THE
HEINZ
CENTER

May 29, 2003

Meeting Summary
First Meeting: Nonnative Species Task Group
State of the Nation's Ecosystems Project
April 16 and 17, 2003
The Heinz Center

The first meeting of the Nonnative Species Task Group was held on April 16 and 17, 2003 at The Heinz Center. Attendees are listed in Attachment A, and included several individuals who participated by teleconference for some or all of the meeting.

The meeting had four major elements. The first morning was taken up largely by presentations and discussion concerning the goals, objectives, timetables, and outputs of the meeting. Presentations by Robin O'Malley, Heinz Center Program Director, are summarized very briefly below. The second element of the meeting was a brainstorming session to identify important aspects of nonnative species should be tracked in order to present a coherent and strategic picture of change in nonnative extent and intensity over time. The third component of the meeting involved examination of the indicators from the 2002 report for each principal ecosystem type, and development of tentative revised / refined indicators applicable to each of the four "natural / semi-natural" ecosystems (i.e., coasts & oceans, forests, freshwater, and grasslands & shrublands). Finally, there was preliminary discussion of the types of indicators that might be applicable to the two "highly managed" ecosystems: farmlands and urban / suburban.

Background and Context for the Task Group

Robin O'Malley's presentations focused on three elements:

1) The overall context for the task group, which consists of the plans and timetable for revising the overall State of the Nation's Ecosystems report for re-issuance in 2007.
2) The specific context for this task group. Key aspects of this are listed below.
3) A brief review of the seven nonnative species (or related topic) indicators from the 2002 State of the Nation's Ecosystems report. This was done by reference to and discussion of a handout that is included in this report as Attachment B.

Task Group Charge: Key points about the Task Group context and charge are:

- The Task Group has two basic charges: (a) to determine whether it is possible to report with greater consistency across ecosystems; that is, to report on the role and impact nonnative species in each of the six principal ecosystem types, using indicators that are more similar to

each other than those in the 2002 report, and (b) to ensure that the indicators cover the most important aspects of the role and impact of nonnative species.

- The goal is to complete this work in approximately one year. There will be three meetings (April 16-17, June 18-19, and August 12-14), with additional meetings added if necessary.
- The Task Group's work will be used in two ways. The principal purpose is to propose revised indicators for the 2007 report[1]. The Task Group will also produce a stand-alone report, which will substantiate the rationale behind selection of the indicators, and identify additional indicators that are important but that will not be included in the 2007 State of the Nation's Ecosystems report, because of space and priority constraints. This stand-alone report will probably be published as part of the Center's (new) working paper series; it may be converted to journal format also.
- A key constraint on the work of the Task Group is that it is important not to increase significantly the number of indicators to be included in the 2007 report. This constraint is derived from the overall context in which the Task Group is functioning. The State of the Nation's Ecosystems project is intended to identify as succinct a set as possible to describe the condition and use of US ecosystems. The inevitable consequence of this goal is that, for any single concern or characteristic (e.g., nonnative species; rare and declining species; nutrient concentrations in water) there must be a very small number of indicators – fewer than might be desirable to provide a broad and comprehensive treatment of the subject. Therefore, since it is likely that the Task Group will identify a larger number of desirable and important indicators, a key decision will be to establish priorities that identify which indicators will be included in the 2007 report, because it is likely that the Task Group will identify a larger number of desirable and important indicators.
- The group generally agreed to the recommendation from the Chair and Project Director to put off discussion of (a) whether the indicators should describe only species that are nonnative to North America or whether they should describe species that have significantly expanded their ranges within North America; and (b) whether the indicators should describe all nonnatives or only *invasive* nonnative species. There was an initial sense that the group sought would likely limit the scope of its recommended indicators to invasive nonnative species (also referred to as *invasive alien* species), although this issue will be discussed in greater detail in future meetings.

Key Discussion Points: Areas of discussion or clarification that arose out of the groups discussion of the charge and context included the following:

- The State of the Nation's Ecosystems project is generally looking at indicators that describe current conditions, and not features that may be used to predict future conditions. This basically means that the indicators will describe invasions that have already occurred, rather than predicting future invasions. While strongly supporting the development of "early warning" indicators, the group also supported the need for indicators that describe the extent of successful invasions.
- While nonnative species are often reported on because of concern over their negative impacts, the group acknowledged that there are both positive and negative impacts from

[1] Decisions as to which indicators are ultimately included in the 2007 report will result from consultation with task groups (such as this Nonnative Task Group), the individual ecosystem work groups (e.g., freshwater, forests, etc.) the Design Committee, and the Heinz Center, and will involve consideration of feedback from external reviewers.

nonnatives, and that the indicators should not be designed only with negative effects in mind. (This point may be revisited in the context of the possibility that the Task Group will focus on *invasive* species, which are more commonly associated with negative impacts.)

- While acknowledging that it is important not to focus on only negative aspects of nonnatives, the group also recognized that indicators must be sensitive to change in ecosystems, so that it is possible for a reader to make a judgment about whether the change is positive or negative. (Again, a more limited focus on *invasive* species would carry a greater implication of negative impacts.)
- The group generally agreed that it would use the term "nonnative" to refer to species that can sustain themselves without continued human intervention. Thus, for farmland ecosystems, the Task Group would focus on nonnative species that inhabit non-cropland elements (hedgerows, woodlots, etc.) or that serve as pests on intentionally planted crops. While many crops are not native to the United States, they are not the focus of the Task Group's work NOTE: Since the use of the term "nonnative" described above appears to be at odds with ecological practice (which uses the term "naturalized" for such species, and use the term "nonnative" to refer to any species with no native population in the US), this issue will be revisited in future meetings.

Key Aspects To be Included in Nonnative Species Indicators

The group identified a broad range of issues and concerns that should be reflected in a sound set of indicators, as well as related issues that should be considered as these indicators are developed.

The group agreed that indicators that described *impacts of invasions on ecosystems* are particularly useful and important. Impact indicators more closely reflect invasive species effects on the state of the Nation's ecosystem than other indicators such as species abundance or presence/absence. For examples, certain species, such as pathogens, may contribute an insignificant proportion of the total biomass within an ecosystem, but significantly impair ecosystem function and profoundly impact plant and animal communities. Impact indicators also integrate multiple influences, thus providing more robust indicators of overall ecosystem change.

Examples of changes made or affected by invasive nonnative species (and that would thus be good *invasion impacts* indicators include:

- Ecological role replacement (nonnatives take over roles or niches of native species)
- New roles (nonnatives occupy roles not heretofore played by native species
- Extinction /extirpation patterns (nonnatives contribute to local extirpation, or even complete extinction of native species)
- Altered population dynamics of native species (nonnatives contribute to population growth or decline of native species; decline is a key concern)
- Alteration of physical environment
- Hybridization with natives, thereby permanently altering the native species gene pool (e.g. ruddy duck, many plants)

Despite recognizing the value of impact indicators, the group agreed that there were sufficiently few instances in which enough is known about the impacts of nonnative species that it was impractical at this time to expect broad implementation of such indicators. However, given the importance of describing effects of nonnatives, the group did identify the general structure of a consistent indicator (i.e., one that applies across ecosystems) as well as several indicators that are unique to certain ecosystems. These are described in greater detail below. The group felt strongly that in the future, such indicators should be developed and data collected so as to allow a transition to reporting on a mix of indicators describing *invasion impacts* and *invasion patterns and characteristics*.

Examples of the factors that might be addressed by *invasion pattern and characteristics* indicators are the following:

- Establishment rate
- Biomass / density / intensity
- Coverage / presence / abundance
- Concentration / clumping
- Rate of spread
- Range expansion / contraction
- Hybridization within a non-native species
- Altered population dynamics of nonnative species.

Finally, the group agreed strongly that if possible, the indicators for each ecosystem should cover a broad range of taxonomic groups, including plants, vertebrates, and invertebrates/parasites.

Development of a Consistent Indicator Set

Based on a review of the indicators contained in the 2002 State of the Nation's Ecosystems report, the group concluded that it was possible to develop both an impacts indicator and an invasion pattern indicator that were applicable to each of the four "natural / semi-natural" ecosystems (coasts and oceans, fresh water, forests, and grasslands and shrublands). The remainder of this section describes these candidate replacement indicators. Attachment C includes notes and commentary on the 2002 indicators and other possible alternative indicators.

Candidate Invasion Pattern Measure
The candidate measure described below is potentially applicable to all four "natural / semi-natural" ecosystems.

This indicator would report the *degree of invasion* within an ecosystem, by reporting the percent of the system[2] that has a *high degree of invasion, moderate degree of invasion, and a low degree of invasion*. *Degree of invasion* would be determined by independently assessing one or more of the following:

[2] This indicator could be applied on a regional basis as well.

- The percent of total vertebrate biomass that is composed of nonnative species (this would be ranked from 0 to 100%)
- The percent of ground that is covered by nonnative vascular plants (this could have values from 0 to multiples of 100%)
- The percent of available host plants that are infested / infected with nonnative species of parasites and pathogens. This portion of the indicator would be calculated based on the percent of a host species that is infested times the percent that that host species occupies of the total ecosystem area, summed over all possible hosts. Thus, a host species that occupies a very small fraction of an ecosystem, even if 100% of individuals were infested, would not result in a high score for this index. Using this approach, this part of the indicator can be represented as shown below, and could have values from 0 to multiples of 100%.

  I_h = % of given host plant, h, that is infested with non-native insect or pathogen
  E_h = % of ecosystem that is occupied by given host plant, h

  for n possible hosts,

  % available host plants infected (overall percentage rank) = $\sum_{h=1}^{n} I_h E_h$

The group recognized that it would have to make decisions, for each ecosystem type and each taxonomic group, concerning what values represented *high degree of invasion, moderate degree of invasion, and a low degree of invasion*. Thus, the group (or someone) will eventually have to identify values for the following table:

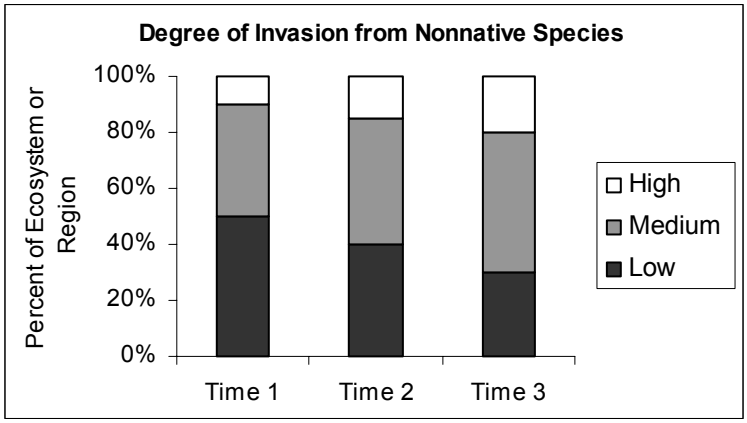
		Vertebrates	Plants	Invertebrates
Ecosystem X				
	Low	0 – X %	0 – X %	0 – X %
	Medium	X – Y %	X – Y %	X – Y %
	High	Y – Z %	Y – Z %	Y – Z %
Ecosystem Y				
etc.				

Note: values for X, Y, and Z could and probably would differ between ecosystems and between vertebrates, plants, and invertebrates

Since there could be three possible "scores" for any ecosystem (i.e., one for vertebrates, one for plants, and one for invertebrates), the following strategy is to be used to generate an overall "score" for an ecosystem or area (see chart below).

Taxonomic Group Rankings (plants, vertebrates, invertebrates)	***Overall Rank***
High rank for any taxonomic group	High
Two (or more) *medium* ranks for any taxonomic group	High
One *medium* rank and two *low* ranks	Medium
Three *low* ranks	Low

This indicator might be presented as follows, presuming sampling was conducted in a fashion that enabled characterization of the condition of large regions or ecosystem types.



Remaining Questions*:*

1) Are we prepared to identify ranges of values for each of the taxonomic groups, for each ecosystem, that would rate as high, medium, and low?

2) Is it necessary to conduct an assessment of all three taxonomic groups in order to have a valid assessment?

3) Are there any aspects of this that would need to be modified to tailor it to specific ecosystem types (other than the values for high, medium, low)?

4) Are there new technological tools that are available but not being used for invasive species that would make the index easier to obtain (cheaper, faster, more precise)?

5) Can we estimate uncertainty? For example (2 above), it may be that including additional taxonomic groups increases the accuracy of the assessment.

6) How would the proposed indicator work for something that has a very high rate of infestation but has killed most of its host off? So, for example, if the current host range is small, but the pre-invasion range was great e.g., Chestnut blight? This raises the issue of whether the indicator is intended to describe the state of the current ecosystem is or the state of the ecosystem that was or could be without the invasive species?

7) It will be important both to provide numerical definitions of low and high degree of invasion, but also to ensure that these definitions can be implemented using standard data collection methods.

8) On what geographic basis should the indicator be applied? Should this indicator be presented regionally or nationally?

Candidate Invasion Impacts Measures

The group identified a single candidate measure of invasion impact that is applicable to all four natural / semi-natural ecosystems, as well as several such indicators that are applicable to specific systems.

The candidate measure that is common to all four ecosystem types would report the *number of instances in which a nonnative species has modified significantly the species composition and function of native species* in an ecosystem. The term *significant* refers to either extinction or a decline in the abundance of a keystone, dominant, or rare species. An *instance* refers to an impact occurring within a single community type or species assemblage; thus, the same nonnative species causing declines in one target species in 5 watersheds would be a single "instance," but if the same nonnative species began to cause a decline in a second native species, this would be a second "instance." Likewise, a nonnative was causing changes in only, for example, shallow prairie pothole wetland ponds, would be considered one instance; if the same species were found to be causing effects in rapidly flowing streams, this would be considered a second instance.

The group noted that this indicator might be relatively insensitive to some kinds of changes that are nonetheless important. For example, a serious decline (but not extinction) of a non-dominant tree species (e.g., butternut) would not constitute an instance for this indicator. (Such changes would be reflected in a separate indicator already included in the report, dealing with numbers of rare and declining species.)

Small working groups were established to further flesh out these indicators, with results to be discussed at the next meeting.

***Remaining Questions**:*

1) Is there sufficient agreement in different ecosystem types as to which species are "dominant" or "keystone" species?

2) What standard would be used to define "rare"? Although this has not been discussed within the group, the Design Committee has rejected the use of ESA listings and endorsed use of listings such as those developed by NatureServe / Heritage programs.

3) How might data for these indicators be obtained? What would be the characteristics of an optimal data set?

The following candidate impacts indicators were suggested for specific ecosystems:

Coasts and Oceans
- Percent of physical habitat (substrate) that has been altered as a result of the action of non-native species. For example, the green alga *Calerpa taxifolia* can cover the ocean floor in the coastal zone, changing the bottom from sand or other substrate, to vegetated coverage.

Freshwater
- Percent of physical habitat (substrate) that has been altered as a result of the action of non-native species. An example might include salt cedar (*Tamarix* spp), which alters hydrology, with significant impacts on stream ecosystems.
- Changes in water chemistry that result from non-natives

Forests
- Number of instances in which a nonnative species has taken over a role / niche of a dominant (?) plant species (role replacement)
- Changes in species composition and function of native species caused by nonnative species
- Mortality of trees resulting from nonnative species or acreage affected by nonnative species.

Grasslands and Shrublands
- Conversion of shrublands or grasslands to other ecosystem type caused by nonnative species (new role / role replacement). This would include changes such as grasslands to forests; grasslands to shrublands, and conversion of perennial grasslands to annual or forb dominated systems caused by nonnative species (new role / role replacement).
- Change in intensity of fire regime caused by nonnative species.
- Birds (need to revisit 2002 bird population measure)
- Wildlife diseases

Preliminary Discussion of Indicators for Farmlands and Urban / Suburban Areas

Farmlands Indicators

There was strong agreement within the group that it was very important to include an indicator that captured the effects of nonnative species on the production of crops and livestock. This contrasted with the focus of the 2002 indicator, which deals with the condition of those lands that are not used for production.

Other options or issues that were noted or discussed:

- Percent of agricultural production that is negatively affected by nonnative species
- Total cost to reduce negative effects of nonnative species (i.e., control activities)
- New nonnative species / pests that are introduced or become established
- Percent of croplands infested with nonnative species
- Pesticide use patterns – quantity, coverage

Urban / Suburban Indicators

Options or issues that were noted or discussed:

- There was some discussion of whether the indicators should apply to all lands (including private lands) or only to lands that were accessible to the public. This point was not resolved.
- The group was not comfortable with the 2002 indicator, which focused not on the origin of the species, but rather whether it was "disruptive" or not. This group felt that inclusion of native species in the indicator would prevent it from providing a good picture of nonnative species effects, and that it was "inconsistent and anthropocentric." [Ed. Note: the 2002 indicator was intended to be presented in a disaggregated fashion, showing both native and nonnative "disruptive" species. See page 192 of the report.]
- There may be utility in distinguishing between species that are planted intentionally and those that escape from cultivation.
- The scope of "nonnative species" is unclear. Some species (e.g., Formosa termites) have effects primarily on human systems (buildings). This can be extended to nonnative species such as HIV. (However, whether one should view HIV as "native to humans" or as "nonnative to North America" was also discussed.) In any case, the group will have to address to what degree nonnative species that affect humans or human systems are to be covered by these indicators.
- Cost of protection and control.
- Quality of life indicators, such as shade lost, species replacement, personal loss (when tree grandfather planted is cut down due to ALHB)

ATTACHMENT A

Attendance at April 16-17, 2003 Meeting
Non-Native Species Task Group

Ann Bartuska (*Chair*)
Executive Director, Invasive Species Initiative
The Nature Conservancy

Jerome Beatty
Deputy Director, Forest Health Protection
USDA Forest Service

Faith Campbell
American Lands Alliance

Gabriela Chavarria
Policy Director, Wildlife Conservation
National Wildlife Federation

Pam Fuller
USGS/BRD
Nonindigenous Aquatic Species Program
Center for Aquatic Resources Studies

Nelroy E. Jackson
Monsanto (*Retired*)

Terri Killeffer
Botanical Research Associate
NatureServe

Richard N. Mack
School of Biological Sciences
Washington State University

Gary C. Matlock, Ph.D.
Director, National Centers for Coastal Ocean Science (NCCOS)
National Ocean Service, NOAA

Richard Orr
USDA Animal Plant and Health Inspection Service
Risk Analysis Systems

Peter M. Rice
Division of Biological Sciences
University of Montana

Greg Ruiz
Smithsonian Environmental Research Center

Chris Dionigi, Ph.D.
Assistant Director for Domestic Policy, Science, and Cooperation
National Invasive Species Council (Liaison to the National Invasive Species Council and the Invasive Species Advisory Council)

Robin O' Malley, Senior Fellow and Program Director
The Heinz Center

By Phone (some or all of the meeting)

Ted Batkin
President, Citrus Research Board

Tom Stohlgren
Biological Resources Division, USGS
Natural Resource Ecology Lab

David Thomas
Director, Illinois Natural History Survey

Kent Cavender-Bares, Fellow and Research Associate

Not in Attendance

Sarah Reichard
Assistant Professor
College of Forest Resources, Center for Urban Horticulture
Washington State University

ATTACHMENT B

Non-Native Species Indicators – *State of the Nation's Ecosystems*

	Indicator Definition	Coverage: All non-native? Only invasives? Only non-native to North America?	Notes / Comments
Coasts & Oceans	Number of species present *and* coverage of available habitat	Refers to EO 13112 definitions of *invasive* and *alien*, but does not specify coverage	Applies to fishes, mollusks, crustaceans, higher aquatic plants, macroalgae. Needs development of algorithm for combining species # and coverage.
Farmlands	For areas with a high percentage of cropland, the percent of non-cropland vegetation that is native	Not specified	Needs definition of "high percentage of cropland," clarification of other elements
Forests	Percent of total area covered by overstory trees and understory trees, shrubs, and ground plants	Applies to all non-native (i.e., invasive and non-invasive); range-shifting species not addressed.	Pathogens, insects not included
Fresh Waters	Number of species with established (breeding) populations by watershed (6-digit HUC)	All non-native; including range-shifting species. Notes future desirability of focusing on small number of truly problematic (invasive) species.	Data for fishes only at this time; indicator would eventually include mollusks, amphibians, plants.
Grass / Shrub	Percent of plant cover that is non-native	Report "all non-natives" and "invasives" separately. Does not specify re: range-shifting.	Pathogens, insects not included
Grass / Shrub	Population trends of invasive bird species compared to non-invasive species	Focused on "invasives," which can be non-native or North American range-shifters.	
Urban / Suburban	Number of *disruptive species* per metro area, disaggregated by native / non-native and plants / animals	Disruptive species *can be either native or non-native*	Pathogens, insects not included

ATTACHMENT C

Comments and Notes on 2002 Indicators and Possible Alternatives

Coasts and Oceans

There was very substantial discussion about, and strong support for, this indicator, which combines a measure of species richness (number or percent of species that are nonnative[3]) with information on the degree to which nonnative species have occupied available habitat. The result is an index of the degree of impact. See Figure 1

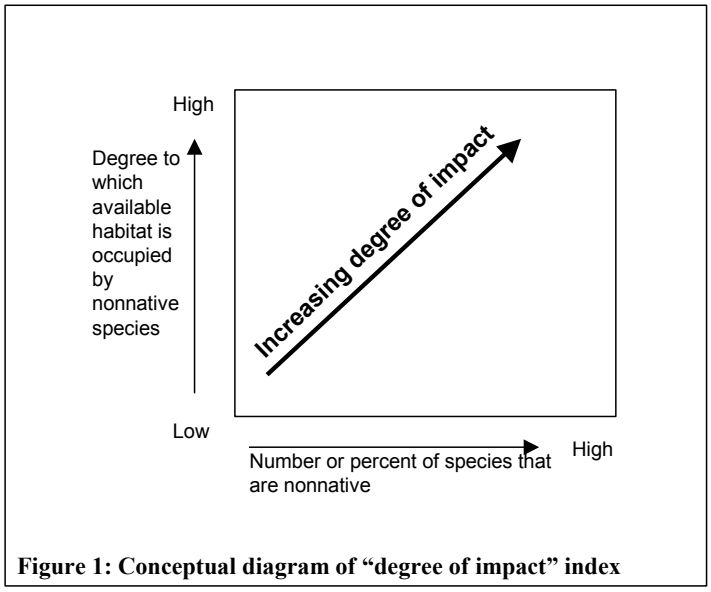


Figure 1: Conceptual diagram of "degree of impact" index

Ultimately, this indicator was not selected, for the following reasons. The primary concern was related to the fact that the dimension of *degree to which nonnative species have occupied available habitat* would have to be an amalgam of information from plants, vertebrates, and invertebrates. Each would be specified differently:

- plants would be described by the percent of ground covered, which might have a range from 0 to well over 100% (in fact multiples of 100 are possible)
- vertebrates would be described by the percent of total biomass, which would have a range from 0 to 100%
- insects/pests/pathogens would be described by the percent of hosts that are infected; again, with multiple pathogens and multiple hosts, this index could have values of 0 to multiples of 100%

[3] There was strong support for both *number* of nonnative species and *percent* of species that are nonnative; however, since this indicator was not chosen, this point did not require resolution.

One member pointed out that it would be very difficult, perhaps impossible, to combine values from three indices with differing scales. Since the group was very uncomfortable with selecting a single taxonomic group (i.e., plants *or* vertebrates *or* invertebrates), this was perceived as a fatal flaw for this index.

Another concern with this indicator was the sense that, for some taxonomic groups and some situations, that the number or percent of species was far less important, provided far less information, than the degree to which habitat was occupied. There was some sense that the species numbers could "overwhelm" the information on occupied habitat, making the index less useful. (This could be addressed through careful calibration of the "degree of impact" values, however.)

Finally, the group as a whole felt quite strongly that setting values for the various index components (i.e., what percentage of species, combined with what percentage of habitat occupied, would constitute a "high" degree of impact) was likely to be a very difficult and potentially very arbitrary exercise.

Fresh Water

The fresh water indicator in the 2002 report was the number of nonnative species with established (breeding) populations by watershed. This indicator would be applied to fishes, mollusks, amphibians, and plants. The group believed that measures that rely upon the number (or percent) of species in an area were flawed, because they did not account for the extent, density, or intensity of the invasion.

Forests and Grasslands and Shrublands

In both these ecosystems, the 2002 report recommended reporting the area covered by nonnative plants. The group felt that indicators that focused on one taxonomic group were flawed because, in this case, a focus on vascular plants ignores the very significant (arguably more significant) impact that various insects and pathogens are having on forests.

Potential Candidate Indicators for Future Consideration

Examples of indicators that might be useful, either if they are further developed or if additional data were collected, were also identified. Some of these were relevant to one ecosystem, while others were potentially applicable in a wide range of settings.

- Changes in dune behavior as a result of nonnative invasion;
- The effects of nonnative species on biodiversity indices. The group recognized several potentially serious problems with such an approach, related to the lack of agreement on and data for biodiversity indices, and to the difficulty of ascribing cause to any observed change in such an index.
- Assessments of the effects of individual species. Analogy was made to fish stock assessments. These are conducted on a stock-by-stock basis. When NOAA reports these assessments, they identify how many stocks are "overfished," how many are not overfished, and how many for which there is insufficient data to make a determination. Impact

assessments could be made on a species by species basis, and reported in much the same manner – how many nonnative species have had a negative effect, how many have not, and how many do we no know enough to make a determination. If such a strategy was employed, it may be necessary to get a "critical mass" of assessments done before beginning to report the data, so that the results would not be biased by the fact that initial assessments would likely be focused on species known to be of concern.

- Number of threatened / endangered / declining species in which the effects of nonnative species were a significant factor in the decline. The group recognized that identifying which causes were most important in the decline of a species is often difficult. If such an approach were used, it might be possible to classify the cases according to strength of inference – "we are certain that nonnatives were a major factor"; "we strongly suspect," "we have reason to believe" etc.
- Water quality impacts were noted as common to a number of aquatic species (salt cedar, watermilfoil, hydrilla, zebra mussels).
- Impacts on human systems or systems of direct human concern (zebra mussels' effect on intake pipes; whirling disease effect on native and nonnative trout populations).
- Percent change in native cover in forests and grasslands/shrublands.
- Board feet of merchantable timber lost to insects / pathogens
- Forest mortality ascribed to nonnative insects and pathogens.