

Appendix 2. Indicators for Analysis of Water/Road Interactions

The following indicators may be useful in analyzing the effects of roads on aquatic and riparian resources.

Exercise caution when any indicator. Indicators alone cannot answer questions, and they can be misleading or misused. Indicators should be chosen, applied, and interpreted only in the context of understanding how roads can affect watershed processes. First, processes must be understood, and then well thought-out hypotheses formed about mechanisms of impact. Then, indicators and road performance data can be developed to test the hypotheses and add spatial and quantitative relevance. The results must then be interpreted in the context of all other watershed processes, with a keen eye to recognizing inherent limitations and assumptions.

Testing indicators

The use of an indicator implies the existence of certain environmental conditions. Usually, this association is based on correlative studies between some variable (the indicator) and the response variable of interest. The true set of environmental variables that produce the response are often complex, unmeasured, or unknown. The ability of an indicator to correctly predict a response depends on the quality of the correlative study and works best when applied under the exact set of conditions under which it was developed. When an indicator is used for a different purpose than intended, or subjected to a different set of conditions, the results can be misleading or incorrect.

Before using an indicator or collection of indicators to draw conclusions about the effects of roads on watersheds, the relation of the indicator to actual effects should be tested. That is, actual data on road performance should be related to the candidate indicator to determine if it is sensitive to and can predict the effect of interest. Simply because a good correlation is found between the indicator and the observed effect does not imply that the measured indicator is the causation of the effect; it may only be correlated to the response. For example, there may be a good correlation between road density and stream sediment levels. The causative mechanism is not the density of roads, but the amount of compaction, drainage rerouting, unstable fills, and other sources of erosion. Simply reducing road density without paying close attention to reducing the sources of sediment will not produce the expected result of reducing sediment. In the discussion that follows, indicators testing is shown as an example of this important step in using and interpreting indicators.

For each indicator, the following are given

- Name of indicator
- Questions potentially addressed

- Description of indicator
- Units of indicator
- Scales
- Related indicators
- Utility
- Acquisition
- -Data needs
- Accuracy and precision
- Durability
- Monitoring value
- Limitations
- Typical availability
- Where applicable
- Examples
- Development needs
- Tools references

A note on the examples

For each of the indicators we provide examples from specific places where they have been used in actual analytical efforts. Many of the examples are from West Coast national forests, especially the Six Rivers. These are given as examples only. Some of the example indicators likely have general value while others might be of limited or local value only. The examples and associated testing show relations that should not be considered applicable to other geoclimatic settings.

Further development is needed

This appendix discusses a small set of relatively easy-to-derive indicators applied to just a few areas. As analysts conduct roads analysis, we expect that new ways to effectively and efficiently learn about the influences of roads on watersheds will be discovered, and indicators appropriate for specific areas will be developed.. We encourage the active development and sharing of these approaches in service of understanding road effects and putting them into proper analytical contexts.

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