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Managing a large-scale island archipelago

The fragmented nature of the Tongass National Forest requires sufficient knowledge and clear understanding of Island Biogeography (MacArthur and Wilson 1967, Smith and Flaherty 2023). Issues of ecological scale are a major concern in wildlife conservation, and many ecological patterns and processes are scale-dependent (Wiens 1989). Perceptions of how populations are spatially subdivided and impressions of extinction and dispersal dynamics depend on the scale at which the population is viewed (Wiens 1996). Conservation of biological diversity also requires maintaining evolutionary diversity (genetic and life-history attributes) of organisms indigenous to a region (Cook and MacDonald 2001, Colella et al. 2021), including the composition, structure, and functions of local ecological communities (Smith 2005, Watson et al. 2018, Grantham et al. 2020). Land management planning for the Tongass National Forest, however, has occurred at the scale of millions of hectares (USFS 1997, 2008, 2016), which is a much broader scale than the contiguous landscapes available to fragmented wildlife populations and ecological communities across an island archipelago and isolated mainland (MacDonald and Cook 1996, Conroy et al. 1999, Cook et al. 2001). Cook et al. (2001) listed 24 endemic mammals, several of which occur only on one or a few islands (MacDonald and Cook 1996, Smith 2005, Cook et al. 2006, Colella et al. 2021). The entire known distribution of the Suemez Island ermine, a small carnivore, is <160 km2 (MacDonald and Cook 1996). Moreover, several species encompass multiple, genetically distinct lineages (some representing incipient or new species) attributable to independent colonization histories from divergent source populations (Cook et al. 2006). The insular landscapes of the Alexander Archipelago have produced highly endemic populations that should be prudently managed as hotspots of biological and evolutionary diversity. Thus, islands available for timber harvest should each initially be considered an independent biological unit (Cook et al. 2006).

Consequences of management at inappropriate ecological scales among island communities

The Wrangell Island vole (Myodes gapperi wrangeli) is a habitat specialist that achieves its highest densities in old-growth forests and is unable to sustain breeding populations in peatland scrub (mixed-conifer) forest, clearcuts, or second growth (Smith and Nichols 2004, Smith et al. 2005a, Smith and Fox 2017). This red-backed vole is known only from Wrangell and Etolin islands (MacDonald and Cook 1996, Runck 2001). Wrangell Island is 544 km2 (54,400 ha) and 85% of the island is in Tongass National Forest, of which 72% is available for timber harvest. Approximately 2,700 ha of old-growth forest has been clearcut logged, with a proposed timber project to harvest an additional 16,600 ha (USFS 2019). The most productive forests have experienced far greater logging; indeed, large tree stands were logged 2.5 times their relative availability (Albert and Schoen 2013). Moreover, there are no explicit conservation directions or actions to protect this vulnerable island endemic from local extirpations (USFS 1997:4-87). Indeed, there are no explicit conservation measures to protect any of the 24 listed island endemic small mammals!

On Wrangell Island, voles are sympatric with the Keen's mouse (Peromyscus keeni macrorhinus), a habitat generalist that flourishes in old-growth, managed, and scrub forests (Smith and Fox 2017). Keen's mouse can be an intense competitor of voles, with interspecific competition between the 2 species explaining more variation in vole abundance (and vice versa) among habitats than the variance associated within habitats (Smith and Fox 2017). Thus, clearcut logging of old-growth forests on Wrangell Island favors populations of the Keen's mouse by creating habitats that breeding vole populations cannot exploit and further reducing vole abundance across managed landscapes because of increased interspecific competition from increasing mice populations

(Smith and Fox 2017). Furthermore, opportunities for voles to reoccupy managed landscapes are limited because broad-scale disturbance can take [ge]300 years for ecological succession to achieve old-growth forest conditions, especially when there is limited (if any) intermediate stand management (Nowacki and Kramer 1998). Thus, when forest management is applied indiscriminately across archipelagos (defacto contiguous landscapes), it is implemented at inappropriate ecological scales and thus insensitive to the variation and uniqueness of species composition, phylogeography, life-history attributes, and interspecific relationships among island communities (Cook et al. 2006). The consequences of disproportional habitat loss and fragmentation typical of island endemics results in isolation, local extirpation, and overall reduction of endemic populations, increasing risk of extinction (Burkey 1995, Frankham 1998, Crooks et al. 2017, P[uuml]ttker et al. 2020, Vynne et al. 2021).

Habitat across a significant portion of the Wrangell Island vole's geographic range has been impacted and corresponding local populations have been extirpated (Smith and Fox 2017). Keen's mouse population density and habitat distribution have increased and represent a significant deterrent to Wrangel Island voles' recovery even if mature forest structure can be hastened through intermediate stand management. Continued harvest of productive old-growth forests will extirpate additional local populations and increase the risk of extinction of this endemic on Wrangell Island. Moreover, similar threats likely exist for other island endemic small mammals for which there is little ecological information or knowledge of how each respond to forest management that is being implemented at inappropriate ecological scales (Smith and Flaherty 2023). Smaller populations are more severely impacted by habitat disturbance, and the likelihood of rescue following extirpation depends on the number and proximity of source populations (MacArthur and Wilson 1967, Laurance 1991, Burkey 1995) and functional connectivity (Fahrig and Merriam 1985, Fahrig et al. 2021, Smith et al. 2011a, b; Trapp et al. 2019). Moreover, the extinction of island endemics has cascading impacts on the functionality of island ecological communities (Brodie et al. 2018, Kelt et al. 2019). Therefore, all endemic small mammal for which there is "Lack of basic scientific information" should be listed as "Threats may be substantial" as there is lack of sufficient information to state otherwise.

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