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# What a long strange trip it's been
# - or -
# Who took the synthesis out of analysis?

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As originally conceived, watershed analysis is a synthesis of information that focuses on issues important to a particular watershed in the context of larger eco-scape scales. Some practitioners of watershed analysis have ascended a steep and unfamiliar learning curve of synthesizing between disciplines and agencies and addressing ecosystem issues at a large scale. Yet, after two years of interagency watershed analysis, many analysis products show little evidence of synthesis having taken place. The implication? "Watershed analysis" was never done. What was done was "watershed characterization". What went wrong? Comparing the original steps in watershed analysis and their underlying philosophy (Reid and McCammon, 1993) with the current counterparts (REO, 1995) reveals that synthesis often has been deferred to give disciplines a familiar free rein to strut their stuff (Table 1). In this review, we will first revisit steps in watershed analysis according to the original version and then briefly discuss what we believe have been fatal departures taken by many watershed analyses. Other series of steps may lead to effective watershed analyses, but the original version serves as an example of how synthesis can be incorporated throughout.

Originally, pre-existing information and data were to be identified and located as a preparatory stage before the watershed analysis team entered the picture (Table 1). It was to be done "at least two months before analysis is scheduled to begin...by personnel of the principal land-management agencies in the watershed" (Reid and McCammon 1993, p.7).

Synthesis was to be achieved in watershed analyses through a simple ploy: each watershed analysis was to be focused on the issues of concern for the watershed. Thus the first stage in the watershed analysis was to identify issues that people care about in the watershed. It was critical to talk to the people (public people, not just agency people) who might care about those issues, because agencies performing the analysis (and particularly the agency charged with managing the land) tend to have a biased view of what is considered important in a watershed. An important product of the analysis would be a clear picture of what people outside the management agencies considered to be important. The agencies' lack of appreciation for the wider context of interest has caused unexpected controversies over land management in the past, and this simple measure was intended to prevent such blind-siding in the future. Instead, many of the watershed analysis teams have found it more convenient to sit in a room and have each discipline's representative list the issues that are important to them, thus destroying the intent and potential utility of this first stage.

These focal issues next would be examined by the interdisciplinary and interagency watershed analysis team to answer the question: what types of impacts could affect the issues (Stage 2)? Interdisciplinarity was essential at this point because it is impossible to ask this question-let alone answer it-without a broad understanding of how processes interact. Interagency effort was essential at this point to ensure that issues would not be subverted by individual agency biases. Strong interagency participation lends support to the credibility of the eventual report. Much of Stage 2 could be done through brain-storming by the assembled interagency and interdisciplinary team. The process was expected to produce flowcharts that would identify the potential influences on each issue and show how those influences interacted (e.g. Figure 1). Each flowchart, by nature, would be an interdisciplinary synthesis of information. At this stage, the assembled interdisciplinary expertise could begin to prioritize the potential impact mechanisms according to which are most likely to be important in that particular watershed. Since each mechanism involves interdisciplinary interactions (e.g. vegetation change affects hydrology affects fish), prioritization can only happen through interdisciplinary-synthesis-reasoning.

The next step (Stage 3) was to use the interdisciplinary hypotheses about important impact mechanisms to divide up the watershed into sub-areas that are likely to behave similarly with respect to the issue in question. Each issue or hypothesized mechanism will likely generate a different stratification scheme. Again, this can only be done through the combined efforts of everyone on the team. As in all previous stages except the preparatory one, this stage is synthesis.

Now begins the detective work (Stages 4 and 5). The hypotheses for impact mechanisms must be tested by examining evidence in the field or in the data provided for the analysis team's use. Together, the team was to examine field sites and data to evaluate the importance of the hypothesized mechanisms and to identify the factors influencing the mechanisms' strengths. At the same time, interdisciplinary reasoning allows the problem to be approached from the other end: the history of land-use activities in the watershed can be used to infer the changes in primary driving variables. With the combined efforts of the assembled expertise, the effects of the changes in driving variables on the mechanisms of influence can be inferred.

As an example, if reduced salmon runs ('fewer salmon', Figure 1) are identified as an issue for a watershed, local information can be used to focus on the sub-issues (e.g., stranding of young salmon) in that particular watershed. Potential mechanisms affecting this sub-issue might be dewatering by diversions, increased intergravel percolation due to aggradation, decreased baseflows due to increased quickflow runoff from compacted soils, perceptions shaped by five years of drought, channel widening due to bank erosion, increased water consumption from conversion to thirstier plants, or altered channel morphology after a major flood. It would take experts of several different flavors and multiple lines of evidence to evaluate the likelihood of any of these potential mechanisms operating in the watershed. Evaluation of the influence of past land use on the factors that control each of these potential mechanisms would provide some of those lines of evidence, and this type of evaluation, too, could only be done by the representatives of several disciplines working together. Such an analysis cannot be done in series (vegetation hands it off to hydrology who laterals to fish), but must occur in parallel (the 8-person WA shell strokes to glory).

Once the mechanisms that have affected each issue are understood and prioritized by their hypothesized level of influence, their likely future effects can also be inferred if the team works together (Stage 6). This information then allows the likely effects of management options to be evaluated.

Note that during no stage in the analysis is a disciplinary representative working on their own - there is no need for a synthesis step, because every single stage in the analysis is a synthesis stage.

There are two reasons that the analysis procedure was originally designed to follow this sequence of stages. First, this is the approach that has ordinarily been followed in the past by successful ad hoc applications of "watershed analysis", ever since G.K. Gilbert (1917) analyzed downstream impacts of nineteenth-century hydraulic mining in the Sierra foothills. Second, it was realized that the concept of watershed analysis was going to be difficult for the agency workforce to grasp: it essentially requires that specialists focus on generalities and not specifics, and this is antithetical to the type of work the specialists have done in the past. The concept is also counter to the common organizational structure in which disciplines and agencies compete rather than cooperate. To get the basic idea of watershed analysis across, it was necessary to develop a procedure that would not permit the business-as-usual approach to prevail. Thus, the procedure focused on issues rather than on disciplines. We were afraid that if the procedure allowed a disciplinary focus, the result would be massive, unsynthesized compendia of disciplinocentric data dumps.

After development of the first procedure, the interagency analysis method was progressively "refined" to make it more "doable" and "understandable". Inevitably, this led to a repackaging of the ideas to more closely resemble familiar "interdisciplinary" strategies that had been used in the past (e.g., NEPA analysis). That is, let each discipline exercise its most advanced state-of-the-art data gathering, and then get someone to integrate the results. Although the REO (1995) version explicitly promotes interactions between disciplines, each discipline is given its separate assignments and "Synthesis and Interpretation" does not happen until Step 5 of six steps (Table 1). The result? Since there is no longer a need to introduce synthesis at the stage at which it can actually be effective-the beginning of the analysis-the reports are unsynthesized compendia of disciplinocentric data dumps. The preparatory step that was to have been done before analysis begins-identify and assemble the available information-has become the central focus of the whole procedure. By turning the procedure into something comfortable and familiar, the revised guide turns the results into something comfortable and familiar. It is not surprising that lack of synthesis has become a problem: the revised procedure is designed that way.

We believe there have been some real costs to the deferral of synthesis in watershed analyses. Watershed analysis was intended to provide the basis for interdisciplinary understanding that would permit enlightened ecosystem management. Not only have many watershed analyses not lived up to this expectation, but watershed analysis has also become a monstrous process-an Olympic event in a GIS arena in which disciplines compete to show off their latest stuff. As a result, watershed analyses often employ the multitudes, not the several, and take months, not weeks. Ecosystem management at the watershed scale hangs in the balance: Are we capable of integrating ecosystem processes at a variety of scales in a practical framework, or will society tell us to give up and return to days of old? We believe that by synthesizing and integrating multidisciplinary information from start to finish we can produce better watershed analyses in a shorter time using fewer people.

## References


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Regional Ecosystem Office. 1995. Ecosystem analysis at the watershed scale: Federal guide for watershed analysis. Portland, OR, 26 p.

Reid, L.M., and B.P. McCammon. 1993. A procedure for watershed analysis. Review draft prepared for the Interagency Forest Ecosystem Management Assessment Team, 14 July 1993. 139 p.


**Table 1.** Comparison of stages in watershed analysis.

| Reid and McCammon, 1993 | | Regional Ecosystem Office, 1993 |
|---|---|---|
| (preparatory) Assemble information | | |
| 1. | Identify issues and concerns | Characterization |
| 2. | Identify mechanisms for environmental change | Issues and key questions |
| 3. | Stratify the watershed | Current conditions |
| 4. | Describe existing conditions | Reference conditions |
| 5. | Describe impact mechanisms | Synthesis and interpretation |
| 6. | Describe future impacts | Recommendations |
| 7. | Prepare the report | |

**Figure 1.** A brainstorming "mind map" of mechanisms that could have led to the observed increase in stranding of young salmonids in an analysis watershed. Once the problem is diagrammed, it is possible to

design an efficient strategy for evaluating the problem. In this case, interactions are shown by duplicating entries (e.g. "shallower channels" shows up several times), and triggering changes related to land-use activities are not yet added.