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By Robert G. Bailey, USDA Forest Service, Inventory & Monitoring Institute

A Suggested Way to Improve the Subsection Mapping Process

Abstract: A map showing the upper four levels of Ecomap down to the section level has been published for the entire U.S. A national team is working to complete a map of the fifth level, termed subsection. The subsection mapping process, however, employs a gestalt approach to defining subsection boundaries. The resulting map appears problematic both in terms of the underlying rationale and in terms of conflict with preexisting maps of the upper levels of Ecomap. I suggest that an alternative route that builds on rather than competes with existing approaches would be to continue at the subsection level the physiographic delineators that characterize the approach used to delineate sections on the published map.

Introduction

Ecomap (1993) is an eight-level, nested, hierarchical and multi-factor approach to classifying and mapping ecosystem units (**Table 1**). The approach (herein referred to as the National Hierarchy) has been adopted by the Forest Service to provide a framework on which National Forest planning and assessment could be built.

Maps of the coarser levels of the National Hierarchy (domain, division, province, and section) have been published (Bailey et al. 1994). Delineation of the remaining,

finer-grained subdivisions (subsection, landtype association, landtype, and landtype phase) has been left for local development. Experts from each Forest Service region trying to complete Ecomap have been provided with limited suggestions about how that should be accomplished.

Problems with the current process

A review of Ecomap (1993) literature reveals a lack of guidance for finishing the Ecomap classification to its finest level. Instead of articulating specific mapping criteria, Ecomap provides only vague statements about an integrated approach using multiple biotic and abiotic factors. It mentions overlaying maps to look for associations of these factors to identify ecological units with similar patterns. It further suggests that these factors may vary in importance geographically. However, Ecomap establishes neither rules nor direction for how this should be done or what factor combinations to look for.[1] In the absence of such rules, ecomappers working to produce finer-grained categories have employed a *gestalt* approach in which boundaries are drawn intuitively around areas that appear homogeneous (Bailey 1996), combining or synthesizing various existing classification schemes not necessarily with the same genealogies. Units generated without identifying which factors were considered are difficult for others to scrutinize or confirm. The results are therefore difficult to communicate convincingly to planners and decision makers.

Additional problems with this approach are readily apparent when a map produced without rigorous control over principles and methodology is joined together

[1] Although the "Terrestrial Ecological Unit Inventory Technical Guide," dated May 5, 2003, offers a great deal of guidance on how units should be classified and described, the sections on map unit design and delineation suffer from the same criticism.

with those of adjacent areas. Under the direction of the National Hierarchy, each Forest Service region was charged with the task of completing an ecological subsection map. However, there is not a universally shared understanding of the concept of a subsection. As a result, subsection delineation was not applied uniformly across the country, and the maps of subsections varied widely. For example, personnel of several of the Forest Service regions in the West used Omernik's gestalt-based ecosubregion maps of their areas as the basis for their subsection delineation. Whereas personnel of some other regions used a "layering approach" in which coincidences in equivalently generalized factors maps were sought to suggest boundaries.

A national Ecomap team has been relying upon the synthesis performed by regional experts for their respective areas, adding their own synthesis to compile a map at the subsection level for the lower 48 States. Some engaged in this process have also proposed to use the resultant subsection map to "refine" the boundaries of published coarser-scale ecological units (sections and provinces). I have addressed the serious shortcomings of this idea elsewhere (Changing Ecoregional Map Boundaries, see http://www.fs.fed.us/institute/news_info/changing_ecoregional_map_boundaries2.pdf).

Three criteria should be the hallmark of ecological unit mapping: methodological explicitness, transparency, and repeatability. I am concerned that subsection delineation on the basis of gestalt synthesis and the various ideas of regional experts will not meet these criteria well enough to produce meaningful results.

Specifically, the delineation process fails on two points, each related to the same flaw: the inherent subjectivity of using gestalt reasoning. First, methodological explicitness suffers because without uniform delineation guidelines regional experts must

develop their own unique methods, which cannot be applied consistently. Second, the transience of regional experts means the outcome is likewise transient. When the experts leave, the entire method set—logic, rationale, intuition, data analysis—leaves, too. Necessarily, only those experts who are involved can interpret any delineation derived through a gestalt synthesis. Ergo, repeatability suffers. Relying on gestalt renders even exhaustive map unit descriptions and comprehensive geodatabases moot.

An alternative way to map subsections

An alternative route *that builds on rather than competes with the existing approach* would be to continue the physiographic (landform and geology) delineations that characterize the approach used to identify section boundaries on the 1994 published map. This was the approach used by personnel of the Northern Region (Nesser et al. 1997). They used section lines from the published map as a template within which physiography further subdivided the sections into subsections. After all, if sections are based on physiography, then it is logical for a subdivision termed “subsection” to be similarly based. Underscoring this point is the fact that using physiography is consistent with the underlying principles of the Ecomap hierarchy (p. 5), which states:

> "On global, continental, and regional scales, ecosystem patterns correspond with climatic regions, which change mainly due to latitudinal, orographic, and maritime influences (Bailey 1987, Denton and Barnes 1988). Within climatic regions, physiography or landforms modify macroclimate (Rowe 1984, Smalley 1986, Bailey 1987), and affect the movement of organisms, the flow and

> orientation of watersheds, and the frequency and spatial pattern of disturbance by fire and wind (Swanson et al. 1988). Within climatic-physiographic regions, water, plants, animals, soils, and topography interact to form ecosystems at Land Unit scales (Pregitzer and Barnes 1984). The challenge of ecosystem classification and mapping is to distinguish ... ecological types and map ecological units that reflect these different levels of organization."

From this statement, it is clear that the developers of the Ecomap hierarchy understood ecosystem patterns to be caused by different factors at different scales. The classification system used on the 1994 published map was designed to capture the coarsest grained scales, within which there are a number of ecological units. In this system a “controlling factor method” is used by which a spatial hierarchy is constructed by successive subdivision of large ecosystems on the basis of controlling factors operating at different scales. At the macroscale, macroclimate is considered the principal controlling factor. Three levels of macroclimatic differentiation are recognized on the map (in order that reflect more refined climatic differences; *domain*, *division*, and *province*). These macroecosystems, termed *ecoregions*, constitute the upper three ecological units of Ecomap (**Table 1**). At the mesoscale, physiography modifies the macroclimate and exerts the major control over ecosystem patterns and processes within climatic regions. Because of this, physiography was used on the published map as a primary mesoscale ecosystem delineator at the ecosubregional, or subregional, scale. *Subregions* are delineated at two levels. In the top tier, *section* ecological units are delimited on the map to form the fourth level of the system. For further refinement, they

may also in turn be subdivided on the basis of physiography into second-tier subregions, termed *subsections*.[2] Therefore, I suggest that the section divisions shown on the published map be maintained and that fifth-level divisions (i.e., subsections) be identified using more refined physiographic delineators in keeping with the principles of the National Hierarchy.

Conclusions

By focusing on processes of how ecosystems form, this approach is the same one used with the already established classification with published maps down through the section level. Adoption of the formative process approach as a subsection delineator would have made a distinct and useful contribution and avoided several of the problems described above.

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[2] At the land unit scale, these are further subdivided into smaller microecosystems based on topographic and edaphic factors.

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Table 1. The National Hierarchical Framework of Ecological Units. From Ecomap (1993), in part.

Scale		Unit
Macroecosystem	Ecoregion	Domain
		Division
		Domain
Mesoecosystem	Subregion	Section
		Subsection
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	Landscape	Landtype association
Microecosystem	Land Unit	Landtype
		Landtype phase