ECOLOGY

Salvage Harvesting Policies After Natural Disturbance

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Natural disturbances and the biological legacies produced by them are often poorly understood by policy-makers and natural-resource managers. Recent large-scale natural disturbances include wildfires that burned nearly 10 million ha in Indonesia in 1997–98, 7 million ha in Russia, 5.4 million ha in Canada, and 4 million ha in Brazil (*1–2*). In forests, recouping of economic losses is usually attempted by salvaging large volumes of timber. Major salvage harvesting operations began in Australian wet forests following the 2002–03 wildfires (*3*). Salvage operations are likely in extensive areas of North American forests burned this summer (*4*).

Enhanced online at www.sciencemag.org/cgi/content/full/303/5662/1303

To many ecologists, natural disturbances are key ecosystem processes rather than ecological disasters that require human repair. Recent ecological paradigms emphasize the dynamic, nonequilibrial nature of ecological systems in which disturbance is a normal feature [see, e.g., (*5*)] and how natural disturbance regimes and the maintenance of biodiversity and productivity are interrelated (*6*).

Major disturbances also can aid ecosystem restoration by recreating some of the structural complexity and landscape heterogeneity lost through previous intense management of natural resources. For example, large floods can reshape riparian areas through mass sediment and debris movement and can revitalize human-modified aquatic ecosystems (*7*). Similarly, major wildfires generate dead and downed trees, which provide habitats but which are depleted by traditional forestry practices (*8*). Species recovery and ecosystem revitalization are strongly influenced by types, numbers, and spatial arrangements of biological "legacies" remaining after natural disturbance (*8*, *9*). They maintain biodiversity and key ecosystem processes in numrous ways, from facilitating species recovery to restoring nutrient levels (*9*).

Post-wildfire salvage harvesting in the Australian Capital Territory has degraded this stream.

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Salvage harvesting activities undermine many of the ecosystem benefits of major disturbances. For example, extensive salvage harvesting after the 1938 New England hurricane produced a long-lasting shift in hydrological regimes on a regional scale (*10*). Hurricane-damaged forests exert strong biotic regulation over biogeochemical and hydrological processes. In Baxter State Park, Maine, soils in blown down forests where salvage logging occurred were more affected by a subsequent fire (as measured by horizon depth, organic soil coverage, and percent combustible organic matter) than soils in comparable forests in the park where salvage logging was not allowed (*11*).

Second, removal of large quantities of biological legacies can have negative impacts on many taxa. For example, salvage harvesting removes critical habitat for species, such as cavity-nesting mammals, woodpeckers, invertebrates like highly specialized beetle taxa that depend on burned wood, and bryoflora closely associated with recently charred logs (*12–14*). Salvage logging after the 1939 wildfires in Victoria contributed to a shortage of cavity trees for more than 40 species of vertebrates, including highly endangered ones like Leadbeater's possum (*Gymnobelideus leadbeateri*). This problem may take more than 200 years to be rectified (*14*).

Third, salvage logging can impair ecosystem recovery. In Southeast Asia, salvage logging of burned rainforests led to substantial forest deterioration and loss, with major negative impacts on the regenerative potential of stands (*15*).

Fourth, some taxa may be maladapted to the interactive effects of two disturbance events in rapid succession. In the forests of southeastern Australia, understory plants such as tree ferns can survive wildfires but are significantly reduced by the combined impacts of fire and logging (*16*). Similar effects are known in other ecosystems (*17*) such as rainforests (*15*).

Large-scale salvage harvesting is often begun soon after a wildfire, when resource managers make decisions rapidly, with long-lasting ecological consequences. A better approach would be to formulate salvage harvesting policies before major disturbances occur. Such policies should make provision for the exemption of large areas from salvaging such as national parks, nature reserves, and watersheds closed to human access to maximize water quality (*8*). Furthermore, good planning should guide the timing and intensity of salvage harvesting.

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