

Reference Values

“To evaluate and use indicators, it is often highly informative to compare status and trends measured by the indicator against some ‘reference state’. Without such a baseline, it is hard to assess the magnitude of change objectively, whether the magnitude of change is important, or if any efforts at amelioration are succeeding.”
(National Research Council 2000)

What is a Reference Value?

“Indicators will only work when they can be referenced against a target.”
(Woodley et al. 2000)

Reference values come in a wide variety of names (benchmark, standard, trend, threshold, desired future condition, norm); but all refer to a comparison to which an indicator can be examined or gauged. The reference value gives a point of reference to help interpret what we know about an indicator; to force discussion about what the measurement of an indicator is telling us; to help us assess whether we are moving in the desired direction and at the right pace; and to help identify what other things interact with or are affected by that indicator.

The result of comparison against a reference value may, at the scale of an individual indicator or measure, trigger a range of responses including management action to correct an undesired situation, special cause-and-effect monitoring, intensified sampling, a change in a management standard/threshold or in the choice of the measurement protocol. Beyond the evaluation of the status of individual indicators, reference values allow the user to synthesize across a suite of indicators and assess the overall state of the systems compared to a desired target.

Reference values, although commonly used in other forms of scientific monitoring and in our everyday life from assessments of the economy to our health, are only beginning to be used in sustainability monitoring. In their assessment of a broad range of C&I initiatives, the Northeastern Area Sourcebook (NE For. Res. Plan. Assoc. 2001) noted that six of the 39 initiatives included some form of reference values from broad benchmark-type statements consisting either of broad qualitative and directional statements (e.g., reduced rate of forest land conversion) to more specific time-oriented, quantitative reference values (e.g., conserve x percent land by x date). The Oregon Benchmarks program is one of the best examples of a benchmarking approach to reference values (Figure 1). When the terms and words used in indicators are examined a bit more closely, however, the numbers of initiatives implying the use of reference values is much greater as many C&I initiatives define indicators with an implied direction.

Types of Reference Values

Reference values are the benchmark, standard, trend, threshold, or desired future condition against which measures are assessed. Reference values provide the means to determine movement towards or away from a desired target for any given indicator.

Reference values help us evaluate how we are doing; consequently, their utility critically hinges on the rationale for what we choose as the bases of these values. Reference values can be formed on a variety of different kinds of bases from current conditions to legal standards to historic range of variation (HRV). All present potentially logical foundations for forming reference values.

A variety of different terms are used to describe reference values. There is little consistency in the use of the terms, and they are not necessarily mutually exclusive. In any given suite of C&I the reference values may be or a combination of different forms or terms as explained below.

Thresholds. The maximum or minimum values of an indicator are its thresholds. They indicate the region of change in the value of an indicator beyond which precipitous declines will occur (e.g., an amount of habitat loss from fragmentation beyond which interior-dwelling species will not be able to survive). Identification of thresholds is very important because indicators do not necessarily progress in a linear fashion, but in reality few actual thresholds are known.

Benchmarks. Points of reference against which a measurement can be made and against which others may judge progress. Benchmarks can be quantitative or qualitative, input or outcome, short-term or long-term. The use of the term *benchmark* is fairly broad and may encompass a range of other kinds of reference values. Some view *benchmark* conditions as a set of intermediate conditions or points along the way to the desired future condition. Harwell (1999) notes that intermediary benchmarks may be particularly useful if, for example, the ecological condition is far removed from the desired condition and progress is focused more on restorative actions.

Reference Condition. Values that may be established based on reference to documented historical values (e.g., HRV) or on monitoring and comparison to nonaffected systems are reference conditions. Some people describe reference conditions as “bounding conditions,” for example, a descriptor of a measure at each end of a spectrum from a high degree of disturbance to a high degree of pristine ecological condition (Harwell 1999).

Targets/Desired Future Conditions. According to Lammerts van Bueren and Blom (1997), a target is a “reference value to strive for.” A target may also be a desired level to be achieved by an indicator. Further, a target by identifying the character of a desired future condition may represent that condition.

Norms. “A norm is the reference value of the indicator and is established for use as a rule or a basis for comparison. By comparing the norm with the actual measured value, the result demonstrates the degree of fulfillment of a criterion and of compliance with a principle” (Lammerts van Bueren and Blom 1997).

Standards. Any agreed upon value or measure can be regarded as a standard. They are frequently associated with Forest Plan standards. Standards may be legal or regulatory targets that must not be violated (e.g., human health water quality standards).

Trends. Reference values based on an assessment of trends look at change in data values over time and potentially at the rate of change. Maclaren (1996) notes that trend indicators “provide only indirect information about the future, they are more useful for reactive rather than proactive policy-making. This is because a review of trend indicators can signal when corrective action may be needed, but they are poor at anticipating future problems, and cannot help us to design policies that will prevent these problems from happening in the first place.”

References

- Harwell, M. A. (1999). "A framework for an ecosystem integrity report card." *BioScience* 49(7): 543-557.
- Lammerts van Bueren, E. and E. M. Blom (1997). *Hierarchical Framework for the Formulation of Sustainable Forest Management Standards*. Leiden, The Netherlands: Bickhuys Publishers.
- Maclaren, V. (1996). *Developing indicators of urban sustainability: a focus on the Canadian experience*. Toronto: ICURR Press.
- National Research Council. (2000). *Ecological indicators for the nation*. Washington, D.C.: National Academy Press.
- Northeastern Forest Resource Planners Association. (2001). *Sourcebook on Criteria and Indicators of Forest Sustainability in the Northeastern Area (Discussion DRAFT)*. NAASF.
- Oregon Progress Board. (2001). *Achieving the Oregon Shines Vision: The 2001 Benchmark Performance Report*. Report to the Oregon Legislative Assembly.
- Woodley, S. J., Alward, G., Gutierrez, L. I., Hoekstra, T. W., Holt, B., Livingston, L., Loo, J., Skibicki, A., Williams, C. & Wright, P. (2000). *North American Test of Criteria and Indicators of Sustainable Forestry. IMI Report Number 3*. Fort Collins, CO: Inventory and Monitoring Institute. Also available electronically at: http://www.fs.fed.us/institute/cifor/cifor_1.html

Lessons Learned and Tips on Using Reference Values

During the LUCID Project forest teams experimented and tested the idea of using reference values for monitoring indicators. Highlights of some of those lessons learned and tips are presented here. For more complete information please see chapter 10 of the LUCID Technical Edition.

Challenges When Using Reference Values:

- Difficulty defining reference values (hard to identify threshold because of lack of information and because it is a subjective process).
- Reference values are subjective in nature (Although there are certain thresholds (albeit hard to identify) beyond which recovery is difficult, many different states can be sustained if the appropriate energies (e.g., management action or resources) are directed to sustaining it.)
- Standardization of reference values (especially when used in a range of settings).
- Implications that using reference values creates a determination of sustainability (misinterpretations that an individual indicator has an absolute value and that subsequently an absolute determination of sustainability can be made simply by summing up the scores of indicators in comparison to their respective reference values).

Merits of Using Reference Values

- Clarification of what is being measured and why, with a reexamination of the measure and the questions the indicator was addressing.
- Identifying the right spatial scale (determining whether or not there needed to be variation in the measures and reference value across different units. For example, could the same reference value

be applied to adjacent counties, watersheds, or forest types or were different reference values needed?)

- Identifying priority measures by determining whether a measure was sensitive to change or had a high information value.
- Creates discussion to address differing perspectives on the meanings or basic assumptions of sustainability.
- Elicits discussions on the temporal dimension to sustainability. Not only did teams discuss the time frame over which a change in values should be measured (for example to smooth out short-term variations), the discussion also often focused on the critical aspect from a sustainability perspective being the rate of change.
- Developing reference values leads to the identification and intervention of missing measures or other information

Lessons Learned from the Process of Developing Reference Values

Participants had no preconception of the complexity and challenge involved in comprehensively using reference values and did not know what would be learned or what would be the value gained. Forest teams reported that developing reference values was the most difficult part of the process and they provided many suggestions for modifying it. Key suggestions include the following:

- à Take time to clarify the rationale and implications of the reference value;
- à Document assumptions used;
- à Start early in the process, to clarify and revise indicators and measures;
- à Be specific;
- à Establish reference values using a collaborative, interdisciplinary approach rather than leaving these to individual specialists.
- à Discuss interrelationships between reference values, and use this information to help clarify systems relationships and tradeoffs between reference values;
- à Recognize that clarifying these tradeoffs will lead to some conflict;
- à Carefully assess the usability of legal standards, their underlying assumptions and scientific validity, and consider a second reference value if necessary; and
- à Seek external expert judgment and input.

The experience of setting reference values proved to be challenging and often imprecise, but LUCID participants found it to be a critical part of the process of monitoring for sustainability.