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Why Watersheds: Evaluating the Protection of Undeveloped Watersheds as a Conservation Strategy in Northwestern North America

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Abstract.

Temperate rainforests are restricted in their global distribution: most of the remaining primary, old growth forest is in northwestern North America from the central coast of British Columbia north through Southeast Alaska. Watersheds with no significant history of industrial, residential, or agricultural development are also globally rare and concentrated in the same area. Over recent decades we have come to understand the profound degree of connection via both physical and ecological processes across these watersheds and the roles landscape scale connections play in regulating productivity and ecosystem dynamics in watersheds. The bi-directional connections from near-shore marine systems through estuaries and riparian forests to upland ecosystems in particular are becoming a dominant paradigm in understanding the ecology and management of these systems.

The juxtaposition of landscapes dominated by old forest in undeveloped watersheds presents a significant conservation opportunity as well as management challenges. In British Columbia, a protected areas strategy has, since 1993, more than doubled the protected area in the province, with a significant investment in the protection of large, undeveloped watersheds. In SE Alaska, the Tongass National Forest also presents an opportunity for watershed-based conservation with many undeveloped watersheds from 1,000 to 10,000 ha in size remaining. These opportunities are, however, not distributed evenly across the ecological and physiographic variation present in the Tongass and largely remain in lower productivity areas of the coastal mainland and outer coast. Thus a focus on intact watersheds can only be part of a comprehensive conservation strategy for the Tongass: it should also include protection of smaller areas for specific conservation goals (e.g., critical habitats, rare species or ecosystems), ecological restoration in priority watersheds with a history of logging and novel silvicultural approaches in managed landscapes.

We consider whether, if society is going to make a significant investment in conserved forest land, under what conditions reserves based on protecting whole watersheds will be better than an equivalent investment in reserves based on other boundaries. We use a framework of criteria for evaluating watersheds as reserves based on *reserve content* criteria, *reserve context* criteria, and *emergent* criteria.

Reserve content criteria include how regional pools of species and ecosystems are reflected in a reserve and how a reserve maintains and is influenced by internal ecosystem processes and disturbances, such as wind, fires, and fluvial processes. To the extent the goal of a reserve system is to represent species, communities, and ecosystems, in direct proportion to their presence on the landscape, watersheds are a good approach—and can form the backbone of a *coarse-filter* conservation strategy. If, however, the goal of a reserve system is to protect focal species or their habitats, or rare, special ecosystems, then protecting whole watersheds is an inefficient approach: it necessarily captures much more area of habitats other than those of interest. If the total investment in reserves is limited, and the watersheds to be reserved are large, then protecting those watersheds can have a significant opportunity cost in the ability to achieve conservation objectives elsewhere within a region. Reserves based on whole watersheds are probably much better than alternative reserves from the perspective of ecosystem processes. Watershed-based protection is less likely to be a useful component of *fine-filter* conservation strategies unless the species of interest are critically dependent on watershed processes.

Reserve context criteria focus on evaluating the reserve in relation to its interactions with its surrounding landscape and its role in an overall reserve system. In terms of reserve context, watersheds are neutral for some criteria and positive for others. For small reserves especially, watershed-based boundaries are likely to provide a greater degree of buffering from external threats, whether physical, ecological, or human, than boundaries which are not based on watersheds. The objectives for an individual reserve need to flow from its role in a reserve system as a whole, and thus evaluating watershed-based versus other reserves needs to be done in that context. We suspect that this relationship is often not clearly articulated and that that lack of clarity leads to difficulty in assessing the relative value of alternative reserve configurations.

Emergent criteria result from interactions among different components of a system and are not present in any individual components; they arise from the interaction between content and context. They include viable populations of key species and ecological integrity. While larger reserves may provide sufficient habitat for viable populations of small, less mobile species, most reserves of even very large size will not do so for large mobile vertebrates. This is true irrespective of whether reserves follow watershed boundaries and thus population viability probably depends more on reserve context than anything else, for instance via the degree to which metapopulation dynamics are maintained across several reserves and the intervening semi-natural matrix. However, watershed boundaries will often reflect the natural patterns of movement of individuals and genes and thus won't constitute an imposition of unnatural administrative boundaries on the system. We suspect that, especially for larger watersheds, reserves based on watersheds will play a more significant role in maintaining population viability than an equal area scattered across several watersheds. Ecological integrity is an idea that, despite its challenges, is the explicit objective of much protected areas policy and is close to the intuitive goal for ecological reserve design. For ecosystems which are strongly structured by watershed scale processes (ecological, geomorphic, hydrologic, meteorological) we

are convinced that watershed-based reserves are more likely to achieve a goal of ecological integrity. In temperate rainforest watersheds, this will be enhanced by defining the watershed to include the adjacent estuarine and near-shore marine areas with which it interacts strongly.

Clarity in the goals of a protected areas system is paramount in evaluating what the best strategies are for reserve design. Watershed-based reserves will be the best option for many, but not all goals. Watershed-based conservation represents an intent to add a focus on ecosystems and ecosystem processes to a domain dominated traditionally by concerns for species. We have much to learn about the nature of watershed ecosystems and processes in temperate rainforests and addressing some of these key knowledge gaps will be critical if we are to be successful in ecosystem conservation.