THE
HEINZ
CENTER

Meeting Report
Fourth Meeting of the Non-Native Species Task Group
February 17-18, 2004
The Heinz Center
Washington, DC

The fourth meeting of the Non-native Species Task Group was held on February 17-18, 2004 at the Heinz Center in Washington, DC. Attendees are listed in Appendix B.

The meeting focused on key remaining questions requiring resolution to complete the development of the non-native species indicators whose development was initiated over the course of the previous three meetings. A summary of the decisions reached with respect to specific indicators and the revised non-native species indicators being proposed are included in Appendix A.

<u>Remaining Process</u>

The Task Group identified the following steps needed to complete the group's work:

1. Task Group members will review the descriptions of the non-native species indicators (i.e., Appendix A of this report) and provide any comments or proposed revisions.

2. These descriptions will be sent out for "pre-review" to a list of experts identified by the Task Group members prior to incorporation into the Task Group's full report.

3. The full report will be reviewed by the Task Group, then sent for external review.

4. Task Group members agreed to provide names and contact information for reviewers that will contact personally to request that they review the report. This group needs to be balanced with respect to participation by experts in business, environmental organizations, academia, and government institutions. The report will also be distributed more broadly to interested parties for review.

<u>Additional items</u>

Revisions to Non-Native Pathogens Indicator: At an earlier meeting, the Task Group recommended inclusion of an indicator describing the degree of infestation by non-native pathogens. Following the February meeting, this indicator was reviewed internally to ensure its soundness, and several concerns were identified. Thus, the text and presentation of this indicator have been revised.

The revisions address two key issues. First, the original formula did not adequately address instances in which a single host species is infested with multiple pathogens. The revised text and formula make it clear that a host species infested with multiple pathogens should “score” as more heavily infested than a species with only one pathogen.

Secondly, the original text (and even the title of the indicator) made it seem as if the indicator was reporting the “percentage of hosts infested” – which is not technically accurate. Rather, the indicator (actually an index) reports an overall “score” that has no units – it is simply an index number, with higher values for more-infested areas and lower values for less infested areas.

Finally, the text has been revised to make it clearer and more descriptive.

Appendix A: Summary of decisions and draft of non-native species indicators with full table of proposed indicators.

Appendix B: List of meeting participants.

APPENDIX A: SUMMARY OF OUTCOMES FROM THE FEBRUARY 17-18, 2004 NON-NATIVE SPECIES TASK GROUP MEETING

HIERARCHY OF PREFERENCE: The task group reaffirmed the "hierarchy of preference" for reporting on non-native species. Although pattern indicators (e.g., presence/absence and prevalence) are useful and informative, indicators that move toward reporting on the impacts of non-native species are more desirable (see Hierarchy of Indicator Preference, Figure 1, Page 3).

PATTERN (1 indicator):

PREVALENCE/FREQUENCY OF OCCURRENCE: This indicator describes the number of non-native species encountered per unit area (% AREA WITH INDICATED # OF NON-NATIVE SPECIES). It can be applied to all taxonomic groups and in all biomes and is significantly more informative than the current basic approach of simply reporting presence/absence. The Non-native Species Task Group has recommended that data collection and reporting move rapidly beyond presence/absence toward efforts that are more indicative of the impacts of non-native species on ecosystems.

IMPACT-ORIENTED (4 indicators):

% AREA COVERED BY NON-NATIVE PLANTS: This indicator reports on the percentage of an area that is covered by non-native species by taking a "birds eye view" (i.e., if non-natives appear in more than one strata, total ground coverage is counted a single time only). This indicator can be applied to plants in all biomes, but cannot be combined with indicators applicable to other taxonomic groups.

DEGREE OF INFESTATION BY NON-NATIVE PATHOGENS: This indicator reports different levels of infestation in host individuals by non-native pathogens, and applies to plants and animals in all biomes. (However, questions remain as to whether this indicator can be applied to coastal systems.) Where feasible, infestations will be reported separately for native and non-native hosts.

DENSITY OF NON-NATIVE VERTEBRATES: This indicator reports on the density of non-native vertebrate individuals per unit area in all biomes.

DENSITY OF NON-NATIVE INVERTEBRATES: This indicator reports on the density of non-native invertebrate individuals per unit area in all biomes.

IMPACTS (4 Indicators):

CROPLAND IMPACTS: This indicator was revised to report on the changes in (1) crop yields, (2) other system outputs (including pollination), and (3) control and management costs that result from non-native species. This indicator is not fully developed.

MORTALITY: This indicator would report on the percentage of an area that experiences different levels of mortality caused by non-native species. Specifically, this would report the percent of all mortality that is attributed to non-native species. Mortality can be caused by plants, pathogens, vertebrates, or invertebrates (i.e., all taxa), and can affect plants and animals in all biomes with the exception of plants in grassland and shrubland ecosystems.

DEFOLIATION: This indicator reports on the level of defoliation, which may be caused by pathogens, vertebrates, or invertebrates, in forests and urban and suburban systems. This indicator does not apply to grasslands and shrublands.

ECOSYSTEM CHANGE INDICATOR: This is an idealized, and as yet not fully developed, indicator that arose from the discussion of the "Instances of known impacts" indicator. The indicator would describe changes in ecosystem services, with a focus on changes to ecosystem structure or function, changes in the ability of humans to use or derive products or value from ecosystems, and impacts on human health. For ecosystem structure or function, the task group suggested that such an indicator might include measurements such as decreases in biodiversity, changes in dominance/co-dominance due to non-native species introductions, and changes in disturbance regimes. It was suggested that an impact indicator that reported the effect on ecosystem services could be developed for each biome since the services provided vary by ecosystem type, e.g. changes in hydrologic regime for aquatic systems, changes in recreational capacity for terrestrial systems, etc. Ideally, such an indicator could be reported using some kind of quantifiable 'ecosystem service units.' This indicator would apply to all taxa in all biomes.

OTHER DISCUSSION ITEMS:

"BAD ACTORS": A suggestion to track only those non-native species with well-documented negative consequences in urban and suburban systems was considered, but not adopted by the Task Group. The group was concerned that this approach would not capture those non-native species that were present but perhaps in the future would be documented as having negative effects on the systems that they colonized.

PROPOSED INDICATOR: INSTANCES OF KNOWN IMPACTS: This indicator was viewed as fatally flawed and ultimately rejected by the Task Group because of the difficulties in finding ways to report unbiased instances of known impacts due to non-native species. The Task Group felt that simply quantifying published accounts of known impacts would incorporate the system and species biases of the researchers and was unlikely to include instances where no impact was found since this kind of reporting is rarely done.

DATA QUALITY: The Task Group made the following suggestions regarding data quality for the non-native species indicators:

1. Data included in the report should be made available in such a way that the results in the report are reproducible (transparent process).
2. The report should include data that is mapped using a Geographic Information System in order to demonstrate rates of spread for non-native species.
3. Changes in data collection methods need to be tracked and where possible reconciled.
4. The State of the Nation's Ecosystems report ought to comply with the Data Quality Act (new legislation) in order to assure that federal agencies can use SOTNE.

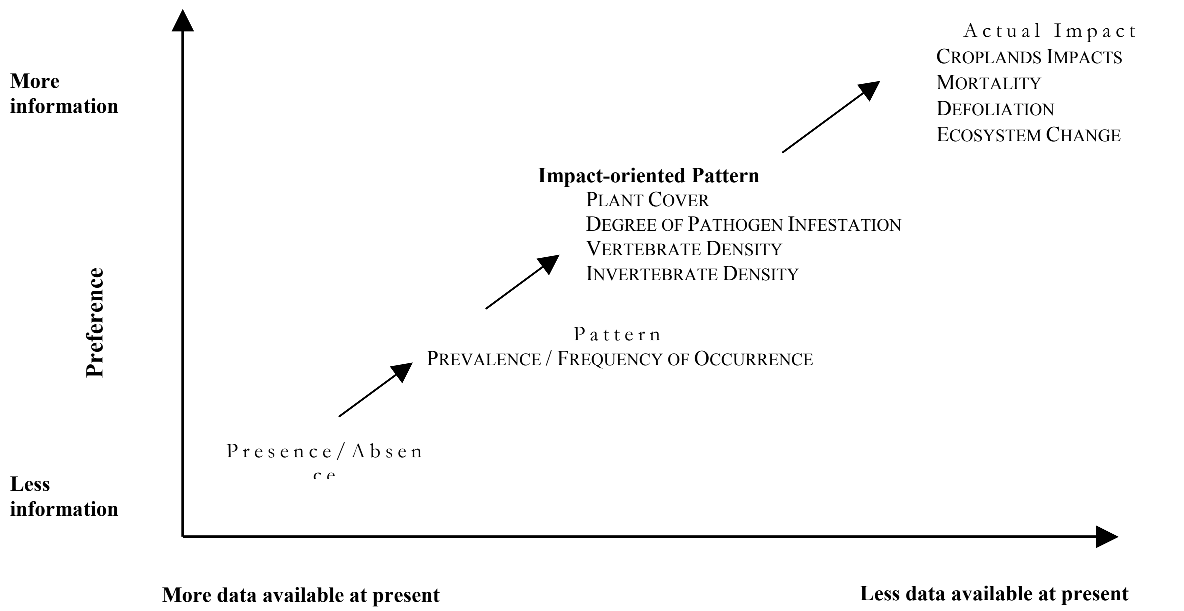
NON-CROP FARMLANDS: The Task Group revisited the question of whether the non-native indicators should address only the cropland portion of farmlands or the non-cropped portion (e.g., hedgerows, etc), or both. The group decided that non-native species indicators should be reported for both the cropped and non-cropped areas, but that these areas should be reported separately. In general, the same indicators that were identified for the other biomes would apply to this area as well.

INCLUSION OF PRESENCE/ABSENCE DATA IN 2007 REPORT: The Task Group recommended that the freshwater non-native species data used in the 2002 *State of the Nation's Ecosystems* report should be included in the 2007 report, despite the fact that it is presence/absence data, which the Task Group believes should not serve as the basis for long-term reporting. The Task Group recommended that the 2007 report text note the strong recommendation to begin moving to data that provides at least the minimum; i.e., prevalence / frequency of occurrence.

Hierarchy of indicator preference

The task group developed a hierarchy of preference for the indicators, beginning with basic pattern indicators and moving towards indicators that describe impacts or provide information that is relevant to degree of impact wherever possible. This ranking of indicators was chosen because the task group decided that whether a species is present or absent is important, but what really matters is the impact that the species are having on the ecosystems that they colonize. At the same time, it is clear that there are fewer data currently available to report on the more information-rich indicators.

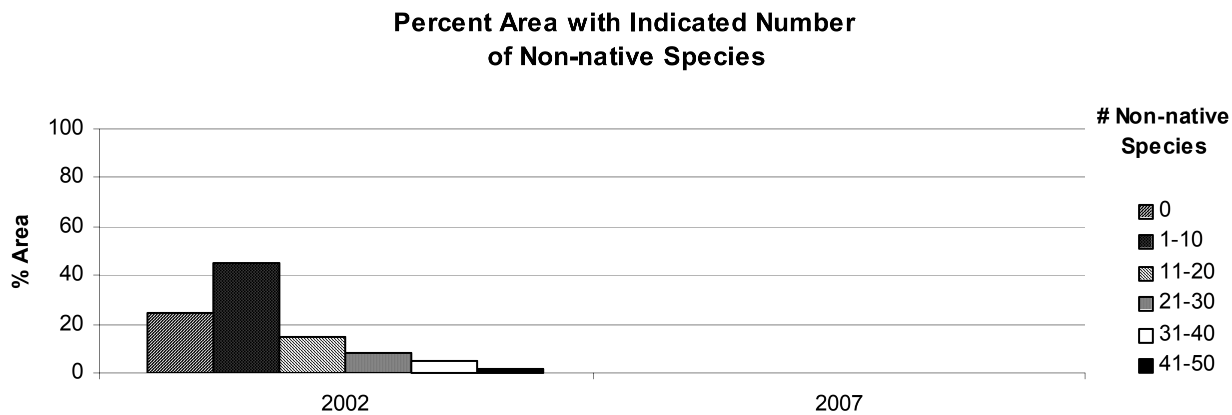
<u>**Figure 1:** Indicator Preference Hierarchy</u>



PATTERN INDICATOR: PREVALENCE/FREQUENCY OF OCCURRENCE

This indicator reports either the percentage of an area with different numbers of non-native species. This would be reported as a time series, and applies to all taxa in all biomes.

Figure 2: Mock Data. For Illustration Purposes Only.



Discussion

Adoption of this indicator accomplishes a major goal of *The State of the Nation's Ecosystems* report, i.e., increasing consistency among and between ecosystems because it is applicable to all taxa across all biomes. Additionally, the pattern indicator can be to "rolled up" to the national level by aggregating the data from all taxa and systems into "core national indicators," and can be used to "drill down" to the local level, making national, regional and local comparisons possible.

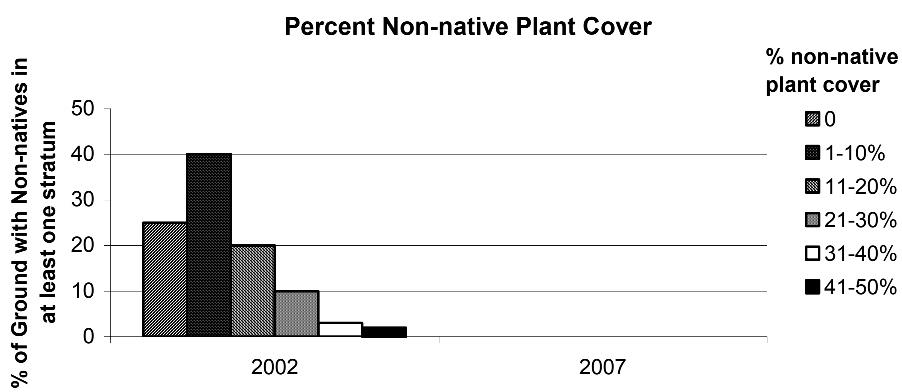
This indicator is immediately practical because much data on non-native species is already collected on an area basis (e.g., # non-native species per unit area), or can be easily collected in this way. In some cases (plants in grassland / shrubland areas), these data can be estimated using spectral signatures from remotely sensed data that are unique to individual species. It is anticipated that data collected using different methods (especially in aquatic systems) can be reconciled and aggregated, although the task group does not minimize the challenge of doing so. Frequency could be expressed for individual species as the % of plots "infected". Among species, it could be expressed as the number of non-native species per plot, or aggregated up to the mean number per plot. These data could then be expanded statistically to represent larger areas.

There are two caveats associated with this indicator. First, the indicator description must make very clear that a higher number of non-native species per unit area does not necessarily result in a greater magnitude of negative impact. Second, individual species could be counted more than once if the species has colonized areas with differing densities of non-native species. That is, a single species might be found in an area with 1-10 non-natives, and might also be found in an area with 11-20 non-natives.

IMPACT-ORIENTED INDICATOR: % AREA COVERED BY NON-NATIVE PLANTS

This indicator reports on the percentage of an area that is covered by non-native plant species in at least one stratum. It would take a "birds eye view" (i.e., if non-natives appear in more than one strata, total ground coverage is counted a single time only). For example, if Japanese stilt grass covers 90% of the ground layer and there are also non-native shrubs growing in the same area covered by non-native grass, the percent area covered remains 90%. By the same logic, if the stilt grass covered 50% of the area, and non-native shrubs covered 20% -- and the coverages were non-overlapping, the percent coverage would be 70%.

Figure 3: Sample Indicator – Mock Data for Illustration Purposes Only



Discussion

This indicator can be used to report on non-native plant cover across all biomes.

IMPACT-ORIENTED INDICATOR: DEGREE OF INFESTATION BY NON-NATIVE PATHOGENS

This indicator reports an index describing the degree of infestation of either plants or animals by non-native pathogens.

The basic unit of information for the index is the proportion of infested individuals in each of the possible host species populations weighted according to the proportion of the total community represented by the infested species. Thus, a system in which a few uncommon species were highly infested would have a lower "degree of infestation" than a similar system in which one or two very common species were highly infested.

Further, the index is calculated so that species that are infested with multiple pathogens are accorded greater weight. For example, a single species in which 10% of the individuals were infested with one pathogen would receive a score of 10, while another species in which 10% of the individuals were infested with two pathogens would receive a score of 20. This approach to multiple pathogens means that the index value may be greater than 100. (Indeed, if all individuals of all species in a system were infested with multiple pathogens, the index value could be several multiples of 100, although this is probably unlikely.)

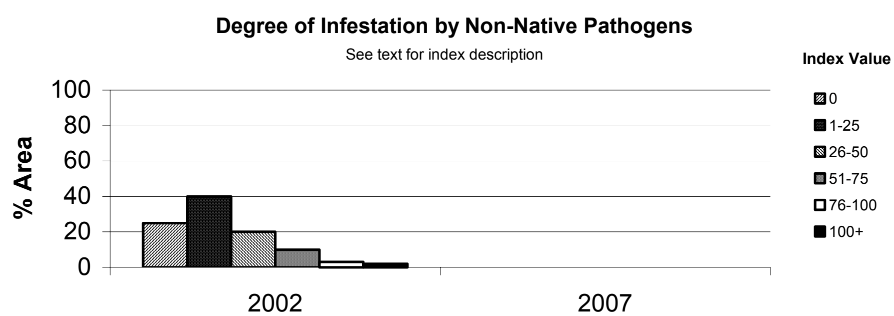
The following formula may be used to calculate the index:

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

For n possible hosts,
The "index of infestation" (which has meaningless units of percent squared, and thus should be reported as a dimensionless index value)) =

$$\sum_{h=1}^{n} E_h \sum_{j=1}^{n} I_{hj}$$

Figure 4: Sample Indicator – Mock Data for Illustration Purposes Only



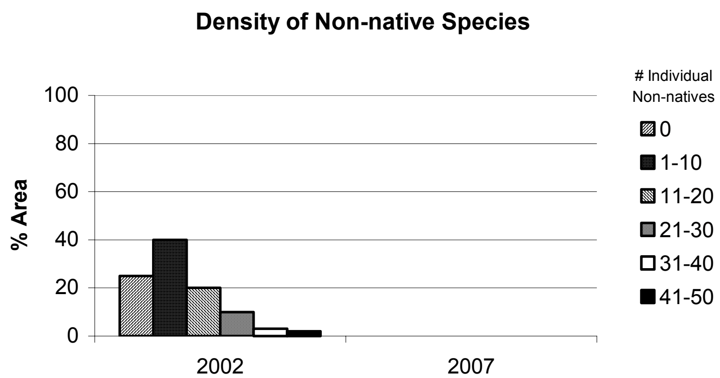
Discussion

This indicator provides a broad view of the degree of overall infestation, including infestations by multiple pathogens, providing a fairly good proxy for impact. This indicator may be applied to plants and animals, including aquatic systems. For all biomes, this indicator will be reported for both native and non-native hosts, but these hosts will be reported separately in all ecosystems.

IMPACT-ORIENTED INDICATORS: DENSITY OF VERTEBRATES
DENSITY OF INVERTEBRATES

This indicator reports the density (i.e., number of individuals) of non-native species per unit area. It is applicable to vertebrates and invertebrates, but these two groups would be reported separately.

Figure 5: Mock Data. For Illustration Purposes Only.



Discussion

This indicator can be reported across all biomes for vertebrates and invertebrates. This indicator goes beyond the basic pattern information (number of species/per unit area) by reporting the number of individual organisms present, and therefore begins to illustrate the effects that non-native species have on the system relative to native species and to demonstrate how these effects are changing over time. Density data are relatively easy to gather or estimate, and in many cases are routinely collected. This approach also allows for quantitative comparisons across ecosystems and over time.

This is a quantitative approach that implies that a larger number of individuals have a greater level of impact. However, but it must be made clear that the density of a particular species may not truly reflect its impact on a system. Much depends on the particular species and the particular system colonized, and there is no predictable ratio between the number of individuals and impact (e.g., 5 bass ≠ 1 carp).

IMPACT INDICATOR: CROPLANDS IMPACTS

This indicator would require additional development prior to implementation.

The basic idea behind the indicator would be to report on changes in outputs from the agricultural system and/or changes in control and management costs that result from infestations of non-native species. Quantifying many of these elements is difficult in part because this information is not routinely collected, and in part, because there are conceptual difficulties in quantifying non-commodity outputs from ecosystems (i.e., "ecosystem services").

Changes in "system outputs" would include both changes in agricultural output (i.e., yield) and what are often referred to as "ecosystem services" – pollination, soil production, carbon storage, cleansing of runoff, etc. While changes in yield are relatively straightforward to quantify[1], attributing yield changes to specific factors is problematic. Yield can be affected by weather, production practices, seed varieties, native pests and weeds, non-native pests and weeds. We are not aware of any techniques currently used or in testing / development that would allow such quantification.

Changes in individual "ecosystem services" – numbers of pollinators, or change in carbon stored – is also relatively straightforward, but it is less clear whether an aggregate index can be developed to describe quantitatively the "bundle of services" that might be generated for any specific area or region.

Changes in control and management costs would include increased pesticide application and other changes in production practices. Changes in control and management costs are not a direct measure of changes in ecosystem condition. However, increased presence of non-native species often generates management responses that reduce pest or weed quantities, increased management costs is viewed by many as a surrogate for the presence of or pressure from non-native species. That is, the presences of non-native species is obvious if one sees non-native species in a field, but it is less obvious, although no less real, if one sees increased management activity that is a result of such actual or incipient presence.

Crop yield and a host of other farm-specific data are currently collected by the National Agricultural Statistics Service (USDA-NASS), and it is possible that data on yield reductions and other impacts described above due to non-native species could be collected as well.

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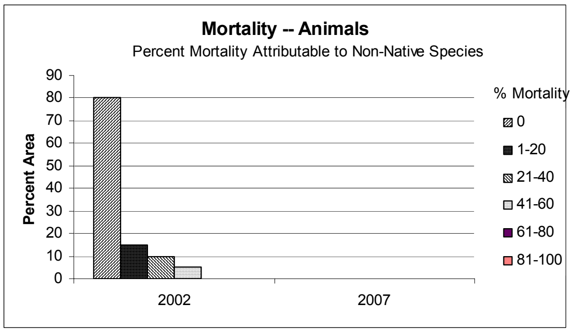
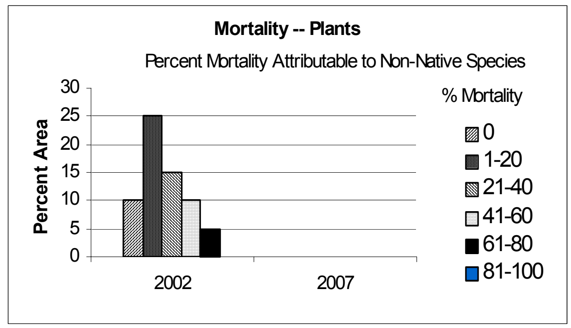
[1] Changes in yield might also include decreased cosmetic quality of fruits and vegetables due to infestations of non-native species, and likely results in lower prices being commanded for the produce, but this information may be difficult to capture.

IMPACT INDICATOR: MORTALITY

This indicator reports on the percentage of an area that experiences different levels of plant and animal mortality, caused by non-native species. Specifically, the indicator would report the percentage of total mortality that is attributable to non-native species. This indicator applies across all biomes and taxa except plants in grassland and shrubland systems.

Figure 7: Sample Indicator – Mock Data for Illustration Purposes Only.





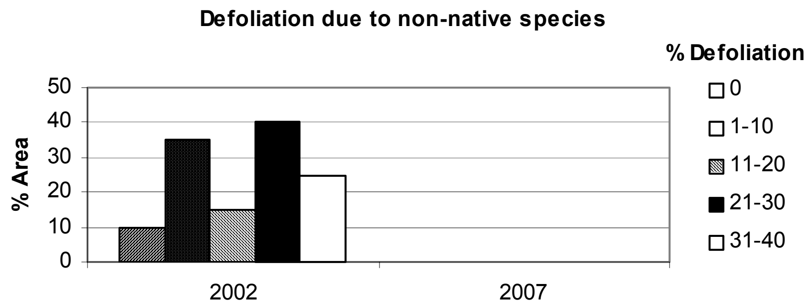
DISCUSSION

While relatively easy to measure using the appropriate methods, it should be noted that mortality is only one of the possible negative effects of non-native species on plants and animals. For example, non-native species can reduce productivity or biomass, or reduce fitness. Further, attributing mortality to non-native pathogens can be complicated when environmental conditions, such as drought, can cause a species to be more vulnerable to a pathogen or could in fact be the actual cause of mortality.

IMPACT INDICATOR: DEFOLIATION

This indicator reports on the level of defoliation or damage, caused by pathogens, vertebrates, or invertebrates, in forests and urban and suburban systems.

Figure 8: Mock Data. For Illustration Purposes Only.



DISCUSSION

Information for this indicator could be collected using remotely sensed data. However, directly attributing defoliation to specific non-native vectors (pathogens, vertebrates, invertebrates) could be difficult.

IMPACT INDICATOR: ECOSYSTEM CHANGE

This indicator would require additional development prior to implementation.

The basic idea behind this "ultimate" indicator is that the introduction of non-native species can have a variety of impacts on native ecosystems. Ecosystem impacts can be many and varied, and can range from direct competition and predation, changes in disturbance regimes, changes in biochemical cycling (nutrient cycling), changes in geophysical parameters (water table depth, sediment accretion or erosion), changes in species composition. Non-native species can also affect the production of goods and services of direct interest and use to humans. Examples include changes in forage composition and desirability, direct effects such as the blockage of water intakes by zebra mussels, effects on agricultural production, and effects on human health (e.g. West Nile virus).

Ideally, a metric could be developed that would aggregate these impacts. Such a metric would be similar or identical to indices of overall ecosystem services, which although discussed conceptually, do not presently exist in any quantifiable form. Were such an index to exist, changes in the index that are attributable to non-native species could, at least conceptually, be reported.

	COASTS	FRESH WATER	FARM (CROPS+ ANIMALS)	FARM (NON-CROP)	FORESTS	GRASS / SRHUB	URBAN / SUBURBAN
PLANTS	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence
	% Cover	% Cover	% Cover	% Cover	% Cover	% Cover	% Cover
	Mortality Ecosystem Change	Mortality Ecosystem Change	Croplands Impacts Mortality Ecosystem Change	Mortality Ecosystem Change	Mortality Ecosystem Change	Mort: Plants: NO Mort: Animals: YES Ecosystem Change	Mortality Ecosystem Change
PATHOGENS	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence
	Degree of infestation	Degree of infestation	Degree of infestation	Degree of infestation	Degree of infestation	Degree of infestation	Degree of infestation
	Mortality Ecosystem Change	Mortality Ecosystem Change	Croplands Impacts Mortality Ecosystem Change	Mortality Ecosystem Change	Mortality Defoliation Ecosystem Change	Mort: Plants: NO Mort: Animals: YES Ecosystem Change	Mortality Defoliation Ecosystem Change
VERTEBRATES	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence
	Density	Density	Density	Density	Density	Density	Density
	Mortality Ecosystem Change	Mortality Ecosystem Change	Croplands Impacts Mortality Ecosystem Change	Mortality Ecosystem Change	Mortality Defoliation Ecosystem Change	Mort: Plants: NO Mort: Animals: YES Ecosystem Change	Mortality Defoliation Ecosystem Change
INVERTEBRATES	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence	Prevalence
	Density	Density	Density	Density	Density	Density	Density
	Mortality Ecosystem Change	Mortality Ecosystem Change	Croplands Impacts Mortality Ecosystem Change	Mortality Ecosystem Change	Mortality Defoliation Ecosystem Change	Mort: Plants: NO Mort: Animals: YES Ecosystem Change	Mortality Defoliation Ecosystem Change

Appendix B: Meeting Attendance

Meeting Attendees

Ann Bartuska, Chair
Deputy Chief, Research and Development
USDA Forest Service

Jerry Beatty
Deputy Director, Forest Health Protection
USDA Forest Service

Faith Campbell
The Nature Conservancy

Nelroy Jackson
Monsanto (retired)

Terri Killeffer
Botanical Research Associate
NatureServe

Gary Matlock
Director, National Centers for Coastal Ocean Science (NCCOS)
NOAA NOS

Peter M. Rice
University of Montana
Division of Biological Sciences

David Thomas
Director
Illinois Natural History Survey

Task Group Members Unable To Attend

Gabriella Chavarria
National Wildlife Federation

Chris Dionigi (Agency Liaison)
Liaison to the National Invasive Species Council and the Invasive Species Advisory Council

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

Richard Mack
University of Washington
Global Invasive Species Program

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

Greg Ruiz
Smithsonian Environmental Research Institute

Tom Stohlgren
Biological Resources Division, USGS
Natural Resource Ecology

Heinz Center Staff

Robin O'Malley, Senior Fellow and Program Director

Laura Meyerson, Staff Scientist