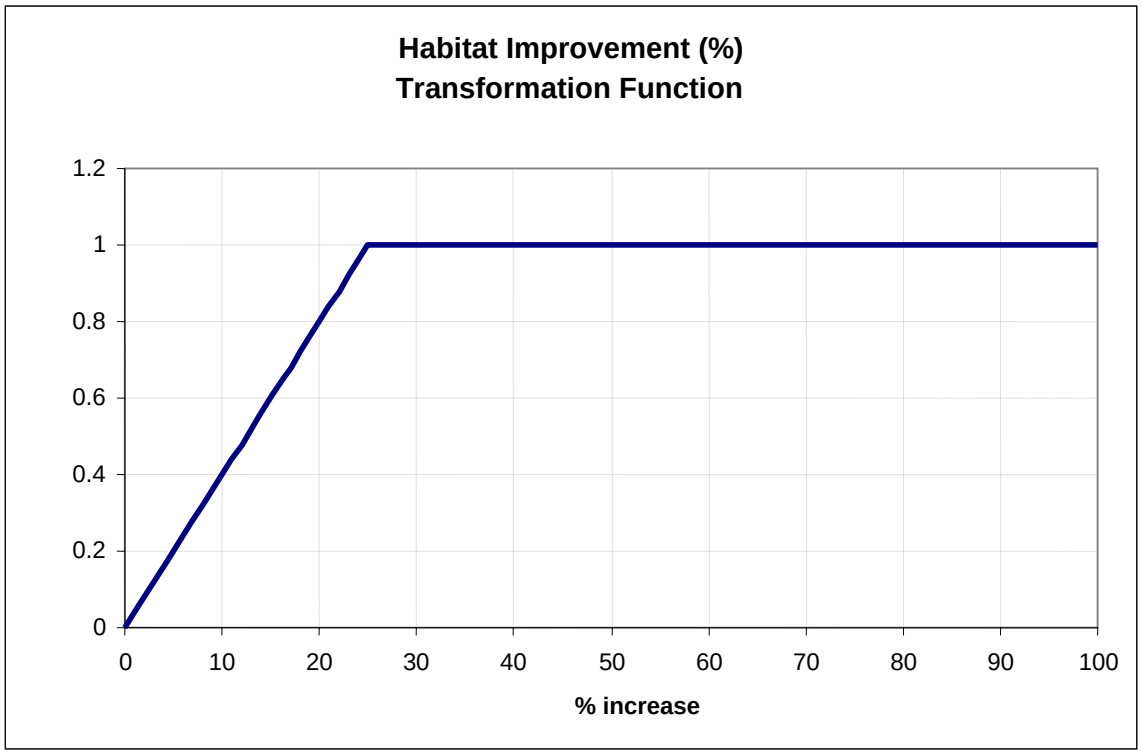
- *1996 and 2001 C-CAP (Coastal Change Analysis Program) land cover classifications and change*
- *1978 MIRIS land use maps*

Description of derivation of input

The C-CAP land cover maps are created using Landsat TM/ETM+ images from 1995 and 2001. MIRIS is a set of maps showing land use by county from air photos collected c. 1978. An increase or decrease in land cover is computed from the remote sensing-derived land cover classifications. The following land cover categories are used to assess wildlife habitat change by county:

1. Grassland
2. Forest
3. Scrub/Shrub
4. Wetland

Transfer Function used in initial EQI analysis



EQI input name	Units of input	Index component
32. T&E&SC species	count	Land Habitat Health

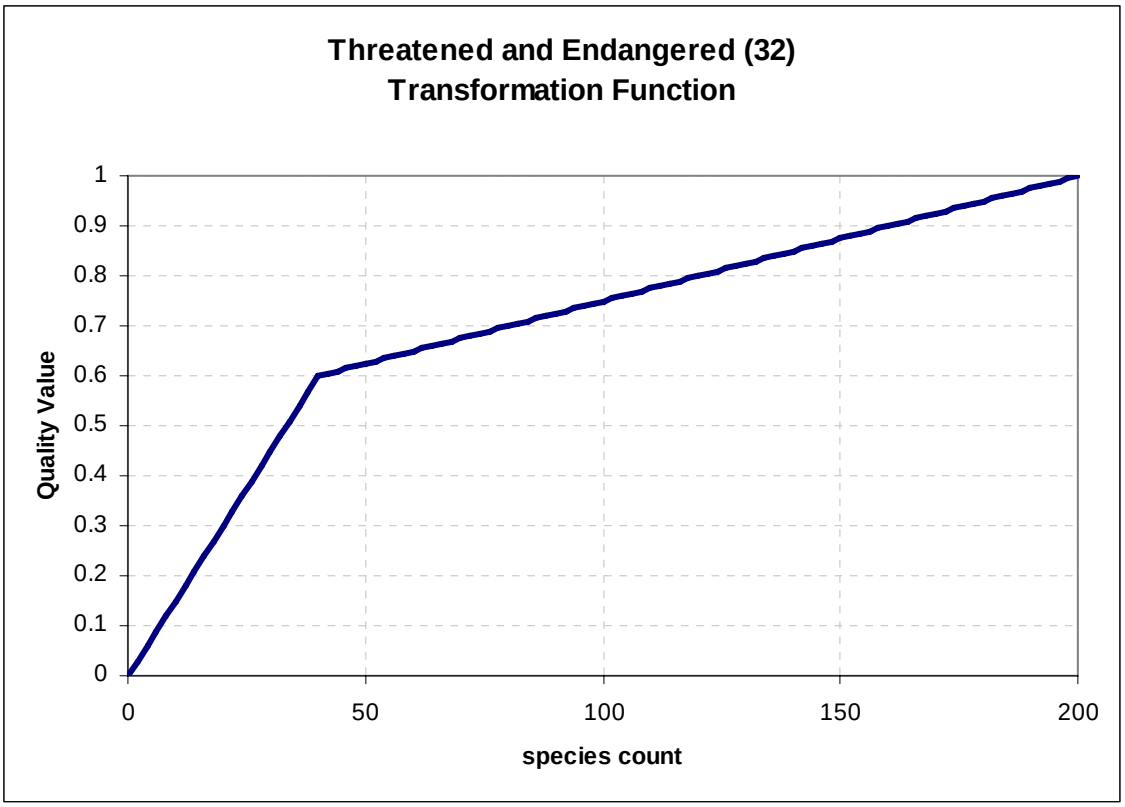
Origin of data for input measure

Michigan Natural Features Inventory (MNFI)

Description of derivation of input

A count of the numbers of state endangered, threatened, and special concern plant and animal species is derived from MNFI census data collected for each county.

Transformation Function used in initial EQI analysis



EQI input name	*Units of input*	*Index component*
33. Fragmentation	(*varies - see description*)	Land habitat index

Origin of data for input measure

Land cover from 1996 and 2001 C-CAP (Coastal Change Analysis Program)

Description of derivation of input

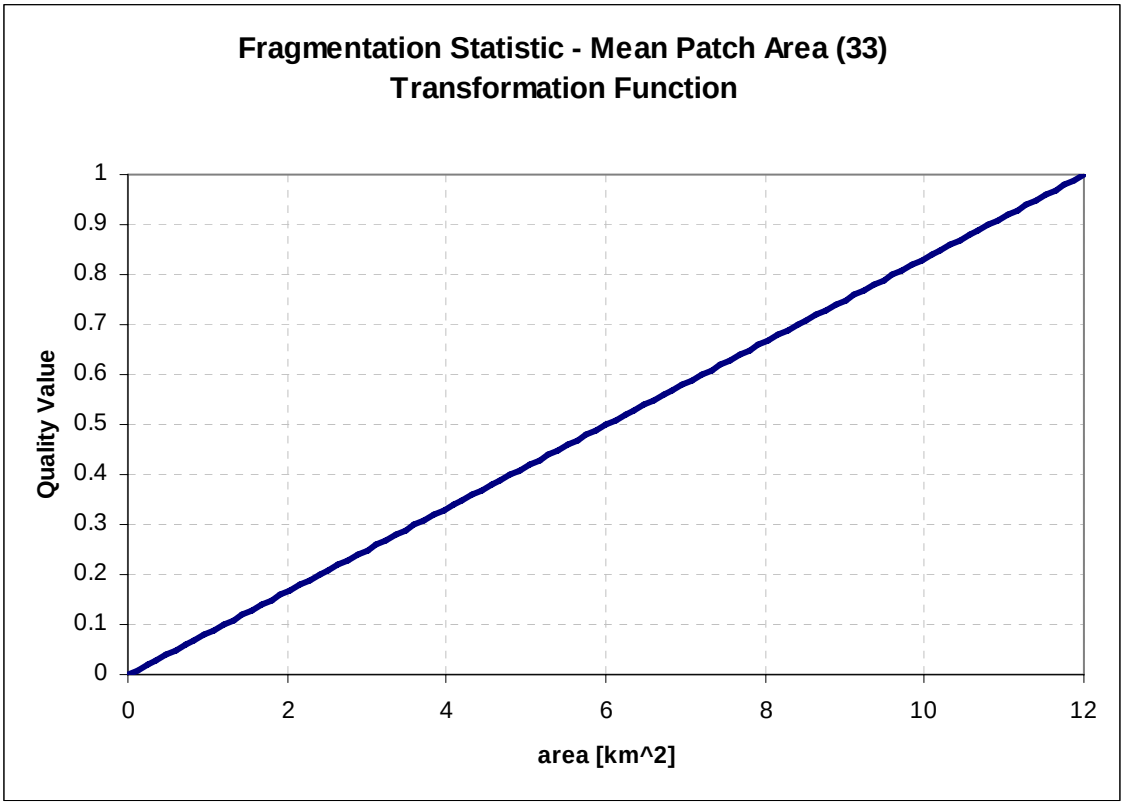
Land cover classes (originally 19) were collapsed into the following categories:

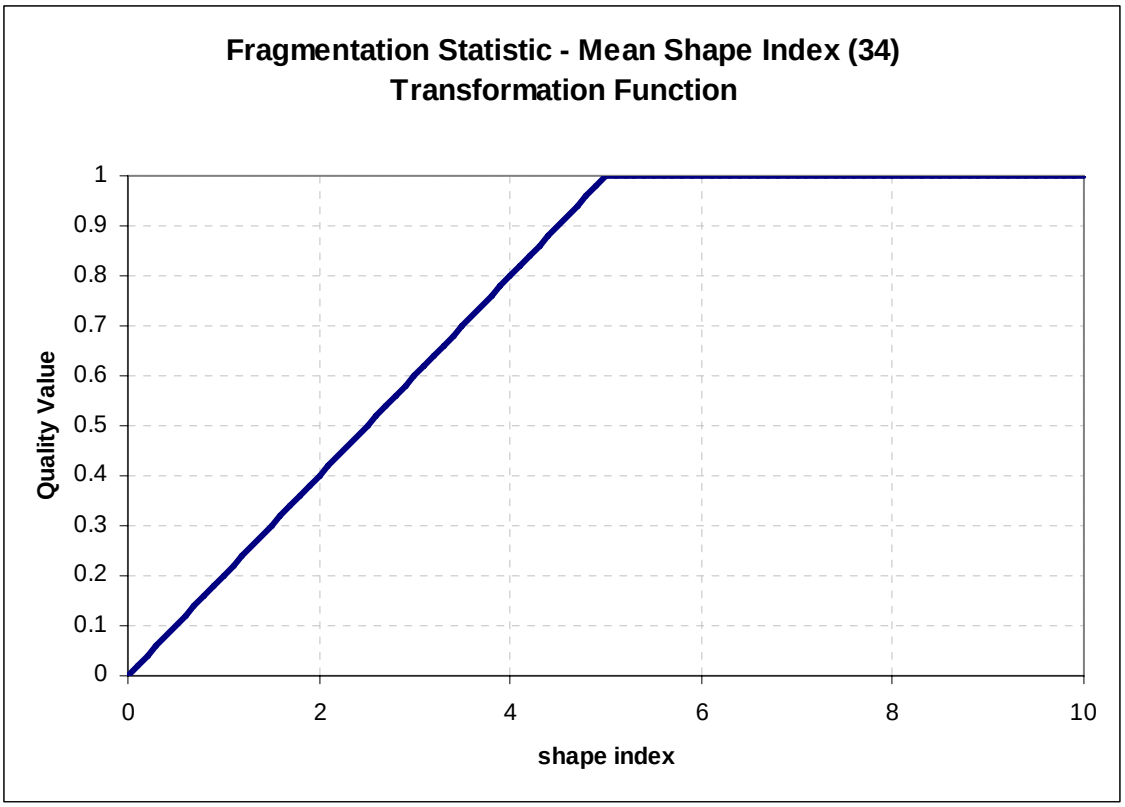
1. Unclassified
2. Developed
3. Cultivated Land
4. Grassland
5. Forest
6. Scrub/Shrub
7. Wetland
8. Bare Land
9. Water

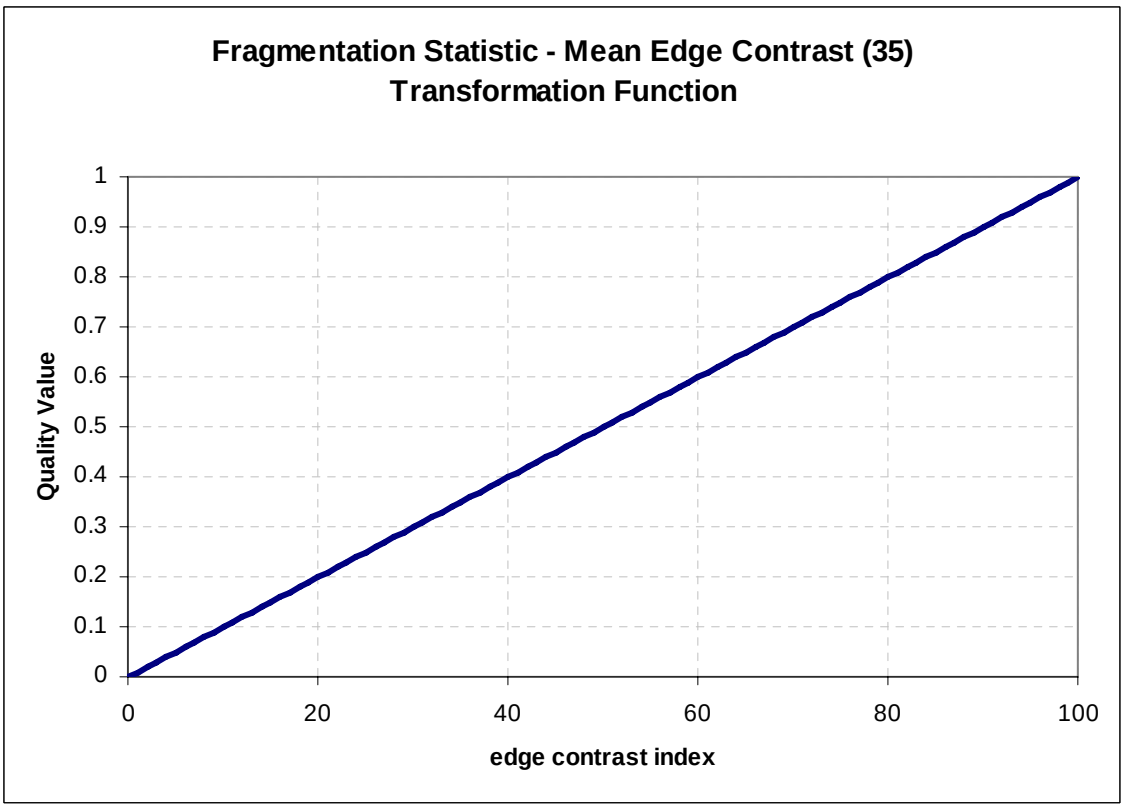
Fragmentation metrics are calculated using FRAGSTATs, a popular spatial statistics program freely distributed by the University of Massachusetts. The three fragmentation measures are:

5. Patch Area (km^2) – mean patch area
6. Shape Index (unitless) – On a scale starting at one and increasing indefinitely, this metric tests the perimeter of a patch against the perimeter of the patch if it were reduced to a square. Hence, the more square a patch is the closer the metric is to one.
7. Edge Contrast (ratio, 0 to 100) – Measures the 'strength' of transition between land covers of differing types. 'Strengths' are determined subjectively through an edge contrast weights table containing a weight for each possible land cover transition.

Transformation Function used in initial EQI analysis




Fragmentation Statistic - Mean Shape Index (34)
Transformation Function
Quality Value
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
shape index


Fragmentation Statistic - Mean Edge Contrast (35)
Transformation Function
Quality Value
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
edge contrast index

EQI input name	Units of input	Index component
41. Ammonia Emissions	kg (month and year)	Air Quality Index

Origin of data for input measure

EPA National Emissions Inventory (NEI)

Description of derivation of input

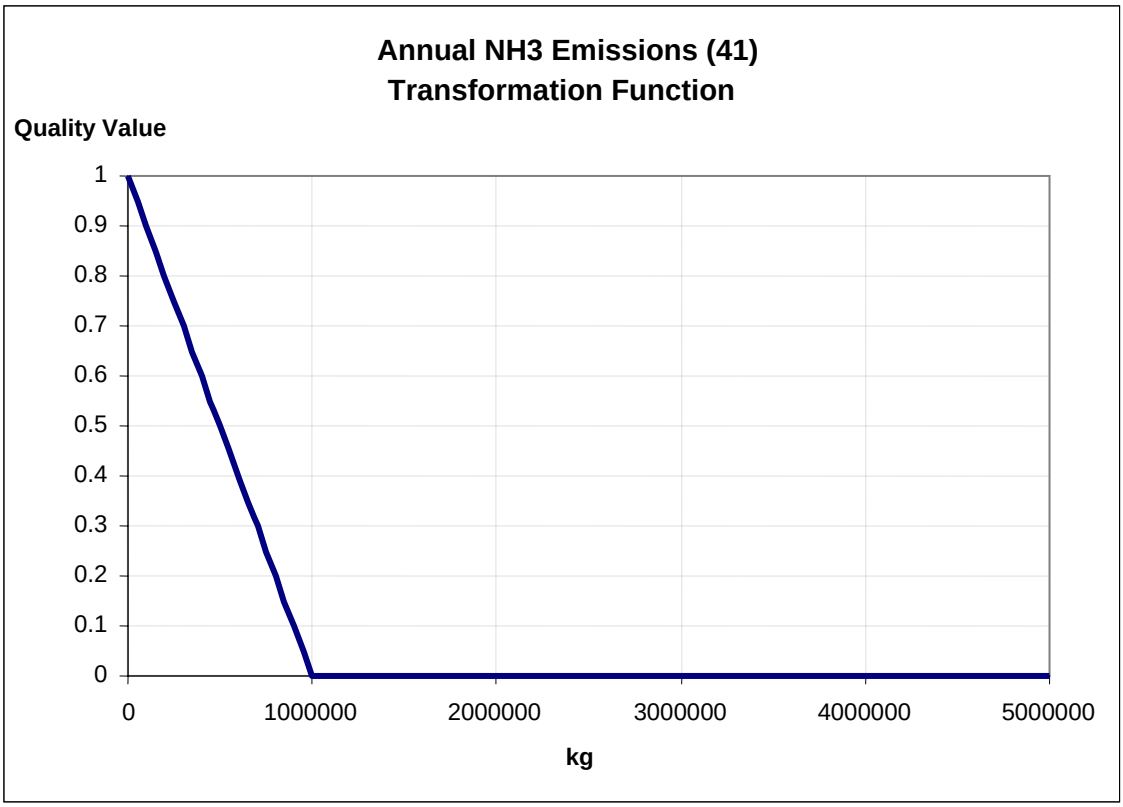
An ammonia emissions inventory model, developed at Carnegie Mellon University for EPA, is used to characterize the amount of ammonia (NH_3) emissions in each Michigan county from agricultural sources.

Agricultural sources consist of livestock (Dairy Cattle, Beef Cattle, Swine, Goats, Poultry, and Turkey) operations and fertilizer applications. Activity levels are derived from the Census of Agriculture for livestock operations and from the Association of American Plant Food Control Officials (AAPFCO) for fertilizer applications. The model output consists of county-level NH_3 emissions, expressed in kilograms, by month, or totaled for the year.

USDA, 2002. "2002 Census of Agriculture." http://www.agcensus.usda.gov/

Association of American Plant Food Control Officials (AAPFCO), 2002. Commercial Fertilizers 2002.

Transfer Function used in initial EQI analysis



EQI input name	Units of input	Index component
42. Methane emissions	kg	Air Quality Index

Origin of data for input measure

- *U.S. EPA U.S. Greenhouse Gas Inventory Reports*

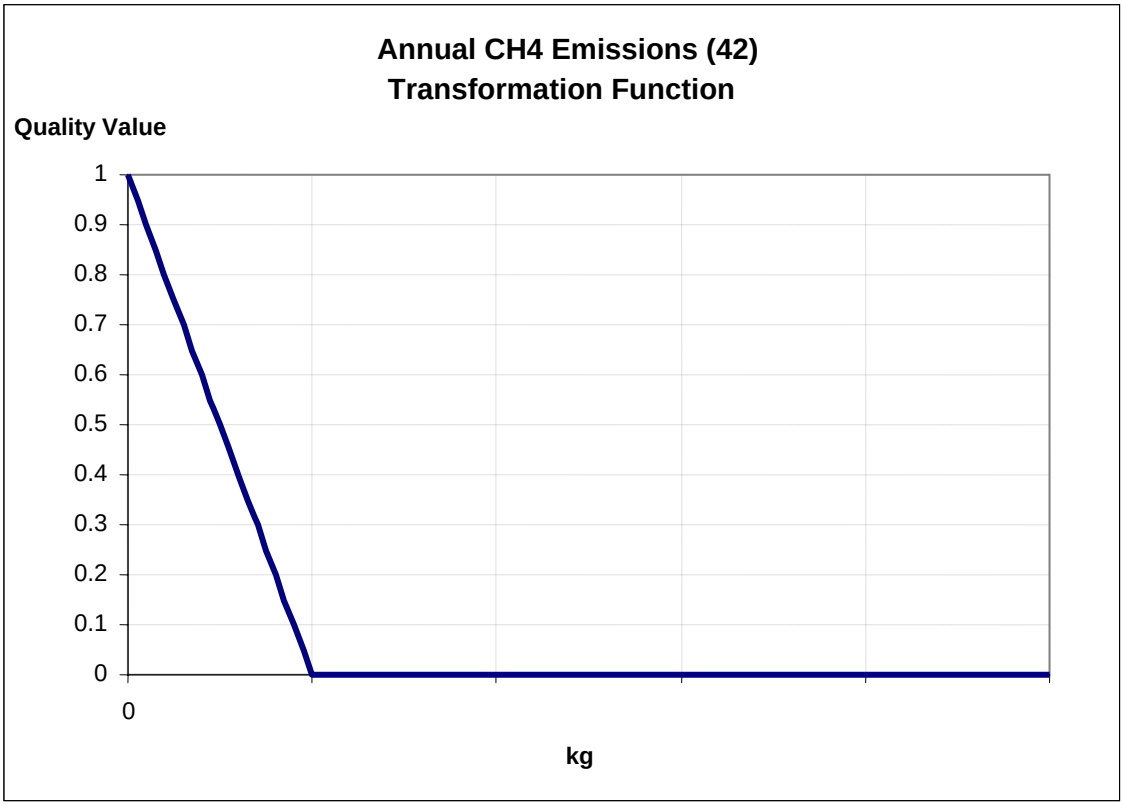
Description of derivation of input

US Environmental Protection Agency (EPA) greenhouse gas emissions reports for agricultural sources of methane (enteric fermentation, manure management, and soil management) are used to characterize methane emissions over time for each county.

U.S. Greenhouse Gas Inventory Reports.
http://www.epa.gov/climatechange/emissions/usinventoryreport.html

http://yosemite.epa.gov/oar/globalwarming.nsf/content/
/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2005.html

Transformation Function used in initial EQI analysis



EQI input name	*Units of input*	*Index component*
43. Particulate levels	$\mu g/m^3$	Air Quality Index

Origin of data for input measure

- *NASA Level1 and Atmospheric Archive and Distribution System (LAADS)*
- *U.S. EPA Air Quality System (AQS)*
-

Description of derivation of input

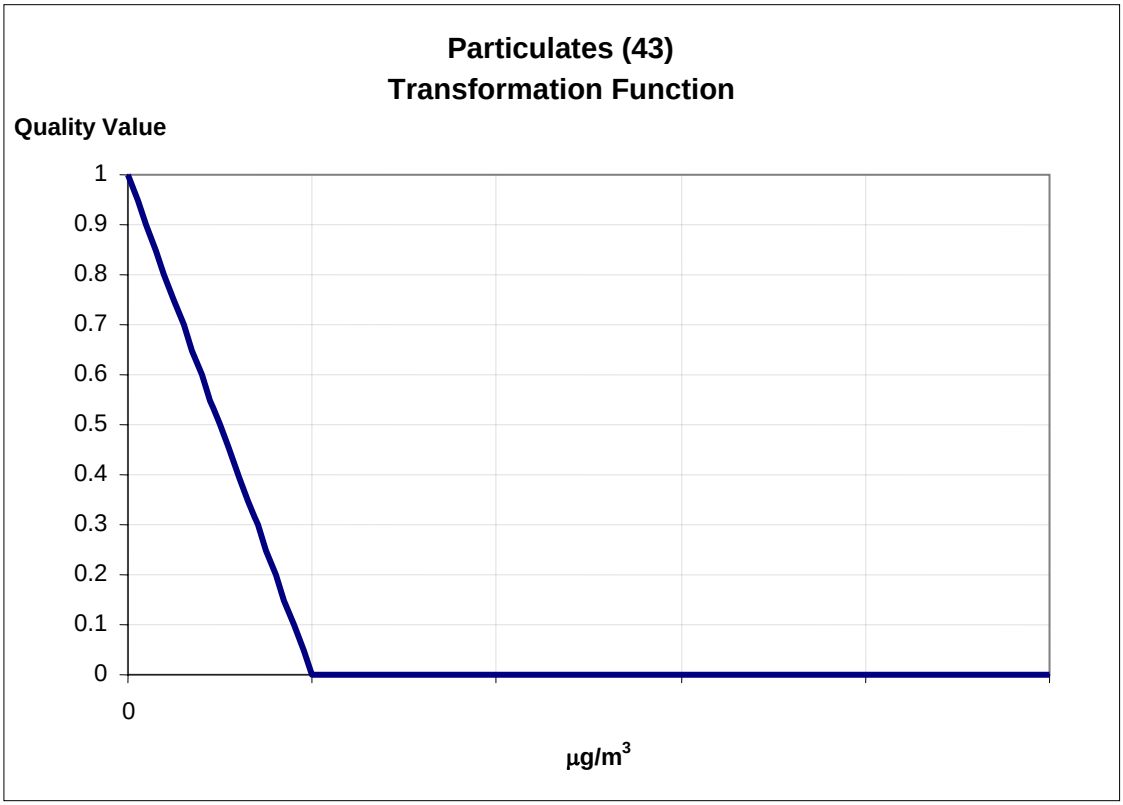
An estimate of particulate concentrations may be derived using data from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor in conjunction with a statistical analysis of US Environmental Protection Agency (EPA) air quality monitoring data.

Engel-Cox, J. A., C. H. Holloman, B. W. Coutant, and R. M. Hoff (2004), Qualitative and quantitative evaluation of MODIS satellite sensor data for regional and urban scale air quality, Atmos. Environ., 38(16), 2495 – 2509.

Liu, Y., R.J. Park, D.J. Jacob, Q. Li, V. Kilaru, and J.A. Sarnat. 2004. Mapping Annual Mean Ground-Level PM2.5 Concentrations Using Multiangle Imaging Spectroradiometer Aerosol Optical Thickness over the Contiguous United States. Journal of Geophysical Research 109 D22206, doi: 10.1029/2004JD005025.

Liu, Y., J.A. Sarnat, V. Kilaru, D.J. Jacob, and P. Koutrakis. 2005. Estimating Ground-Level PM2.5 in the Eastern United States Using Satellite Remote Sensing. Environmental Science and Technology 39: 3269–78.

Transfer Function used in initial EQI analysis



EQI input name	Units of input	Index component
51. Economic Value	($1,000)	Societal Utility Index

Origin of data for input measure

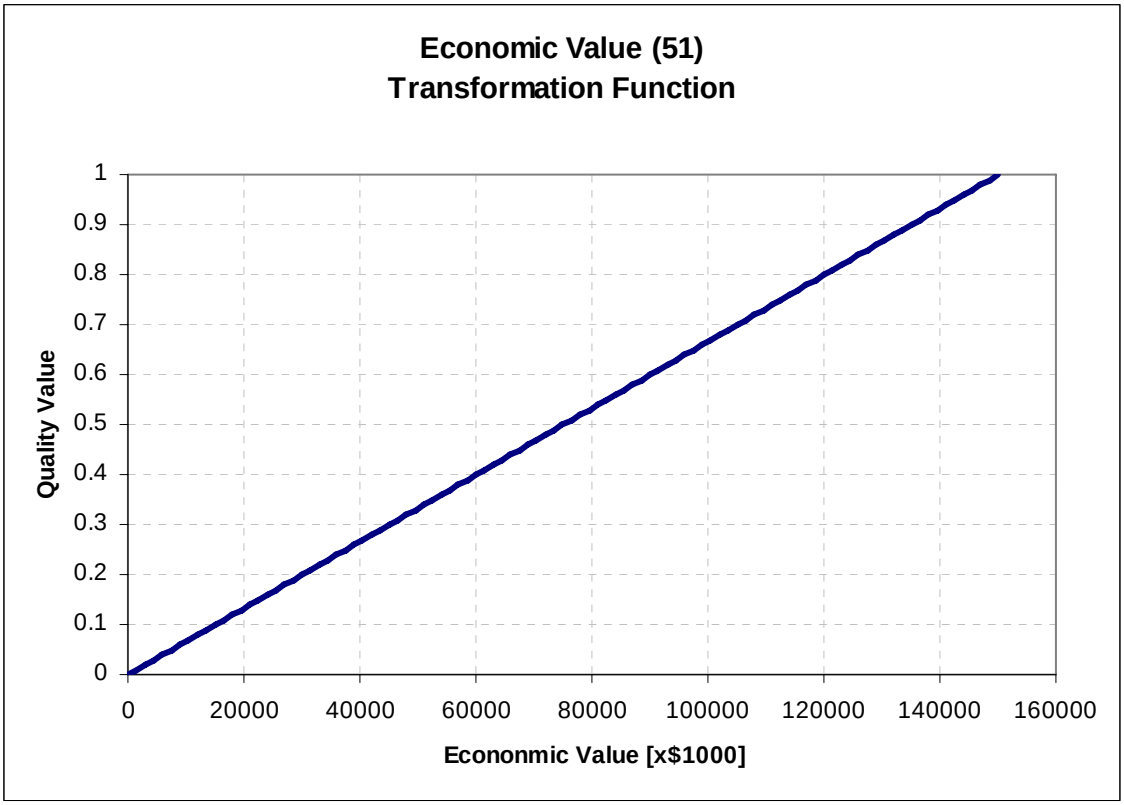
- *USDA, 2002. "2002 Census of Agriculture." http://www.agcensus.usda.gov/*
- *USDA, 1997. "1997 Census of Agriculture." http://www.agcensus.usda.gov/*

Description of derivation of input

The gross market value before taxes and production expenses of all agricultural products sold or removed regardless of who received the payment. It is equivalent to total sales and includes both crops and livestock. It does not include income from farm-related sources such as customwork and other agricultural services, or income from nonfarm sources.

Market Value of Agricultural Products Sold Including Direct and Organic: 2002 and 1997. 2002 Census of Agriculture. Volume 1 Chapter 2: Michigan County Level Data. http://www.nass.usda.gov/census/census02/... volume1/mi/st26_2_002_002.pdf

Transformation Function used in initial EQI analysis



Attachment C

Agenda (as conducted)
[NOTE: Planned agenda is given in briefing slides. Attachment A]

9:00 – 10:30	Workshop purpose, approach & expected outcome
10:30 – 10:45	NRCS participants fill out initial questionnaire
10:45 – 11:00	Breakout session assignments
11:00 – 12:00	Breakout sessions
	Group 1: Soil & Water quality discussions
	Group 2: Land habitat & Air quality discussions
12:00 – 1:00	Lunch (on your own)
1:00 – 2:45	Review of weightings & transformations for each input with all
2:45 – 3:00	Final discussions & wrap-up

Attachment D

The Environmental Quality Index (EQI): Experts Meeting & Workshop
USDA-NRCS Michigan State Office, East Lansing, MI
September 17, 2007

Participant List

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Jerry Grigar	jerry.grigar@mi.usda.gov, 517-324-5250
Gary Rinkenberger	gary.rinkenberger@mi.usda.gov, 517-324-5266
Lynn Sampson	lynn.sampson@mi.usda.gov, 517-324-5267
Ruth Shaffer	ruth.shaffer@mi.usda.gov, 517-324-5239

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Robert Shuchman	shuchman@mtu.edu, 734-913-6860
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Michelle Wienert	mwienert@mtu.edu, 734-913-6870

Environmental Quality Index (EQI)
component/input weighting questionnaire

Describe your area(s) of expertise:

Name (optional):

INSTRUCTIONS:

1. Complete Sections A & B of the questionnaire before the breakout session by filling in the "initial" column (*)
2. Determine a final weighting after breakout session discussions; they need not change nor comply with consensus of breakout group (**)

Section A. EQI component weighting:

1. How would you weight the EQI components (groupings). Your weights should add up to 100%:

		initial*	final**
1	Soil condition	_____	_____
2	Surface water health	_____	_____
3	Land habitat	_____	_____
4	Air quality	_____	_____
5	Societal utility	_____	_____
	Total	100%	100%

2. Do these five components (groupings) cover the resource concerns that should be included in evaluation of program effectiveness for this program? Please comment.

Environmental Quality Index (EQI)
component/input weighting questionnaire

Section B. Weighting of index inputs:
Please fill out within your area of expertise and any other areas to which you would like to contribute

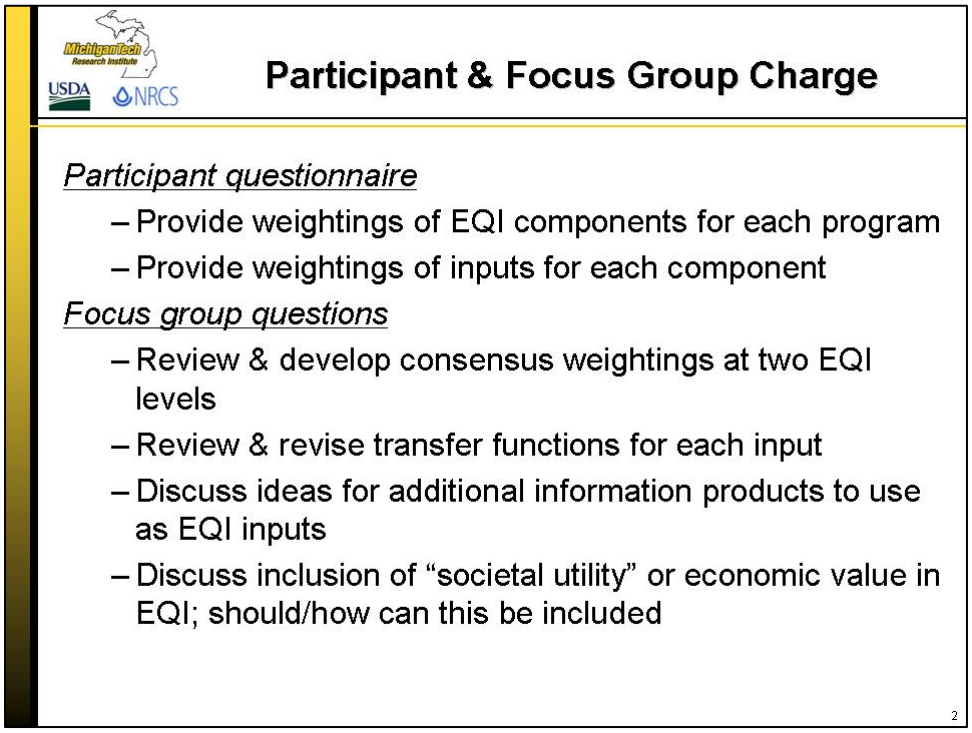
3. Weight the inputs for each component. Weights should add up to 100% for each component group.

		initial*	final**
1 Soil condition index			
11	Soil erosion reduction	_____	_____
12	HEL treated	_____	_____
13/14	Tillage practice	_____	_____
15	Carbon sequestration	_____	_____
	Total	100%	100%
2 Surface water heath index			
21/22	Lake clarity	_____	_____
23	Riparian buffers	_____	_____
	Total	100%	100%
Land habitat index			
31	Habitat improvement	_____	_____
32	T&E&SC species counts	_____	_____
33	Biodiversity/Fragmentation	_____	_____
	Total	100%	100%
Air quality index			
41	Ammonia (NH_3) emissions	_____	_____
42	CH_4 emissions	_____	_____
43	Particulate levels	_____	_____
	Total	100%	100%
Societal utility index			
51	Economic value	_____	_____
50	Other	_____	_____
	Total	100%	100%

4. Do these inputs cover the resource concerns that should be included in evaluation of program effectiveness for this program? Please comment (use back of page if necessary)

Additional comments (use back of page):


MichiganTech Research Institute
The Environmental Quality Index (EQI)
Workshop assignment
USDA-NRCS Michigan State Office, East Lansing, MI
September 17, 2007
USDA
NRCS
www.mtri.org


Participant & Focus Group Charge
Participant questionnaire
– Provide weightings of EQI components for each program
– Provide weightings of inputs for each component
Focus group questions
– Review & develop consensus weightings at two EQI levels
– Review & revise transfer functions for each input
– Discuss ideas for additional information products to use as EQI inputs
– Discuss inclusion of "societal utility" or economic value in EQI; should/how can this be included
2

Questionnaire sample

Section A. EQI component weighting:

1. How would you weight the EQI components (groupings). Your weights should add up to 100%:

		initial*	final**
1	Soil condition	_____	_____
2	Surface water health	_____	_____
3	Land habitat	_____	_____
4	Air quality	_____	_____
5	Societal utility	_____	_____
	Total	100%	100%

2. Do these five components (groupings) cover the resource concerns that should be included in evaluation of program effectiveness for this program? Please comment.

3

Questionnaire sample (cont)

Section B. Weighting of index inputs:

3. Please fill out within your area of expertise and any other areas to which you would like to contribute

Weight the inputs for each component. Weights should add up to 100% for each component group.

1 Soil condition index

11	Soil erosion reduction	_____	_____
12	HEL treated	_____	_____
13/14	Tillage practice	_____	_____
15	Carbon sequestration	_____	_____
	Total	100%	100%

⋮ MORE

4. Do these inputs cover the resource concerns that should be included in evaluation of program effectiveness for this program? Please comment (use back of page if necessary)

4

Breakout slide 1
Component weighting

- Review and discuss weightings of the five (5) EQI components (groupings):

Component	Weight (consensus)
Soil Condition Index	_____
Surface Water Health Index	_____
Land Habitat Index	_____
Air Quality Index	_____
Societal Utility Index	_____

BOTH GROUPS

5

Breakout slide 2
Component weighting (cont)

- Do these five components (groupings) cover the resource concerns that should be included in evaluation of program effectiveness for this program?

- Summary of discussions of component weighting

BOTH GROUPS

6

Breakout slide 3
Weighting of index inputs

- Weight the inputs for each component. Weights should add up to 100% for each component group.

1 Soil condition index		
11	Soil erosion reduction	_____
12	HEL treated	_____
13/14	Tillage practice	_____
15	Carbon sequestration	_____
	Total	100%
2 Surface water heath index		
21/22	Lake clarity	_____
23	Riparian buffers	_____
	Total	100%

GROUP 1

7

Breakout slide 4
Weighting of index inputs (cont)

- Weight the inputs for each component. Weights should add up to 100% for each component group.

Land habitat index		
31	Habitat improvement	_____
32	T&E&SC species counts	_____
33	Biodiversity/Fragmentation	_____
	Total	100%
Air quality index		
41	Ammonia (NH3) emissions	_____
42	CH4 emissions	_____
43	Particulate levels	_____
	Total	100%

GROUP 2

8

Breakout slide 5
Weighting of index inputs (cont)

- Weight the inputs for each component. Weights should add up to 100% for each component group.

Societal utility index

51	Economic value	_____
50	Other	_____
	Total	100%

- Discuss the inclusion of societal utility as a component of the EQI.

BOTH GROUPS

9

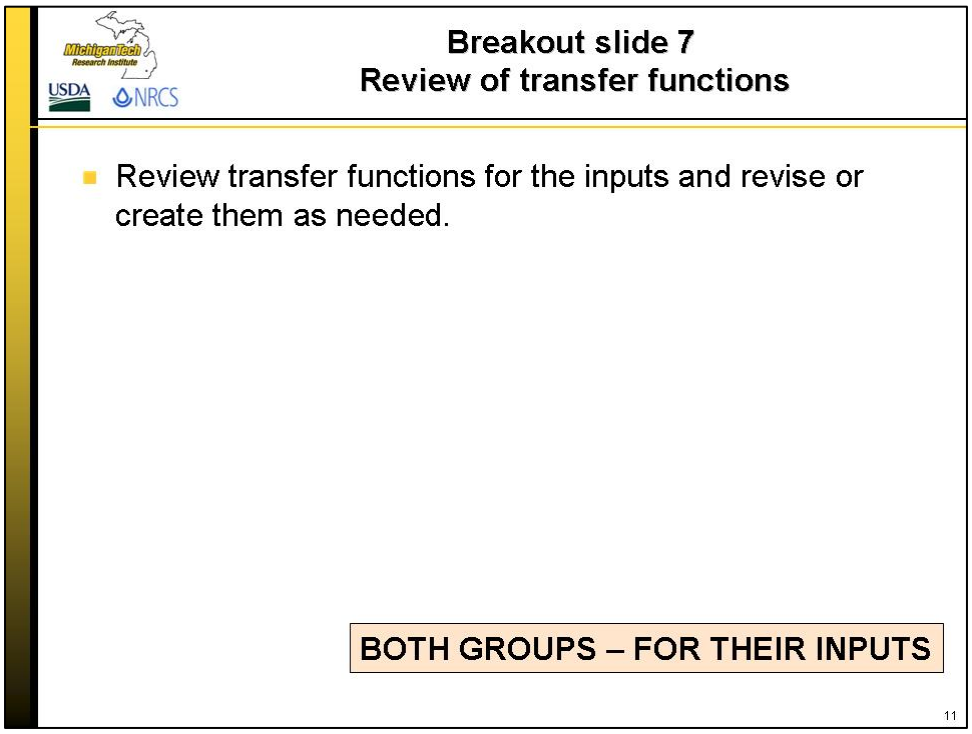
Breakout slide 6
Weighting of index inputs (cont)

- Do these inputs cover the resource concerns that should be included in evaluation of program effectiveness for this program?

- Summary of discussions of input weighting

BOTH GROUPS – FOR THEIR INPUTS

10


Breakout slide 7
Review of transfer functions
Review transfer functions for the inputs and revise or create them as needed.
BOTH GROUPS – FOR THEIR INPUTS
11

Notes from Breakout Groups

At approximately 11AM, meeting participants divided up into two breakout groups. The notes collected are included below. The culmination of the discussions resulted in EQI weightings that are summarized in a separate attachment of this report.

Group 1: Discussions of Soil condition and surface water components of the EQI
Participants: Betsy Dierberger, Mike Gangwer, Ruth Shaffer, Gary Rinkinberger (Joined late after Group 2 discussions on Air quality), Tyler Erickson, Colin Brooks (MTRI facilitator), Rick Powell (MTRI note-taker)

Weightings (both components and inputs) were discussed and compiled (see Attachment H). This group concluded that the Societal Utility component should be dropped because it was not comparable to the other components that are attempting to measure environmental change on the ground in response to NRCS conservation programs. Inclusion of this type of economic and social information should be done trough another means, potentially as a separate stand-alone "EQI"-like assessment.

Discussion of additional inputs resulted in one suggestion (adding crop rotation as an input):

<u>Additional Inputs:</u>

Conservation Crop Rotations

- Can be assessed using remote sensing and FSA-578 records. Preferable to model output.
- However, a component of both Soil Erosion and Tillage practice.
- Assumption = The higher the level of, the greater the environmental benefit
- The advisory group wants this added as an additional component, we agreed to develop as best as possible in the time remaining.

<u>Other inputs discussed, but not recommended by the group for adding to the EQI at this point in time:</u>

Wind Erosion

- Not especially applicable to Michigan. Focus on water erosion.

Pathogens | BOD5 | Nutrients

Further investigation would be needed, potential exists for future application

Pasture Quality for Riparian Buffers

Further investigation would be needed, potential exists for future application

Stream Health

Further investigation would be needed (current focus is on lakes as water quality indicators), potential exists for future application

Group 2: Discussions of Land habitat and Air quality components of the EQI
Participants: Lynn Sampson, Gary Rickenberger (Gary moved to Group 1 after discussion of the air quality component discussion), Nancy French, Ben Koziol (MTRI facilitator), Michelle Weinert (MTRI note-taker).

Component weights were first reviewed:

- "We need a better vision for good research/modeling, so that we can rate [the Air quality] component."
- Would like flexibility in ranking past vs. future because air is a relatively new set of concerns for NRCS.
- Societal utility needs to be addressed separately, should be a stand alone model.
- Economic value from recreation and forest products should be included into the societal utility component of EQI

Air quality was discussed next:

- Particulate Levels (wind erosion and NRCS uses the wind erosion equation) Where do you draw the line and how will you know where the source is (Wisc./MI)?
    - Apr/May highest levels of wind erosion (look at it during those time periods). If it spikes in the spring, that may show agriculture. What level? PM2.5, PM10. PM2.5 is a good level (improvement of what they already have).
    - Numbers to stay static? They will probably shift.
    - Monitor it by concentration would be valuable, but the tons/year is more representative.

Land habitat was discussed next:

Lynn - Overall weights: **Hab** 40% **BioDiv** 40% **TEandSC** 20% (Threatened, Endangered, and Species of Concern)

Listings for **T,E, & SC** may not be good reflections of poor/good habitat… Some species of concern happen due to geography N/S line. Mitchell's Satyr butterfly (poor flyers, don't spread easily) is an example of a species that have life history restrictions. A lot of species indicates a diverse habitat, but does it mean anything (quantifiable). Can you select species that are habitat related? Indicator species should come from the federal lists. Should we separate animals from plants? Lynn thinks we should consider federal list to indicate that they are threatened or endangered across a whole range. The numbers will change drastically, but using the 25 listed species would be good… Candidate species - Eastern Massasauga Rattler. Using Federally Listed species would make applying it nationally easier.

BioDiversity/Fragmentation – Given a five year timeframe might not show much change. We should look at areas that have been implemented by programs to see if you can see the activity using remote sensing. Think about testing WRP lands (GIS data). This will also help determine **habitat improvement.** CREP has filter strips geographically (Saginaw Bay). CREP minimum width is 66 ft. wide for

filter strips (enhanced program). Think about how you want to classify the Mean Edge Contrast… You'll want to weight all the different contrasting land cover types… Weight the transition with what you think it should be (soft edge, hard edge). Are the three factors weighted equally right now, yes. Edge contrast should be weighted less than the other two by Lynn's suggestion. 40/40/20? Are there better measures of fragmentation? No, Lynn thought it was fine.

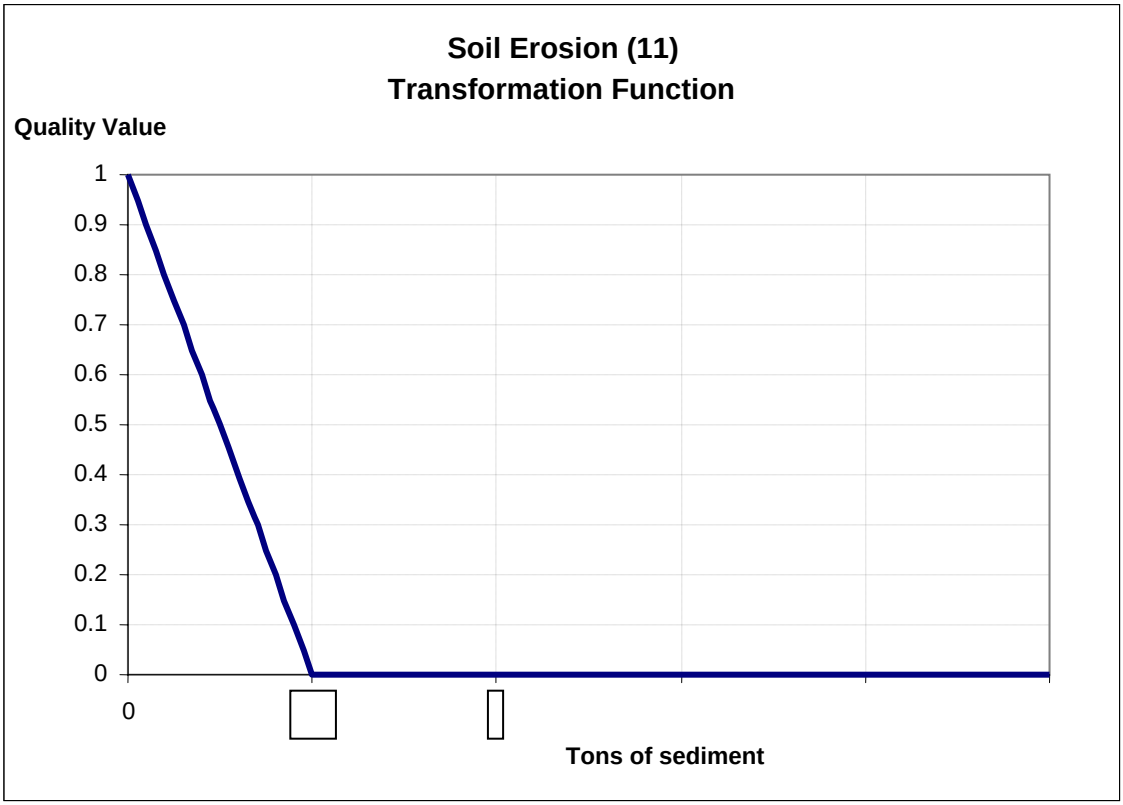
EQI Component and Input Ranking Results

	Consensus	Participant ranks						Avg Rank
Component Rankings								
Soil Condition	**30**	30	35	25	X	X	30	30
Surface Water Quality	**30**	30	30	25	X	X	30	29
Land Habitat	**25**	20	25	25	X	X	30	25
Air Quality	**15**	20	10	25	X	5	10	14
Sum	**100**	100	100	100		5	100	
Input Rankings								
1 - Soil Condition Index								
Soil Erosion	**25**	30	20	25	30	X	X	26
HEL	**15**	10	25	5	20	X	X	15
Tillage	**20**	20	15	25	25	X	X	21
Carbon	**25**	25	25	30	10	X	X	23
Crop Rotation	**15**	15	15	15	15	X	X	15
	100	100	100	100	100			
2 - Surface Water Health Index								
Lake Clarity	**45**	50	40	50	40	X	40	44
Vegetative Riparian Buffers	**55**	50	60	50	60	X	60	56
	100	100	100	100	100		100	
3 - Land Habitat Index								
Habitat Improvement	**40**	X	X	X	X	X	40	40
T&E species counts	**20**	X	X	X	X	X	20	20
Biodiversity/fragmentation	**40**	X	X	X	X	X	40	40
	100						100	
4 - Air Quality Index								
Ammonia NH3 emissions	**20**	X	33	X	15	X	15	21
CH4 emissions	**20**	X	33	X	10	X	25	23
Particulate levels	**60**	X	34	X	75	X	60	56
	100		100		100		100	

Notes on revision of transformation functions

EQI input name	*Units of input*	*Index component*
11. Soil erosion	tons	Soil condition index

Transformation Function (see notes for changes)

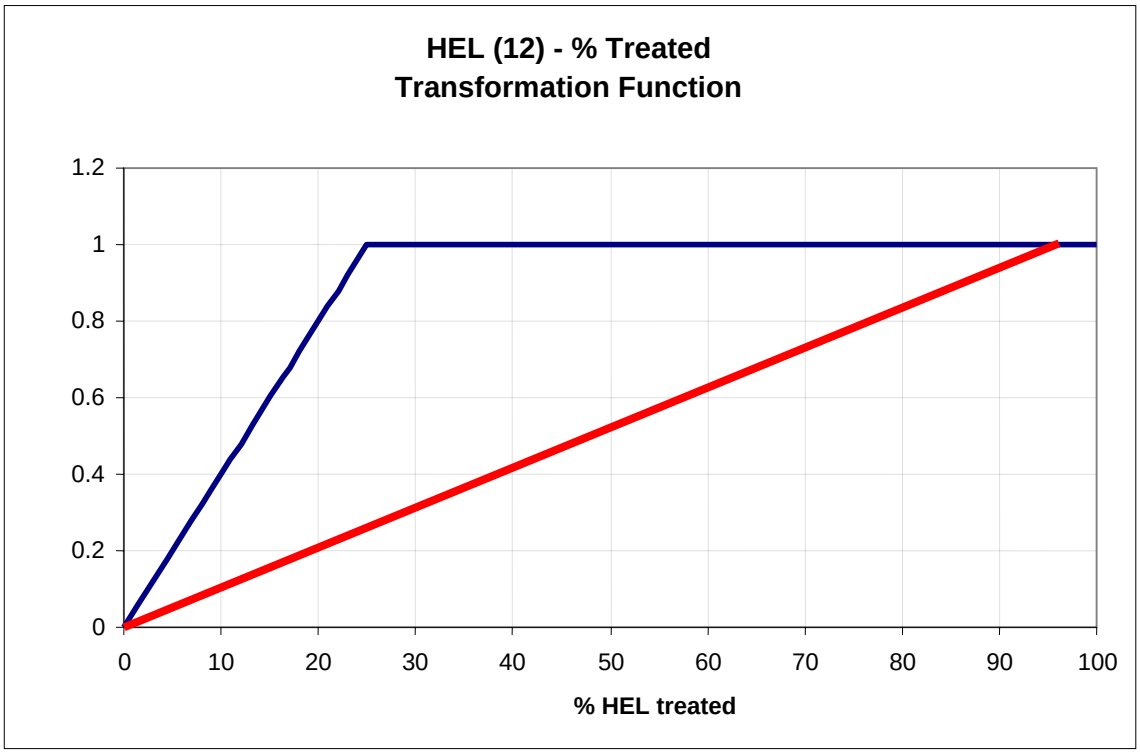


Rate by soil (T)
NRI data gives data in ton/acre (not looking at agriculture only, but the whole county)

- (Lynn) Instead of total tons of sediment, maybe average tons per acre. Agricultural areas…
  - Comparing the LP with the UP, Ag. Land is so different. How do you normalize… Maybe collapse the different land uses.
- No change to the straight line.

EQI input name	Units of input	Index component
12. HEL land	% treated	Soil condition index

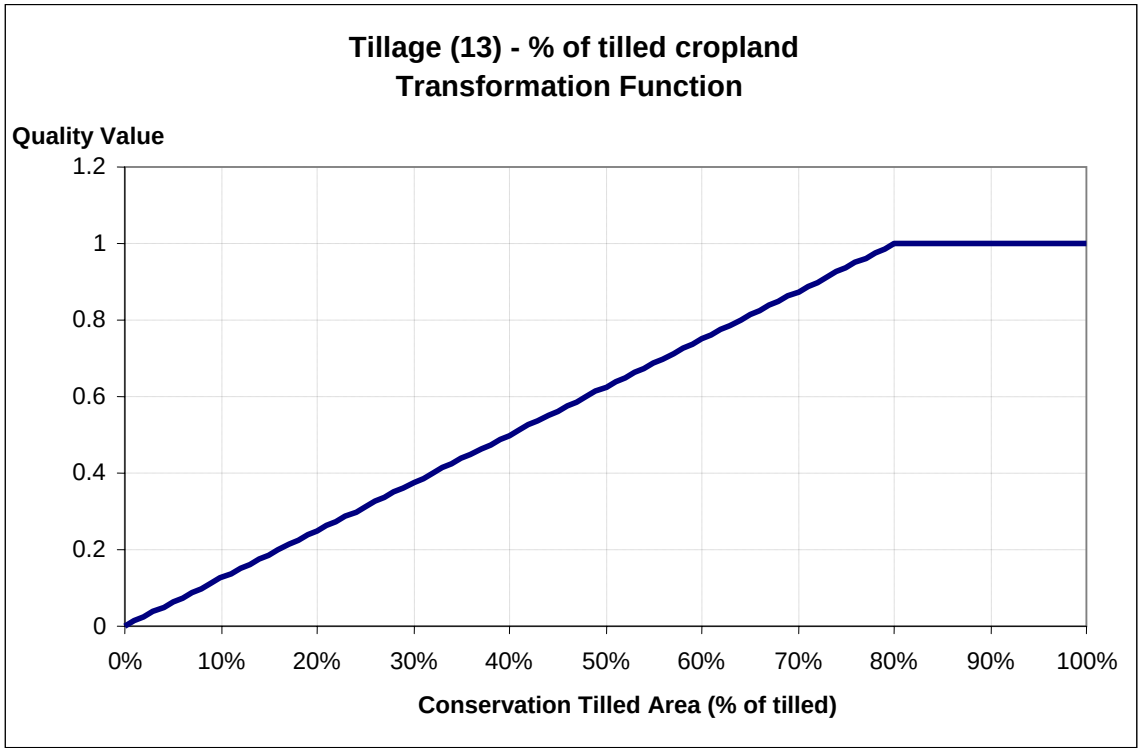
Transformation Function (revised)



This is progressive modeling.
Slope ok? No. Red Line supports the new slope rating, 95% to score a 1.

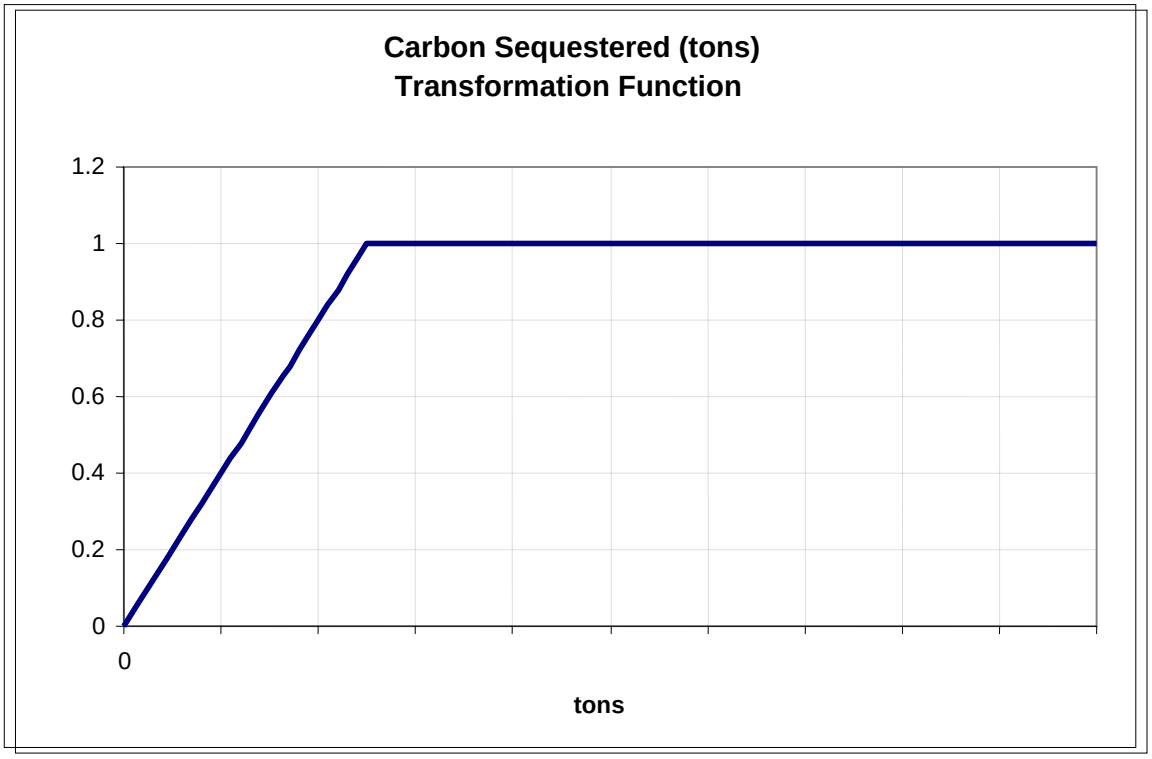
EQI input name	Units of input	Index component
13 &14. Tillage practice	% of conservation tillage	Soil Condition Index

Transformation Function (unchanged)



EQI input name	Units of input	Index component
15. Carbon Sequestration	Tons	Soil condition index

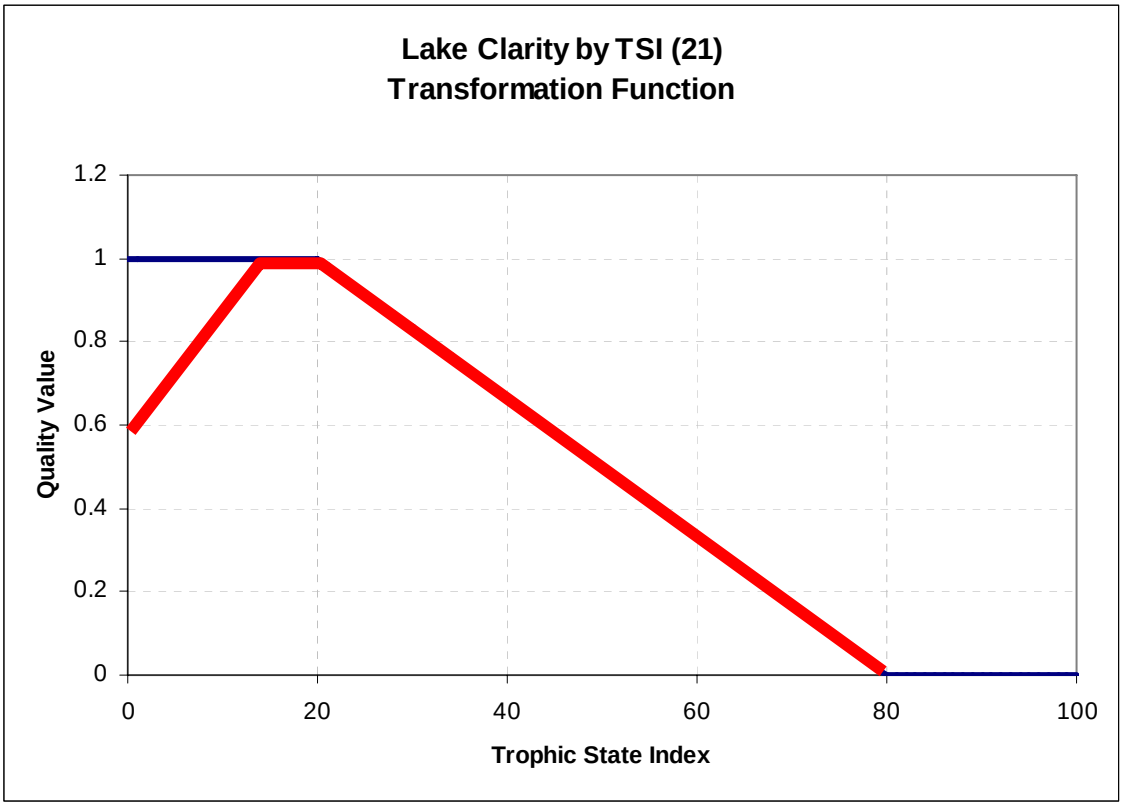
Transformation Function (unchanged)



Reflectance data will help with this input of the model.
Extreme change in land use may cause an extreme change in carbon

EQI input name	Units of input	Index component
21. Lake Clarity	index	Surface Water Health

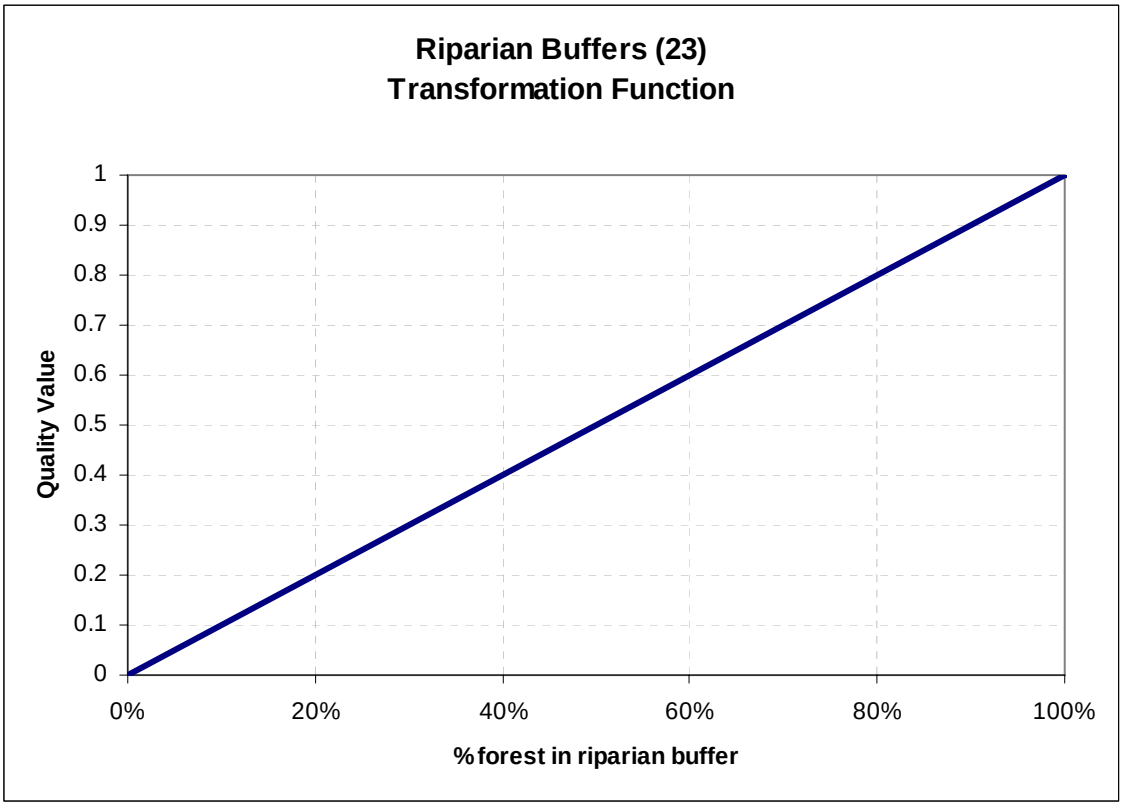
Transformation Function (revised)



Is there a point where the water is unnaturally clear and account for it?
Updated line in red!

EQI input name	*Units of input*	*Index component*
23. Riparian buffers	% forested	Surface Water Health

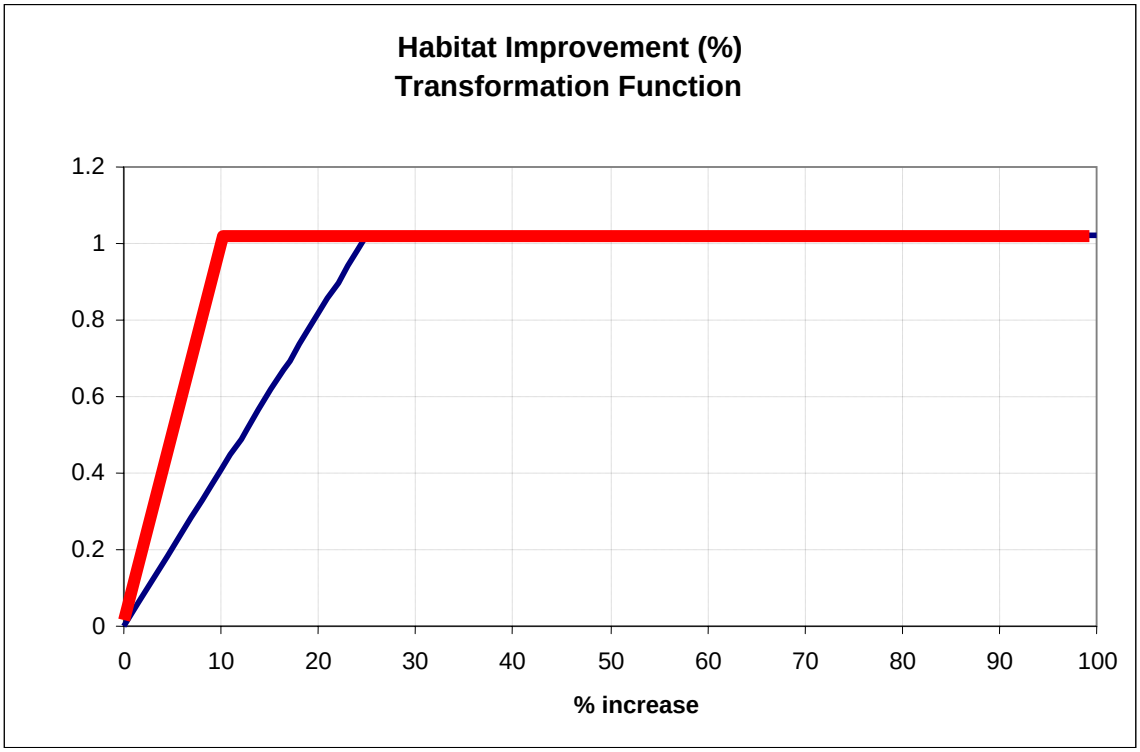
Transformation Function (unchanged)



Keep as a linear model.

EQI input name	*Units of input*	*Index component*
31. Habitat improvement	% of area improved	Land habitat index

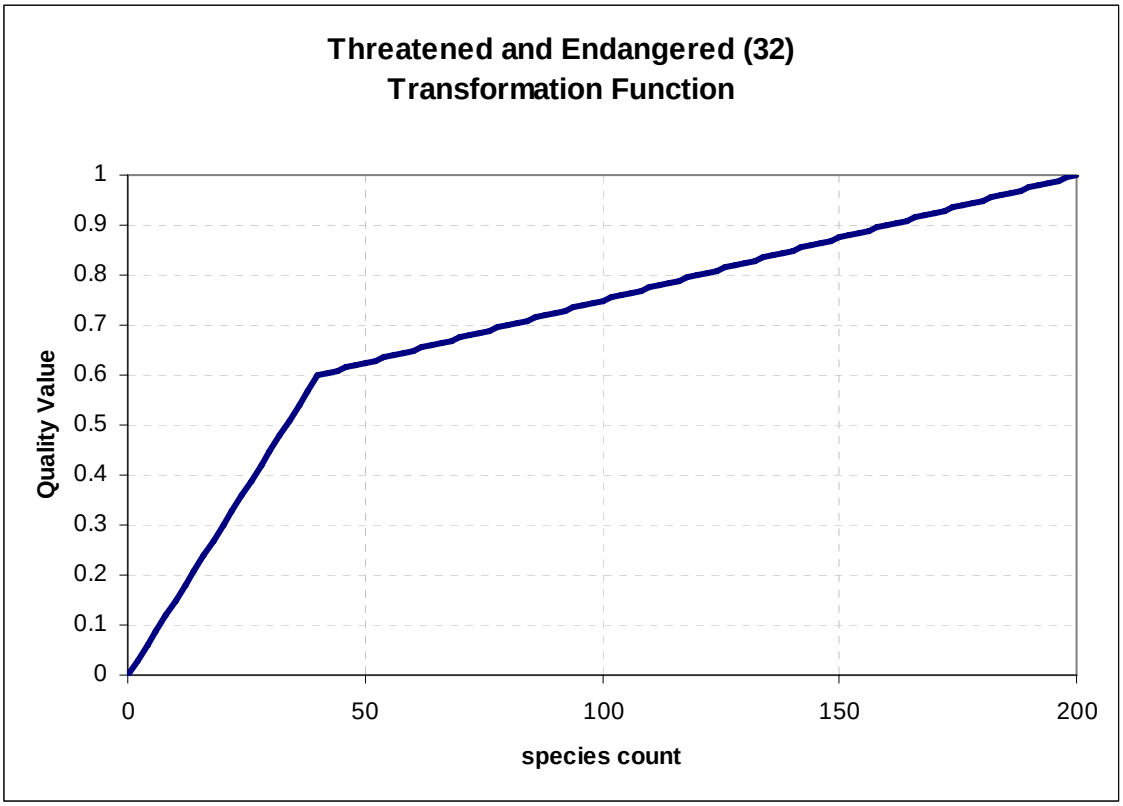
Transformation Function (revised)



10% would be a better break.

EQI input name	*Units of input*	*Index component*
32. T&E&SC species	count	Land Habitat Health

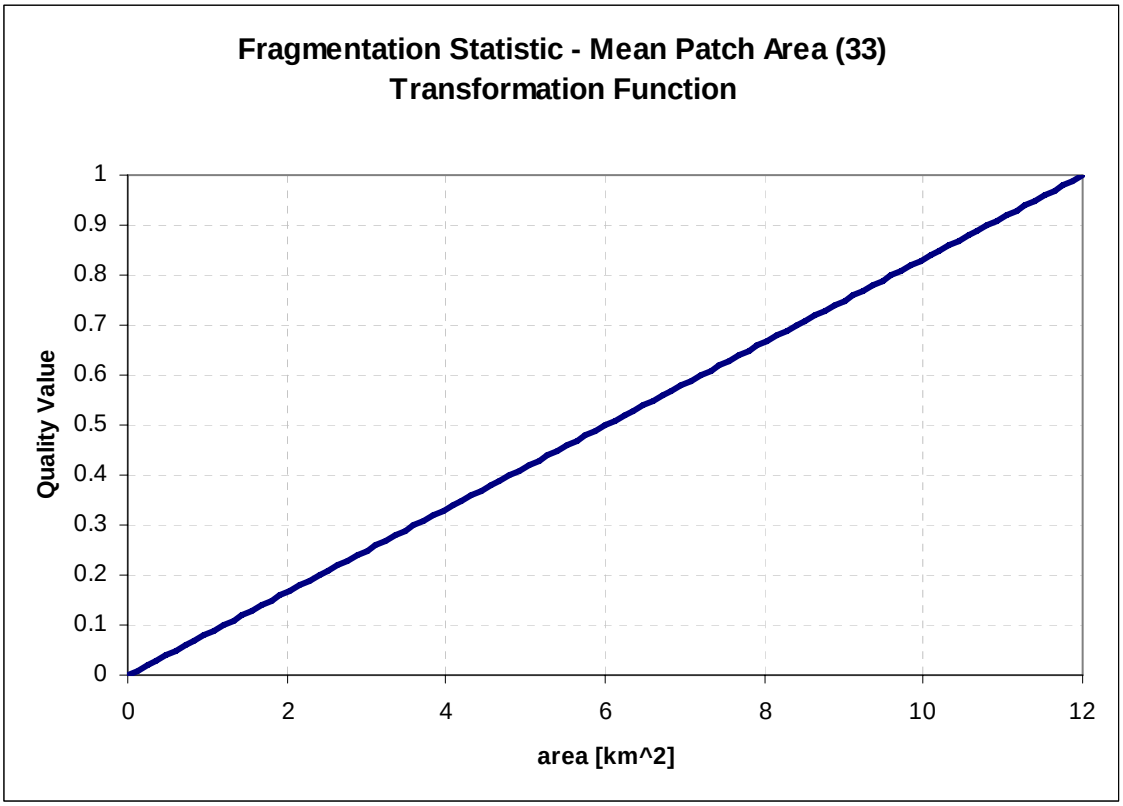
Transformation Function (unchanged except axis scale)



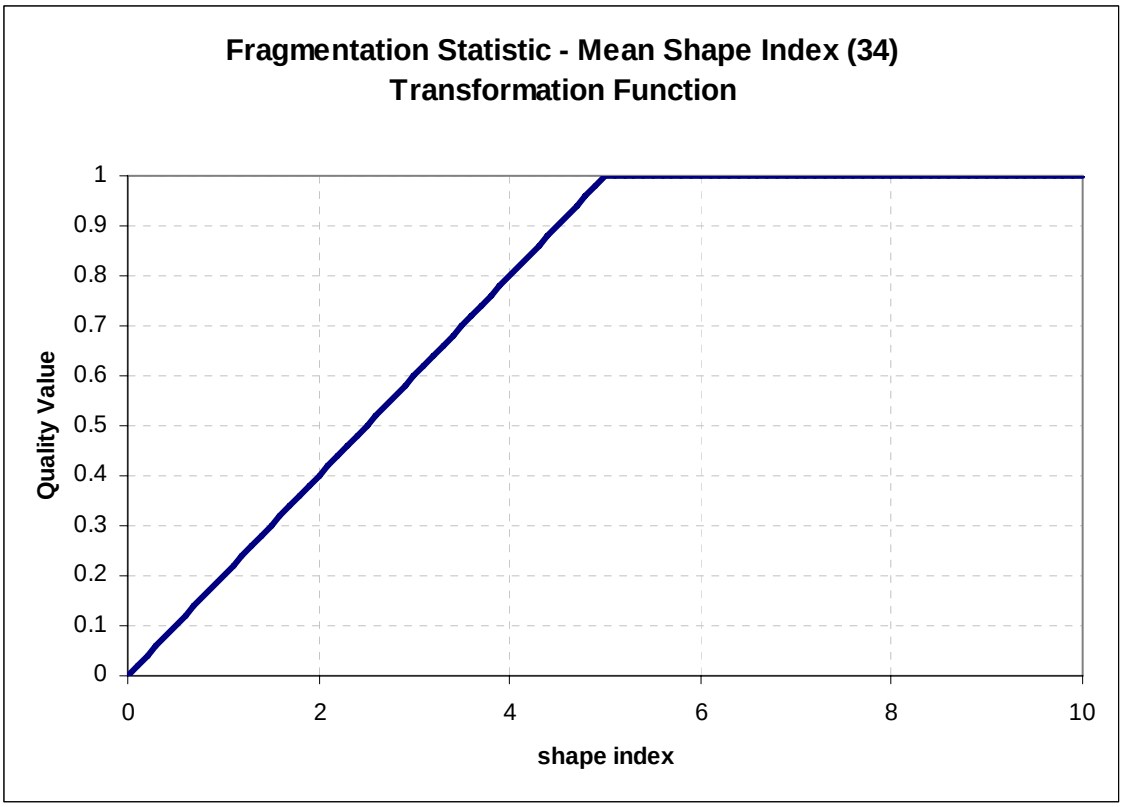
Use federal listed species only.
#'s of species to change.

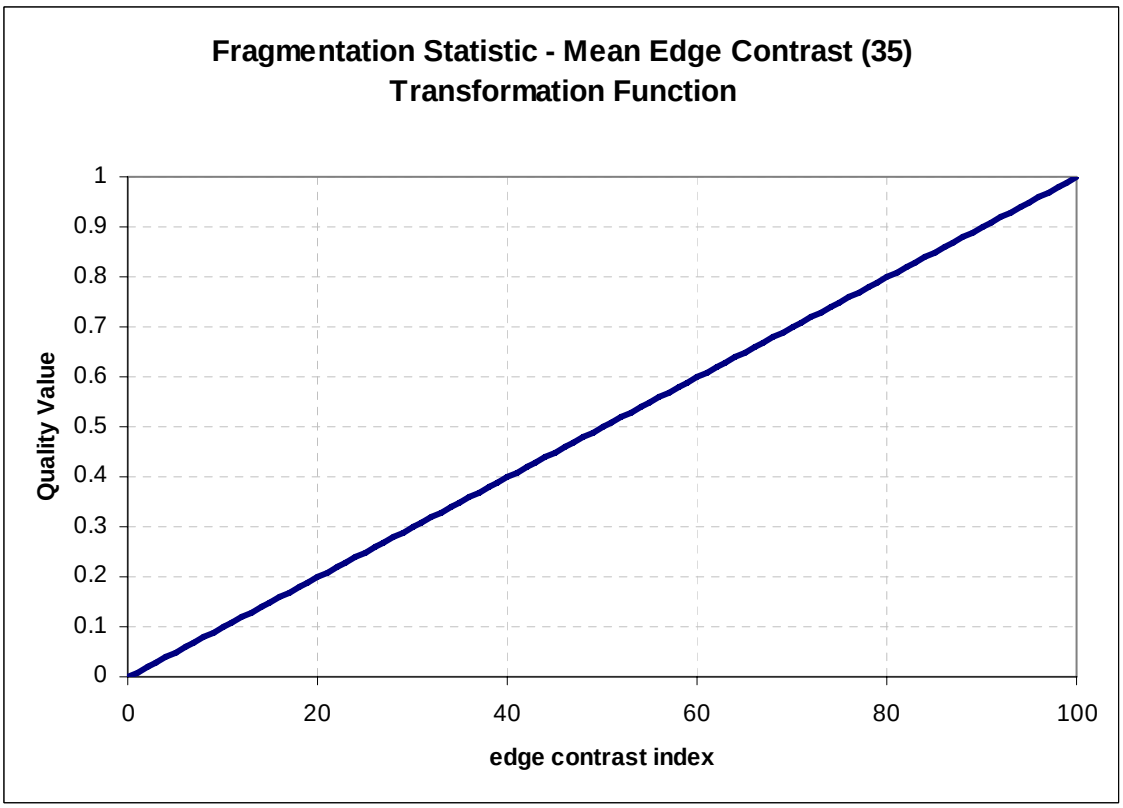
EQI input name	Units of input	Index component
33. Fragmentation	(*varies - see description*)	Land habitat index

Transformation Functions (unchanged)



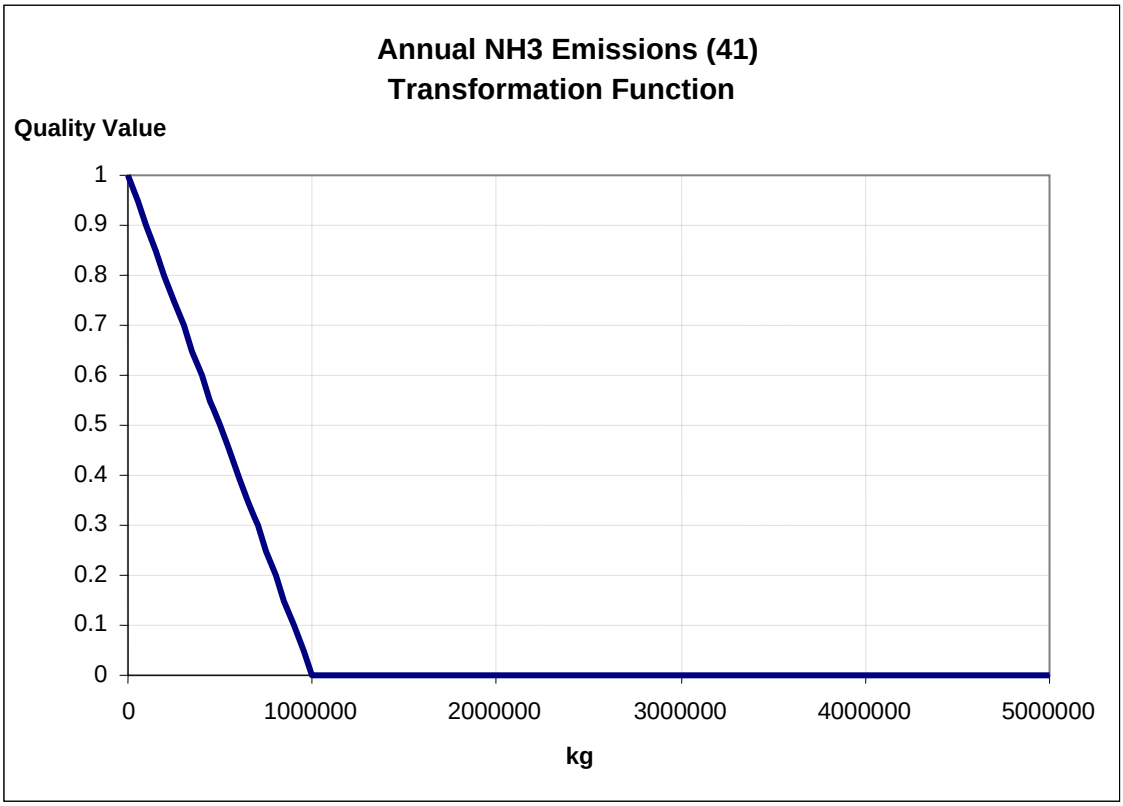
Separate out the land cover types and apply the linear model.


Fragmentation Statistic - Mean Shape Index (34)
Transformation Function
Quality Value
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
shape index


Fragmentation Statistic - Mean Edge Contrast (35)
Transformation Function
Quality Value
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
edge contrast index

EQI input name	*Units of input*	*Index component*
41. Ammonia Emissions	kg (month and year)	Air Quality Index

Transformation Function (unchanged – check on axis scale)



What's the natural break point? It's in concentrations.

EQI input name	*Units of input*	*Index component*
43. Particulate levels	µg/m^3	Air Quality Index

Transformation Function (unchanged except for axis scale)