

Submitted Jan 6, 2011

The accompanying report is a simple literature review regarding the extreme sensitivity of wolverines to disturbance of their natal (birthing) den areas. It is provided for the purpose of assisting local decision-makers in considering potential impacts of heli-skiing to wolverine populations. I believe the information here demonstrates how wildlife (and especially wildlife associated with truly *wild* lands) may be affected in unexpected ways by newly introduced, widespread mechanized and industrial activities.

For a variety of reasons, wolverines have historically received less scientific attention than many other species. However, over the last 15 years or so, this remarkable resident of northern and mountainous regions has been the subject of increasing biological research, resulting in some very important new understandings of the species.

Wolverines have long been associated with wild, remote, and snowy areas. Where human civilization has spread, wolverines have generally disappeared from the country. And yet, they are also sometimes seen around human residences, so how truly "sensitive" are they? Well, the recent research (which has steadily increased to include areas in 5 US states and at least 4 additional countries) has shown with very strong agreement that one of the most limiting factors for continuance of wolverine populations is *freedom from human disturbance in their denning areas*.

During late winter, female wolverines create dens in rocky subalpine and alpine areas where they give birth. During late winter and spring they use these natal dens, and additional maternal dens, to raise the kits, keeping them safe from other predators under the deep snowpack in these remote mountain basins. Researchers in many areas, but especially in the mountains of western Canada and the US, have repeatedly observed mother wolverines abandon these critical birthing and maternal dens as a result of human activity--especially loud, mechanized activity such as snowmachine and helicopter use.

I have not attempted here to draw any biological conclusions of my own. I am simply providing a sampling of some of the sections of published wolverine research that are relevant to our local issue of heli-skiing. All of the material here is easily available by simple searches on the internet

Throughout the accompanying document, I have highlighted with ***bold and italicized*** lettering those segments most related to the sensitivity of wolverines during reproduction and denning. I have also underlined the specific statements most important to management decision-making related to heli-skiing's potential impacts to wolverine populations. The non-highlighted sections of text are included to show the context in which the researchers' statements were originally made, and in some cases provide additional information helpful for the the general understanding of wolverine biology. Anyone interested in looking further into existing wolverine research is encouraged to particularly investigate published research reports by: Magoun in Alaska; Copeland in the US Rocky Mtns; and especially Krebs in British Columbia,

whose research area in the snowy & glaciated Selkirk Mtns includes active heli-skiing, and provides what are probably the most relevant results to our situation here in the Chilkat Valley.

In our area of unique climatic conditions, we don't currently know the exact elevations and slope aspects that our resident wolverines use for denning, and therefore we don't know if the current helicopter activity during this critical period (February to late April or May) is already diminishing, or even eliminating, wolverine reproduction here.

When we enact a dramatic change in our environment (such as extremely loud, mechanized noise across the valley, and significantly increased human presence in remote mountain basins), we can reliably expect significant changes to occur in our environment. Responsible management and decision-making requires sincere efforts to understand and predict the consequence of any changes that are decided upon.



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(from Forest Service document prepared for Umpqua National Forest):

It appears that wolverines, at least in the Pacific Coast mountains, are associated with relatively large expanses of alpine habitat conditions and snow cover that persists through the spring denning season (Schwartz et al. 2007). Although these findings have range-wide implications, they may be most relevant in peripheral portions of the wolverine's range where increasing temperatures associated with global climate change could shift treeline to higher elevations, in effect shrinking the alpine zone (Millar et al. 2004) and decreasing the probability of spring snow cover. If such changes occur, current wolverine habitat at the periphery of the range may lose the ability to support viable populations of wolverines (Schwartz et al. 2007).

Threats:

Wolverine may be impacted by management practices that influence subalpine and alpine communities, particularly those that reduce the presence and opportunity for carrion availability (Copeland et al. 2007).

Resource extraction (including timber harvesting), backcountry skiing and snowmobiling, roads, and other forms of human disturbance can impact wolverine (Ruggiero et al. 2007). **Researchers in British Columbia found a consistent negative association between wolverine occurrence and areas where helicopter and backcountry skiing occur.** However, the causal factors associated with these patterns are not well understood (see Copeland et al. 2007, Krebs et al. 2007).

Trapping has been the primary source of wolverine mortality in North America (Predator Conservation Alliance 2001). Wolverines are managed as a commercial furbearer species in British Columbia (Hatler 1989), and they have been harvested commercially for nearly two centuries (Novak et al. 1987). Wolverine populations have limited growth capability and are sensitive to overharvest. Because current provincial wolverine harvest is within overall sustainable limits, harvest management changes are likely not warranted. Wolverine populations in British Columbia are contiguous to those in adjacent jurisdictions of Canada and the United States. Management of wolverines in British Columbia will likely influence wolverine populations in those jurisdictions and vice versa (Lofroth and Ott 2007).

High road densities, timber sales, or housing developments on the fringes of subalpine habitats may reduce potential for winter foraging and kit rearing, and increase the probability of human-caused wolverine mortality.
(www.wolverinefoundation.org).

Conservation Considerations:

Management programs bear likely most effective when covering a regional, rather than local scale, for this wide-ranging, low-density species. Maintaining wilderness and roadless areas is critical (NatureServe 2007).

Protection of natal denning habitat from human disturbance may be critical. Montane coniferous forests, suitable for winter foraging and summer kit rearing, may only be useful if

connected with subalpine cirque habitats required for natal denning, security areas, and summer foraging. In addition, these habitats must be available during the proper season. Subalpine cirque areas, important for natal denning, may be made unavailable by winter recreational activities (www.wolverinefoundation.org).

These environments become increasingly fragmented at southern latitudes, where wolverine populations occur at low densities and are potentially vulnerable to human-caused mortality (Ruggiero et al. 2007). High levels of genetic structure observed in both current and historical populations indicate that dispersal between mountain ranges is limited. Where populations are fragmented, persistence is critically dependent on dispersal between habitat islands (Ruggiero et al. 2007).

Although available data indicate that the habitat conditions required for wolverine dens play an important role in limiting their distribution and abundance, the understanding of habitat requirements continues to be extrapolated from a limited data set. Additional field studies are urgently needed to fill these and other critical information gaps, including the potential effects of global warming (Ruggiero et al. 2007).

Because alpine conditions become increasingly fragmented at southern latitudes, opportunities for population recovery and natural recolonization will be limited in these areas (Ruggiero et al. 2007). Given current predictions about warming climates, this situation will likely be exacerbated (see Aubry et al. 2007, Copeland et al. 2007, Schwartz et al. 2007).

Because wolverine are highly susceptible to the effects of human disturbance, protecting areas to reduce or mitigate disturbance can be effective management tools. Options to consider include restricting access to areas utilized by wolverine. Roads and trails that provide vehicle access and snowmobiles and skiing that provide cross-country access all contribute to potential disturbance within wolverine habitat. In certain areas it may be appropriate to seasonally restrict this type of access in order to protect the species.

Ski area development or expansion is another potential impact to wolverine, resulting in loss of habitat and an increase in disturbance to the species. Any proposed areas should be carefully assessed for their impacts. Potential development should be situated in areas less likely to be used by wolverine. Areas of suitable denning habitat should be protected from development.

Other pertinent information (references to Survey Protocols, etc):

Rowland et al. (2003) evaluated performance of landscape models for wolverines within their historical range at 2 scales based on recent observations (n = 421) from Washington, Oregon, Idaho, and Montana. At the subbasin scale, simple overlays of habitat and road-density classes were effective in predicting observations of wolverines. At the watershed scale, they used a Bayesian belief network model to provide spatially explicit estimates of relative habitat capability.

The model had three inputs: amount of habitat, human population density, and road density. At both scales, the best models revealed strong correspondence between means of predicted counts of wolverines and means of observed counts. Their results can be used to guide regional

conservation planning for wolverines.

ATTACHMENTS:

Appendix 1. Wolverine Photos (Copyright C. Long, The Wolverine Foundation, Inc.

Appendix 2. Wolverine Distribution Information. Aubry et al. (2007).

Appendix 3. Keystone Conservation Management Recommendations.

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Date Completed: 26 September 2007

Appendix 3. Keystone Conservation Management Recommendations

Draft - January 24, 2001 - Draft (used by permission)

Science-based policies needed to protect and restore the wolverine and its habitat throughout the U.S. lower 48 states

A. Forest practices, access, and recreation

1. Maintain forested areas largely free of human disturbance

a. Identify priority habitat for wolverines

b. Protect suitable habitat from human disturbance

i. Maintain unroaded areas and restore roaded areas by maintaining road densities at no greater than one mile of road per square mile of habitat.

ii. Limit clearcut logging within priority wolverine habitat.

iii. Roads used to access logging operations and other developments should be closed and obliterated, including snowmobile use in winter.

iv. Mining activity, developed campgrounds, and other permanent developments should be prohibited from priority wolverine habitat, because the associated human activity is likely to displace wolverines from the area.

2. Protect wolverine denning habitat from human disturbance

a. Identify suitable denning habitat

b. Protect suitable denning habitat from snowmobiles, helicopter skiing, and other forms of intensive human use, especially during denning season

(February through May)

3. Maintain and restore quality habitat for ungulates and other prey within wolverine habitat.

B. Trapping

1. Trapping has been the primary source of wolverine mortality in North America.

2. Trapping for wolverines should be prohibited from all areas where the practice is not known to be sustainable and compatible with maintaining healthy and robust

wolverine populations.

- 3. Incidental take - wolverines killed in traps set for other species - is a significant threat to the wolverine, and thus all trapping that may pose a risk to wolverines should be prohibited within priority wolverine habitat.

C. Connectivity vs. Fragmentation

- 1. Because of their wide ranges and low population densities, wolverine conservation and management requires a regional perspective. Priority habitats for subpopulations should be identified and protected, as well as areas of connection between these sub-populations, across the entire western United States and Canada.
- 2. Highways threaten wolverines due to direct mortality and especially because they may pose a barrier to movement, thereby isolating wolverine populations and areas of suitable habitat across the Rocky Mountains of the U.S. and Canada.

(from July 14, 2000 petition by the Biodiversity Legal Foundation to the US Fish and Wildlife Service to list wolverine):

Page 74

Threats to Denning Habitat

A recent survey for wolverine denning sites on the Island park Ranger District of the Targhee National Forest found a potential wolverine den in the only alpine cirque habitat inaccessible and therefore untracked by snowmobiles (K. Heinemeyer, pers. comm., Western Forest Carnivore Committee Conference, May 2000, May 1999). This is current anecdotal evidence to support the threat posed to wolverines by snowmobiles and other winter recreationists documented by Copeland (1996), Krebs (1998), and others.

Data compiled by the Montana Department of Fish, wildlife and Parks demonstrates extensive use of snowmobiles in Montana and dramatic increases in snowmobile use since the 1970s. The numbers of snowmobiles registered each year in Montana has increased approximately 50% during the past decade, from just over 15,000 in Fiscal Year 1991 to 22,600 in FY 1999 (B. Walker, State Trails Program Coordinator, Montana Dept. of Fish, wildlife and Parks, pers. comm., November 1999; Appendix U). Since not all machines are

registered and more than one person may ride each machine, these figures are conservative. A recent report (Sylvester, 1998; Appendix V) estimates that in 1998 about 12% of Montana's households ride snowmobiles, or nearly 100,000 Montanans each winter. This does not include the many visitors from out of state who snowmobile in Montana as well.

Page 75

Additional data from the Montana Dept. of Fish, wildlife and Parks indicates that the money spent grooming trails for snowmobiling in Montana has increased by more than ten times during the past two decades: from less than \$30,000 in 1978 to nearly \$400,000 in 1999 (B. Walker, pers. comm., November 1999; Appendix V). Another important factor when considering the increased threats posed by snowmobiles to wolverines over time are the advances in snowmobile technology which have

resulted in far more efficient and powerful machines that are able to access many areas of wolverine habitat that were previously inaccessible.

Furthermore, snowmobile use is certainly occurring in areas where they may adversely affect denning wolverines. Biologists on the Lolo National Forest recently modeled the overlap of snowmobile use and potential wolverine den sites within the "Statelier" area of the forest, and found that the area contains about 38% of the cirque basins (habitat known to be selected by denning wolverines) found on the entire forest. Under a "no-action" alternative, 100% of these areas would be open to snowmobiles; under an alternative that continues to allow snowmobiling to occur in areas "commonly used by snowmobilers," 52% of the potential wolverine habitat is open to snowmobiling (USFS, 1998).

Page 60

Protection from Human Disturbance

The level of human activity is clearly a primary factor for wolverine habitat (Banci, 1994). "within its geographic range, the wolverine occupies a variety of habitats. However, a general trait of areas occupied by wolverines is their remoteness from humans and human developments."

Wolverines are known to be associated with large areas that have little or no human use. For example, to build a road into a previously roadless area will negatively affect wolverines. Banci (1994) wrote:

Refugia, large areas that are not trapped and free from land-use impacts, can serve as sources of dispersing individuals and have been shown to be effective at ensuring the persistence and recovery of fisher and American marten populations (deVos 1951, Coulter 1960). ***The persistence of wolverine populations in Montana, despite years of unlimited trapping and hunting, was attributed solely to the presence of designated wilderness and remote, inaccessible habitat (Hornocker and Hash 1981). Wolverines persisted in southwestern Alberta despite their extirpation elsewhere in the province, largely because of the presence of large refugia in the form of national parks" (Banci, 1994, p. 108).***

Empirical data from an extensive wolverine field study currently underway provides added evidence for the wolverine's need for areas remote from human activity and disturbance:

All dens have been found within roadless, tributary valleys in the ESSFvc biogeoclimatic subzone under woody debris or a combination of woody debris and large boulders. ...Four of the seven den sites were located in National Parks. ...Overlay techniques clearly demonstrate that high use areas ("peaks") are found in protected areas in greater proportion than expected based on relative trapping effort and park areal extent. Protected areas comprise approximately 20% of the study area; include approximately 11% of the high trapping

Page 61

effort area (25% contour), but contain over 68% of the high use area. ... (Krebs and Lewis, 1999, pp. 11, 1415) Based on these observations, Krebs and Lewis conclude: National Parks and unroaded wilderness areas appear to act as refugia at present. Pressures from commercial backcountry use, snowmobiling and logging may erode the capacity of these areas to support wolverine, particularly reproductive females. (Krebs and Lewis, 1999, p. 20)

As added evidence that wolverines need areas free of human disturbance, there seems to be no wolverine crisis in the circumpolar tundra and taiga, still comparatively inhospitable to human intrusion. For example, the following response to an inquiry came from Ontario:

There are currently no significant threats in Ontario to populations of wolverines. However, forest management plans envision increasing utilization of these northern boreal forests. Trapping pressure is very light. ...Given that the wolverine's former range has been drastically reduced by such factors as trapping, human settlement and reduced bison herds (as well as other prey species), it is safe to say that wolverines prefer to live well away from any form of human occupancy/utilization of the land. ...This is not a problem in over half of Ontario at present. ...In combination with such protective measures as eliminating wolverine harvests and limiting timber operations to small cut-overs, it is clear that to ensure a viable reproducing population large tracts of isolated land are necessary. (Heydon, February 3, 1999, Letter to J. Jensen).

Current data on wolverine distribution and roadless areas in the northern Rockies shows a remarkable correlation between the two: every area of the northern Rockies that is believed to be currently occupied by wolverines also contains an inventoried roadless area (Appendix L).

Page 62

Yet Banci (1994) also noted some inconsistencies in the general truth that wolverines are intolerant of people: Human presence alone is not a deterrent to the presence of wolverines, as evidenced by their feeding in garbage dumps in northern Canadian communities. If large tracts of undeveloped and unroaded habitat are essential, why do wolverine occur in the logged forests of the Sub-Boreal Interior of British Columbia and in the habitats crisscrossed with seismic lines on the Boreal Plains? (pp.100-101)

The overall literature considered, it seems plausible that absolute avoidance of human beings may be critical primarily in the denning phases. At other times, it may be best summed up that although wolverines do not court human society, they do seem to follow food; and humans do keep food stores.

Protection of Denning Habitat

We also know that wolverines are extremely sensitive to human disturbance at their natal den sites, and human disturbance of these areas via snowmobiles, helicopters, skiing, or snowshoes is harmful to wolverines. Recent research (Copeland, 1996; Krebs and Lewis, 1999, 1998) has reiterated the sensitivity of wolverine denning habitat and the fact that it must be undisturbed and almost without exception is found far from human occupation. Copeland (1996) discusses the sensitivity of females with young to human disturbance:

Females in arctic Alaska remained at a single den until late April or early May and did not appear disturbed by the presence of human observers (Magun 1985). ... Finnoscandian studies report den abandonment as a common

Page 63

response to human disturbance. ... Myrberet (1968) mentions 4 instances of den abandonment due to human disturbance and suggests that secondary dens may be less suitable. My data is consistent with this. My first direct contact with denning females did not occur until late April and resulted in immediate den abandonment. (p. 93).

Copeland's thesis (1996) also relates an anecdote of a mother wolverine who discovered the researchers' snowshoe tracks near her den, followed them to within 20 m of the researchers, immediately returned to her den and took off in the opposite direction with a kit in her mouth. She returned 30 minutes later to repeat this with her second kit (pp. 96-97).

As mentioned above, Researcher John Krebs recently related an anecdote whereby a helicopter skiing operation appeared to displace a female wolverine 10-15 kilometers from her newborn kits.

Based on his observations, Copeland (1996) concludes that adequate wolverine denning habitat, secure from human disturbance, is critical: "Central Idaho wolverines appeared highly selective in choice of natal

denning and kit rearing habitat. ...Even with adequate food, wolverines may not be resident without suitable denning habitat" (p. 72). Further: "When viewed in conjunction with potential displacement and disturbance of denning females by winter recreational activities of humans, denning habitat may be a limited and critical component of wolverine habitat" (p. 93). Copeland (1996) proposes some management recommendations that

Page 64

incorporate this conclusion:

Protection of natal denning habitat from human disturbance is critical for the persistence of the wolverine in Idaho. The clear association between wolverine presence and refugia may be strongly linked to a lack of available natal denning habitat outside protected areas. ... Technological advances in over-snow vehicles and increased interest in winter recreation has likely displaced wolverines from potential denning habitat and will continue to threaten what may be a limited resource.

...

Subalpine cirque areas important for natal denning may be made unavailable by winter recreational activities. Conversely, high road densities, timber sales, or housing developments on the fringes of subalpine habitats may reduce potential for winter foraging and kit rearing and increase the probability of human-caused wolverine mortality. (pp. 129-130)

(from website of the British Columbia government's Ministry of Environment)

Mammals Affected by Recreation: Wolverine (Blue-listed)

Wolverines occupy large home ranges, and are therefore likely to intersect winter recreational activities of many kinds. Winter is the critical period for Wolverine and other carnivores, and winter recreational activities can potentially affect them in several ways. Their foraging behaviour along groomed trails and other travel corridors may be disrupted, or they may retreat from the sound of snowmobiles or human presence. Wolverines seem to avoid human settlements. In the northern Columbia Mountains of B.C., national parks and unroaded wilderness areas receive high Wolverine use, but pressures from commercial backcountry activities, snowmobiling, and logging may jeopardize the ability of these high-use areas to act as refugia for Wolverine populations

In late winter (February 15 to April 30), reproductive females establish natal dens in areas with little or no human disturbance, in non-forested habitats (avalanche debris or large blocky talus) of upper-elevation forested zones (e.g., Englemann Spruce-Subalpine Fir biogeoclimatic zone). These natal dens are often in the same subalpine cirques that snowmobilers seek. Females with kits are extremely vulnerable to human disturbance and will abandon den sites if disturbed.

Principal sources of information:

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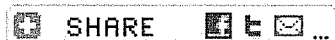
(from a website "Current Results," which provides information and documents from recent scientific research):

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Wolverine Declines Continue



by Liz Osborn © Current Results Nexus

Wolverines have disappeared from many parts of North America over the last century, and recent research shows that some of the remaining populations continue to plummet. The ongoing declines are of particular concern since new evidence suggests that mountain-dwelling wolverines seldom travel between major ranges. This means that many populations are biologically isolated and cannot expand in size or genetic diversity with immigrating animals.

In the 1800s, wolverines of the contiguous United States lived in the western mountains and the Great Lakes region. By the mid 1900s, their US range had shrunk substantially, and since 1995 they've only been located in portions of Washington, Idaho, Montana and Wyoming.

The fully isolated and genetically distinct wolverines of California's Sierra Nevada Mountains became extirpated by the 1930s. The eastern Canadian population may also have gone extinct, with the last confirmed sighting in 1978 in Quebec.

More recently, a subspecies, *Gulo gulo vancouverensis*, confined to Vancouver Island in British Columbia is now feared extinct. Across the island, large-scale forest harvesting has fragmented its habitat. According to records, 1992 was the last time a Vancouver Island wolverine was ever spotted.

On mainland BC, wolverines are estimated to number 3,520. They comprise part of the western Canada population that spans boreal and arctic regions. Western Canadian wolverines in 2003 probably totalled 15,000 to 19,000 animals. Their populations, however, have lately fallen in Alberta, Ontario and southern BC.

The same factors that have removed wolverines from much of their range - overharvesting and human encroachment into their habitat - continue to plague them. Wolverine suffer from unsustainable hunting and trapping in 21% of BC's population units. A 2005 study in western Montana found that licensed trapping largely contributed to wolverine population declines of 30% a year in four mountain ranges.

Research in BC's Columbia Mountains concludes that outdoor recreation and logging activities cause wolverines to avoid habitat. In this popular winter recreation region, wolverines stay away from areas used by heli-skiers or backcountry skiers. In summer, females also shun roads and recent logging.

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(from website of The Wolverine Foundation, an organization formed by wolverine biologists to compile and make available information from all known wolverine research worldwide)

Management Considerations

In the United States, wolverine may be harvested only in Alaska and Montana. Outside of these areas a lack of basic information on wolverine distribution and habitat requirements has resulted in little management beyond administrative protection. Hatler (1989) suggested that appropriately responsive management will require a better knowledge of the nature, extent and correlates of wolverine occurrence. Zielinski and Kucera (1996) argued that distributional surveys are essential to the generation of habitat-relations models in the evaluation of land-use changes and the effects of human density and disturbance. Surveys should focus on determining occurrence and may include snowtracking surveys or remote camera bait surveys (Zielinski and Kucera 1996). Winter aerial surveys of potential denning habitat may provide an alternative to ground methods. Female wolverine in Idaho located reproductive dens on northerly aspects in isolated subalpine talus cirques. These sites generally lacked overstory canopy, allowing snow trails of females traveling to and from the natal den to be visible from aircraft.

Protection of natal denning habitat from human disturbance may be critical for the persistence of wolverine. The clear association between wolverine presence and refugia may be strongly linked to a lack of available natal denning habitat outside protected areas. Idaho wolverines selected specific natal and kit rearing habitat and responded negatively to human disturbance near these sites. Technological advances in over-snow vehicles and increased interest in winter recreation has likely displaced wolverines from potential denning habitat and will continue to threaten what may be a limited resource.

Vegetative characteristics appear less important to wolverine than physiographic structure of the habitat. Montane coniferous forests, suitable for winter foraging and summer kit rearing, may only be useful if connected with subalpine cirque habitats required for natal denning, security areas, and summer foraging. In addition, these habitats must be available during the proper season. *Subalpine cirque areas, important for natal denning, may be made unavailable by winter recreational activities.* Conversely, high road densities, timber sales, or housing developments on the fringes of subalpine habitats may reduce potential for winter foraging and kit rearing, and increase the probability of human-caused wolverine mortality.

Management practices that reduce carrion may affect wolverine foraging success. A close relationship exists between wolverine and ungulate presence. Ungulate carrion is a primary food item and activities that decrease large mammal populations may negatively affect carrion availability. Excessive hunter harvesting and loss of ungulate wintering areas (Banci 1994), as well as displacement of ungulate populations due to excessive timber harvest and urbanization, may adversely impact wolverines. Wounding mortality of ungulates from hunting and livestock losses on public grazing allotments most likely provides a consistent carrion source.

Refugia may be most important in providing availability and protection of reproductive denning habitat. Life history requirements of the wolverine are tied to the presence and stability of ecosystems lacking broad scale human influence. Dispersing wolverines in Idaho traveled over 200 km following routes across isolated subalpine habitat. Habitat alteration may isolate subpopulations, increasing their susceptibility to extinction processes.

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