# **2.64 Indicators, Indices and the Report on the Environment**

**Project Number & Title**

2.64 - Indicators, Indices and the Report on the Environment

**Project Lead and Deputy**

Lisa M. Smith (NHEERL), Project Lead; Seema Schappelle (NCEA), Deputy Project Lead

**Project Period**

FY16 – FY19

**Project Summary**

SHC 2.64 research will help advance our understanding and communication of the causal relationships between human health, ecosystems, and well-being by evaluating and developing indicators for application to tools that enhance community sustainability. Research will focus on identifying and developing appropriate indicators and indices for community stakeholders to utilize when assessing the broad range of impacts, outcomes, costs and benefits associated with the decision process and post-decision execution in context of protecting human health and the environment and fostering economic growth and human well-being. Through the use of decision support tools, community stakeholders will be better able to assess and predict the interactions between the natural and built environment using scientific knowledge of ecosystem services and health outcomes to promote human health and well-being and maintain or restore environmental quality. Communication and demonstration of the utility of indicators and indices emerging from this research (e.g., Report on the Environment) will provide Program Offices, Regions, and communities a means of interpreting the relationships between ecological condition, environmental quality, and community health and well-being in context of community goals, objectives and decision-making. The indicators and indices developed within the scope of this project will serve as measures to track progress towards sustainability goals.

**Project Description**

Problem and Decision Context

Decision makers need the appropriate indicators and indices to assess, track, and equitably weigh integrated human health, socio-economic, environmental, and ecological factors to foster sustainability in the built and natural environments. This project will accomplish a number of activities to assess the utility of multiple scale indicators for addressing sustainability issues. The current use of indicators and indices within research programs will be cataloged and information gaps will be identified in order to inform the Report on the Environment (ROE), other projects, approaches, and tools across the Agency. The ecological relevance of environmental quality indicators will be systematically evaluated to provide the Agency with a robust set of indicators to measure ecological condition on a broad scale. Additionally, measures of ecosystem condition, human health and well-being will be holistically integrated to address the three pillars of sustainability for use in SHC tools (e.g., Projects 1.61, 1.62 and 4.61). Current and newly developed indicators will be evaluated for their utility in systems approaches for examining sustainable outcomes (e.g., Total Resource Impacts and Outcomes (TRIO)) in order to crosswalk them with other themes in the SHC program. Lastly, the Agency will produce an enhanced ROE with a trend interpretation component, broadening the utility of the ROE’s indicators.

In order to accomplish these activities, the research outlined for this project will address the following science questions:

• How can indicators and indices help decision makers assess final ecosystem goods and services (FEGS), sustainability, climate change, human health and well-being?

• How can ecological, human health and well-being indicators help communities assess sustainability decision options (an important part of defining what’s sustainable)?

•How can sustainability indicators help EPA and its partners make decisions about environmental policy, education, and monitoring?

•What is the role of national level indicators in informing community-level indicator development and community-level decisions?

•How can environmental indicators be utilized in decision support tools that evaluate the sustainability of short and long-term community decisions in the context of protecting the environment and public health?

Outputs

2.64.1 Incremental Report on the State of the Practice for Environmental Indicators (FY16)

2.64.2 Provide indicator information necessary for the incorporation of environmental indicators into SHC Decision Support Tools (FY17)

2.64.3 Draft report on the Environment (ROE) -2017 with Interpretation of Trends (FY18)

2.64.4 Incremental Report on the State of the Practice for Environmental Indicators, including Community Sustainability and Indicators of Well-Being (FY19).

Focus Areas

This project has emerged as the evolution of indicators and indices research developed earlier within SHC. This project consolidates previous research focused on (1) reporting the condition of the environment and human health in the United States (formerly SHC 3.4.1 Report on the Environment (ROE)); (2) identifying and creating indicators and indices that inform community sustainability in terms of environment and human health outcomes (Environmental Quality Index (EQI)), provisioning of goods and services and well-being endpoints (Human Well-being Index (HWBI)); (3) demonstration of web-based tools and data bases that help stakeholders identify sustainability indicators relevant to community priorities (Database of Sustainability Indicators and Indices (DOSII), formerly SHC 1.2.2 Provide Indicators and Indices to Assess, Track, and Inform Community Sustainability)); and (4) research supported through the Science To Achieve Results (STAR) program’s Environmental Public Health Indicators (EPHI) portfolio of extramural research grants (2.2.1.3 Environmental Public Health Indictors (STAR) Reliable public health indicators linking source to exposure to public health outcomes ).

The existing inventory of indicators has informed and will continue to inform efforts to develop national-level indicators of sustainability for incorporation into the ROE and SHC decision support tools. Combining these project areas creates opportunities for the inclusion of existing and newly developed ecological, environmental public health, human well-being and sustainability indicators into future versions of the ROE. Specifically, this research will support updates and interpretive analyses for the ROE, provide information for incorporation of new and existing indicators into SHC decision support tools and examine human and ecological resilience.

Within the scope of this project, four focus-areas have been identified. Collectively, the research identified will demonstrate holistic approaches for assessing human health and well-being in regards to changes in environmental conditions, ensuring that indicators are transferable to different community types and various spatial scales.

The research objectives within the scope of these focus areas include:

• Catalog the current use of indicators and indices within SHC and other ORD Programs and identify information gaps.

• Determine ecological relevance of environmental quality indicators

• Integrate measures of ecosystem condition and human health and well-being to address holistically the three pillars of sustainability for use in SHC tools.

• Produce ROE with new indicators and trend interpretation.

Focus Area #1: *State of the Practice for Sustainability Indicators* - Assist communities in assessing the sustainability of decision outcomes through communication to EPA program offices and regions, researchers and community stakeholders, the current state of practice for environmental indicators in sustainability research and identify research needed to fill information gaps.

Environmental indicators are useful in determining progress in the protection of the environment and human health. Further, these same indicators may help identify where challenges remain. To assist communities in assessing the sustainability of decision options, it is necessary to communicate to EPA program offices, regions, researchers and community stakeholders, the current state of practice for these indicators and to identify research needed to fill information gaps. Such communication can be achieved through an integrated compendium of indicators and indices, developed through the Sustainable and Healthy Communities (SHC) research program and other indicator research efforts ongoing since FY12 (2.64.1; 2.64.4). These reports will include indicators and indices used to assess ecological condition, ecosystem goods and services, environmental quality (natural and built), climate change, as well as environmental public health and human well-being. Information regarding the utility of these indicators—what they describe, how they are being used and how they could be used—will inform research in the development of SHC decision support tools, such as DASEES, EnviroAtlas, and C-FERST/T-FERST. Relevancy and value will be vetted through research, application and community demonstrations, as addressed in our communication strategy. Communication across SHC projects will help guide the use of existing indicators and the development of new indicators for holistically addressing a variety of sustain ability issues (2.64.3; 2.64.2). These reports will allow EPA’s program offices, regions, and communities to understand the relationship of indicators and indices to community well-being and the impacts of decisions on the community sustainability goals and objectives and provide information regarding the evaluation of current and new indicators for utility in decision support tools.

To better assist communities in assessing sustainable decision options, it is necessary to compile the current state of the practice for these indicators and to identify research needs to fill the information gaps. Research products will communicate research specific to the following:

* Develop an integrated compendium of indicators and indices provided as a synthesis report on the state of the practice for environmental indicators mined from research efforts occurring in FY12 to FY15.
* Develop an integrated compendium of indicators and indices provided as a synthesis report on the state of the practice for environmental indicators mined from research efforts occurring in FY16 to FY19.
* Develop a synthesis report of completed grants under EPA’s Science To Achieve Results (STAR) Environmental Public Health Indicators Research.

Focus Area #2: *Development of Indicators of Ecological and Community Resilience*- Advance the field of resilience science by exploring the interdependence of human and natural systems to inform TRIO approaches for community sustainability planning and understanding potential trade-offs.

The concept of sustainability encompasses the need to maintain conditions necessary to support socio-ecological systems while ensuring the persistent provisioning of ecosystem goods and services. Further, it underscores the fact that sustainability is impossible to maintain or achieve without resilience. In simple terms, resilience is the ability of a system to respond to or recover from a disturbance, whether short or long term in nature. In the natural environment, resilience refers to the amount of disturbance required to shift a system from one regime (set of conditions) to another. Human and natural systems typically have inherent resilience and can persist under some external impacts. However, it is possible for the pressure on a system to cross a threshold and reach a tipping point where it loses resilience such that the function and services that system provides may be degraded or completely lost. Understanding regime shifts and identifying measures that provide early warning of transitions is critical to system resilience and therefore, sustainability.

This effort responds to the need for measures, frameworks and management strategies that facilitate conditions necessary to foster social-ecological resilience in the face of patterns of growth, resource use, development and environmental change. Research will advance the field of resilience science by exploring the interdependence of human and natural systems to inform community sustainability planning (2.64.4 as well as potentially outputs associated with other SHC Projects; e.g., 2.62 and 2.63). Research within this focus area will explore the linkages between sustainability, resilience and environmental change and develop information on qualitative aspects and quantitative measures of resilience to provide guidance to regions and program offices that may contribute to climate change adaptation and the sustainability of ecosystems and communities. These measures will be employed to case study systems to test their ability to assess spatial and temporal trends and tipping points in human and natural system dynamics. The development of these approaches will be the foundation for frameworks to support adaptive management of social-ecological systems and resilience based governance to promote sustainable ecosystem management and inform community planning decisions.

Research products within this focus area will relate social-ecological resilience indicators to sustainability and investigate their utility by evaluating the impact of variations in human and natural systems. These products will communicate research specific to the following:

* + Review and compilation of measures for assessing the resilience of human and natural systems.
  + Qualitative aspects of resilience that will inform strategies for incorporating resilience, law and policy (to include governance and adaptive management)
  + Application of indicators to ecological and human systems to assess system resilience
  + Identification of key characteristics of system dynamics to include stability, tipping points, critical transitions and possible drivers useful for planning and management

Focus Area #3: *Interpreting environmental conditions in terms of ecological relevance, public health outcomes, and well-being endpoints* - Utilize holistic approaches for assessing human health and well-being in the interpretation of changes in environmental conditions for evaluating the utility of full suites of indicators in the SHC decision support tools, TRIO approaches and ROE.

Indicators provide evidence that certain conditions (environmental, social, economic) exist. Condition indicators need to be combined in a way that provides a means for assessing progress towards desired outputs, outcomes, goals and objectives when considering the sustainability of solutions. In terms of environmental quality, both ecological relevance and human health and well-being endpoints must be evaluated. Ecological condition is reflective of processes and function as well as the provisioning of ecosystem goods and services. Environmental quality, inclusive of the built and natural environments, is inherently linked to economic and social function, all of which have direct and indirect relationships with public health outcomes and core aspects of overall well-being.

The indicators and indices developed under the scope of this project must address the issue of concern and be technically sound, easily understood and accepted by stakeholders. The construct validity of indicators and indices will be evaluated to make sure that they are robust and meaningful measures of specific issues of concern (i.e., ecological, environmental, human health). Indices and indicators will be evaluated for their ability to respond to changes and be useful for comparisons and tracking progress over time. A key objective of this project is to give interpretation to indicators of environmental quality beyond “good, fair, poor” so that assessments of environmental conditions can be appropriately evaluated in a structured decision context. Environmental conditions will be assessed not only in context of adverse effects, but also in relation to beneficial effects of ecological relevance, public health outcomes and well-being endpoints.

Research will include linking environmental quality to specific public health outcomes (e.g. low birth weight, asthma, obesity), incorporating the EQI into HWBI relationship functions equations, examining the human health domain of the HWBI for applications to vulnerable populations and developing composite indices of ecological condition that characterize the natural environment and its relationship to human well-being at multiple scales. This expanded characterization of environmental quality is essential to the evaluating the utility of full suites of indicators in SHC decision support tools (e.g., DASEES, EnviroAtlas, C-FERST/T-FERST) and will potentially inform trend analysis efforts for the Report on the Environment (2.64.2; 2.64.3; 2.64.4).

Suites of indicators for evaluating the relationship between ecological condition and human health and well-being will provide a better understanding of the ecological relevance of environmental quality indicators. Research products will communicate research specific to the following:

* Analyses of health outcome data in relation to environmental quality at multiple geographic scales
* Modification of HWBI models linking services flows to well-being endpoints using environmental quality parameters (EQI)
* Adaptation of HWBI approaches to selected vulnerable populations with an emphasis on health
* Interpretation regarding the ecological relevance of ecological conditions (from an ecosystem and human perspective) as a holistic measure to be considered in alternative solutions relating to sustainability and resiliency

Focus Area #4: *Report on the Environment* - Evolve the ROE program in both form and substance to meet changing programmatic needs, to respond to new scientific information and to incorporate new indicators researched and developed by SHC and other ORD staff in collaboration with EPA program offices.

EPA’s Report on the Environment (ROE) is a comprehensive source of scientific indicators that describe the trends in the nation’s environmental and human health condition. The ROE indicators help to answer important questions about the status and historical trends in US air, water, land, human health and exposure, ecological systems, and aspects of sustainability at the national and regional levels. They provide timely information to help EPA and others make decisions about environmental policy, education, and monitoring priorities. Existing iterations of the ROE have not analyzed or diagnosed the reasons for, and relationships between, the reported trends in stressors and environmental and health outcomes. To fill this information gap and further enhance the utility of the ROE, this project will: 1) develop and maintain a scientifically refreshed and up to date ROE website; 2) develop new indicators in collaboration with EPA program offices (including ORD); and 3) develop a new component piece to the ROE that analyzes and interprets the reported trends in a specific topic area (2.64.3; 2.64.4).

The ROE program has been ongoing since 2001 and has evolved in both form and substance to meet changing programmatic needs and to respond to new scientific information and knowledge. Continuing this successful approach, ideas for, and decisions on, new indicators will be developed in conjunction with staff from new and ongoing SHC indicator development and application projects and tasks as well as EPA program offices (2.64.2; 2.64.3; 2.64.4). To ensure the ROE 2018 continues to meet the needs of its users, the specific topics for interpretation will be selected following consultation with the program offices.

Specific products will be produced to support the following areas:

* Develop and maintain a scientifically refreshed and up to date ROE website;
* New indicators developed in conjunction with EPA program/regional offices (including ORD, see other products from this SHC project);
* A component piece to the ROE that analyzes and interprets the reported trends in a specific topic area

**Nature of the Work**

This project anticipates drawing from expertise in the following disciplines.

* Social Scientists (Sociology; Anthropology) (in-house and extramural)
* Economists (in-house and extramural)
* GIS Specialists (extramural)
* Policy Analysts (in-house)
* Epidemiologists (in-house)
* Physical Scientists (in-house)
* Ecologists (in-house)
* Statisticians (in-house and extramural)
* Web-developers (extramural)
* Communication Specialists (in-house and extramural)
* Database Managers (in-house and extramural)
* QA/QC Specialists (in-house)
* Contracting Officer Representatives (in-house)
* Web-services (e.g. geoplatform) ( extramural)

Approximately 15-20% of the work in the focus areas, with the exception of the ROE, will be dependent upon extramural funding for GIS specialists, data purchases, web development, web services, ORISE Post-docs and Student Services Contracts.

Approximately 75% of the proposed work for the ROE is dependent upon extramural funding for technical support contracts and Association of Schools and Programs of Public Health (ASPPH) Fellows through cooperative agreements.

Environmental public health indicators work has already been funded through the STAR Grant Program and FY15-FY19 efforts are related to completion and delivery of associated products.

**Collaboration**

Collaboration with Other SHC Projects

Within the scope of this project, coordination will occur with the Decision Science & Support Tools Team (SHC Project 1.61). This will be done through an exchange of information on methods to calculate indicators and indices of sustainability and well-being within communities (FY 17). Additionally, this project will contribute to next-generation web-based community public health tools that incorporate cumulative exposure and risk research and guidance, additional decision support capabilities, and other user needs identified by case studies and peer review (FY 19). Contributions will also be made to (1.62) the EnviroAtlas, geospatial analysis tool by providing community metrics (FY 17).

There will be collaboration with the Community-Based Ecosystem Goods & Services (EGS) Team (2.61) on their incremental report on the impacts of social (including public health), economic and environmental drivers (particularly climate change), on the production, supply and protection of final ecosystem goods and services (FY 20). Collaboration will also occur with the Community Public Health and Well-Being Team (2.62) by working to enhance community public health tools (e.g., C-FERST) providing access to information for identifying, prioritizing and addressing environmental health issues in local decision-making (FY 19).

This project will contribute to 2.63, Assessing Environmental Health Disparities and Vulnerable Populations by supporting decision-support tools to inform tribal sustainability decisions (FY 18). This project will also collaborate with 3.61, Contaminated Sites and Groundwater on tools for evaluating temporal and spatial impacts of contaminated sites on public health and the environment, for use in site remediation, restoration and revitalization (FY 17), where possible.

Collaboration will occur with the Environmental Releases of Oil and Fuels Team (3.62) on tools for evaluating temporal and spatial impacts of fuels/oils site cleanup on public health and the environment, for use in site remediation, restoration and revitalization (FY 17). This project will also collaborate with the Sustainable Management of Materials to Support Community Sustainability Team (3.63) on tools for evaluating temporal and spatial impacts of materials management on public health and the environment, for use in restoration and revitalization decision making (FY 17).

This project will collaborate with the Systems-based Assessment Methods for Community Sustainability Team (4.61) on its interim and updated Guidance for Total Resource Impacts and Outcomes (TRIO) assessment approaches, for use to proactively inform community decisions and advance sustainability (FY 19). The Application of Systems-Level Approaches to Achieve Sustainability Team (4.62) will contribute to this project through seeking to achieve community sustainability by developing a “state of the practice” in using systems approaches in community decision making for sustainable outcomes (FY 19).

Collaboration with Other ORD Research Programs

Coordination and collaboration with other ORD Research Programs will include working with the Air, Climate, and Energy (ACE) program to mine urban resilience indicators and provide additional indicators for consideration to the technical input report on urban area indicators, as well as providing indicators for consideration in the HYGIEIA Model Group.

Collaboration with the Safe and Sustainable Water Resources (SSWR) program includes using indicators developed for aquatic monitoring and assessment and for mapping aquatic condition and watershed integrity. Work with the Chemical Safety for Sustainability (CSS) program includes assessing pesticide usage data to refine environmental quality parameters in EQI models. Additionally, the Homeland Security Research Program (HSRP) will be consulted in developing strategies that are needed to make communities more resilient, including their water systems.

Communication of research and results (web) will be in coordination with the Office of Sustainability, Office of Science Information Management (OSIM) and Office of Environmental Information (OEI).

Collaborations with EPA Program Offices and Regions

Program Office and Regional POCs

* Administrator/Deputy Administrator
* Office of Water (OW): Kitty Miller, Treda Grayson and Sarah Lehmann, Phil Zahreddine
* Office of Sustainable Communities (OSC): TBD
* Office of International and Tribal Affairs (OITA): Bill Sonntag
* Office of Air and Radiation (OAR): Margaret Walters, Randy Waite (OAQPS), Rick Haeuber, Ginger Tennant (OAQPS), Jason Lynch (OAP/CAMD), Mike Kolian (OAP/CCD)
* Office of Solid Waste and Environmental Remediation (OSWER): Brigid Lowery, Maricruz MaGowan, Priscilla Halloran
* Office of Chemical Safety & Pollution Prevention: Jim Cowles, Mark Corbin, David Hrdy
* Office of Children's Health Protection: Gregory Miller
* Office of Policy: Carl Koch, William Nickerson, Beth Termini (R3 & OP), Derry Allen
* Office of Enforcement and Compliance Assurance (OECA): Jessica Aresta-Dasilva
* Region 1: Matt Hoagland, Sarah Levinson, Linda Teuschler
* Region 2: Marie O‘Shea, Larry Granite, Alyssa Arcaya, Charles Harewood, Darvene Adams
* Region 3: Nicoletta DiForte
* Region 4: Angie Billups, Anne Keller, Beth Walls, Ravi Rao, Lael Butler (R4/Gulf of Mexico Program), Kristie Friesenhahn
* Region 5: Tom Brody, Lawrence Lehrman
* Region 6: William Rhea, Mike Morton
* Region 7: Brenda Groskinsky, Richard Sumpter
* Region 8: Gerard Bulanowski
* Region 9: Vance Fong, Matthew Small, Eileen Sheehan
* Region 10: Ann Williamson

Collaboration outside of EPA

This project anticipates collaborating with the following stakeholders outside of EPA.

* Office of Management and Budget (OMB)
* Center for Environmental Quality (CEQ)
* Office of Science, Technology and Policy (OSTP)
* Army Corps of Engineers (USACE)
* US Geological Service (USGS)
* Congressional committees
* US citizens
* Communities associated with Tampa, Guanica Bay, San Juan, Gulf of Mexico and Caribbean Community Sustainability, Pacific Northwest, and Great Lakes regions
* Environmental and Social Indicators Consultant (Ainsley Lloyd), Consultant at United States Global Change Research Program
* ARC Centre of Excellence for Coral Reef Studies: Kirsty L. Nash, Nicholas A. J. Graham
* Emory University: Lance Gunderson
* Ezemvelo KZN Wildlife, Louwsberg, South Africa: Chris Barichievy
* National Oceanographic and Atmospheric Administration (NOAA): Craig A. Stow
* U.S. Fish and Wildlife Service: Dean Granholm, Melinda Knutson
* Stockholm Resilience Centre, Stockholm, Sweden: Magnus Nystrom
* Swedish University of Agricultural Sciences: David G. Angeler
* U.S. Geological Survey–Nebraska Cooperative Fish and Wildlife Research Unit: Craig R. Allen
* University of Nebraska: Shana M. Sundstrom
* University of Victoria, British Columbia, Canada: R. John Nelson
* Green 13 - Natural Environment Team of the City of Huntsville, Alabama: Robin Cox
* Department of Environmental Protection,  Harrisburg, PA: Huang S. Lin
* Office of Sustainability, City of San Antonio, TX: Bill Barker
* Institute for a Sustainable World, Queen’s University Belfast, Northern Ireland: Robin Curry
* Sarasota County Sustainability, Sarasota County, FL: Lee Byron
* Sustainability Program Manager, City of Knoxville, TN: Susanna Sutherland
* Dept. of Decision Sciences, School of Business, The George Washington University: Sanjay Jain
* Fire and Resource Assessment Program, California Department of Forestry and Fire Protection: Justin L. Johnson
* Centre for Well-Being, London: Kaitlyn Gilles
* Senior Water and Environment Consultant,  Alexandria, VA: Sharon Murray
* Sustainable Communities and Environmental Services, SRA International, Inc.: Bill Michaud
* University of Florida: Lantz Holtzhower
* Stanford University: Suzan Carmichael
* Texas Department of Health
* CDC Environmental Public Health Tracking Branch
* National Parks Service
* U.S. Forest Service

**Assumptions/Constraints**

The following assumptions relate to the Report on the Environment (ROE).

• ROE program gets a formal, top-down mandate to continue and to formally engage program offices in this effort

• Concept of new ROE work on trend interpretation has formal buy-in and agreement on implementation from Program Offices, including providing appropriate staff, data, and other information to successfully complete the work in the expected time frame

• ROE workgroup is composed of folks with the necessary skills

• Timely internal review by ORD and other involved Program offices

• Timely website guidance from OWC

Assumptions relating to the incorporation of indicators in SHC tools and TRIO approaches are also being made. The indicators and indices developed in this project will be provided for use in multiple SHC tools that have been developed or are in development (e.g., DASEES, EnviroAtlas, C-FERST/T-FERST). The utility of these measures is dependent upon appropriate interpretation of the indicators for use in such tools. The incorporation of these measures into various tools requires a collaborative partnership between this project and the “receiving” projects. Therefore, it is essential that the tool developing projects identify tasks for incorporation of indicators and indices into the tools. Stakeholders can only benefit from this project’s research if the tools, of which these indicators are to become a part of, reach the communities. To this extent, demonstration of these tools in a variety of community types with different priorities is vital in order to determine the success of this research and the potential impact as delineated in the following:

• Community stakeholders will use appropriate indicators and indices to inform the methods and tools of decision science and sustainability assessments to frame their decisions.

• Communities will use appropriate indicators and indices to assess the broad range of impacts, outcomes, costs and benefits associated with decisions, including the ability to consider impacts on the environment, economics, and community health in similar terms.

**Project Charter Team Members**

Linda Harwell (NHEERL)

Matt Harwell (NHEERL)

Danelle Lobdell (NHEERL)

Lisa M. Smith (NHEERL)

Tarsha Eason (NRMRL)

Pat Murphy (NCEA)

Seema Schappelle (NCEA)

Tim Buckley (NERL)

Tom Purucker (NERL)

Maggie Breville (NCER)

Kevin Summers (NPD Representative)

Kathryn Saterson (MI-NHEERL)