Appendix E:

Resource Risk Indicators

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Appendix E. Resource Risk Indicators

Table of Contents

Introduction

This Appendix presents a useful approach for identifying and analyzing risks to natural and cultural resources. For discussion about road benefits, refer to the guidebook.

Travel Analysis provides an opportunity for National Forests to recognize risk of adverse impacts to environmental, ecological, and cultural resources. Resource risks have been categorized (see categories below). Risks are further defined as areas (polygons) on the landscape by setting thresholds for metric indicators. Often, selected points and lines from resource layers are buffered, clipped, etc. to create the risk polygons. If a road intersects a particular risk polygon, it is assigned an affirmative value in the corresponding column of its GIS table. Once this process is complete for all Risk Categories, the team is able to query and display all roads based on the identified potential risks.

Instead of creating a bivariate risk layer (areas are either "high risk" or "not"), some forests may wish to weigh certain factors higher than others and create a mathematical scoring system that acknowledges gradations of risk. These weighting and scoring approaches, although sometimes useful, are often overly complicated, so this analysis method does not attempt to pursue them. The proposed process presented here simply flags routes that intersect with the derived high-risk polygons.

The risk factors outlined in this document are available in existing corporate GIS layers; no new data collection is envisioned. The intersection of a particular road and a risk-derived polygon will inform—but not absolutely determine—a TAP team's recommendation for that road as needed or unneeded. Ultimately, when it comes to identifying a minimum road system that provides for safe and efficient travel and minimizes effects, resource risk is merely one of several considerations.

It is expected that the National Forest System of Roads (NFSR) will be periodically evaluated and adjusted, particularly as more detailed watershed or landscape-scale analyses are conducted at finer scales. The following categories, indicators, and metrics simply enable

Forest TAP Teams to delineate areas where roads may pose a higher risk. The indicators do not inherently demonstrate that an impact exists; they only indicate that the potential for an effect exists. The Forest's TAP Team must use other information, including local knowledge, to evaluate if the potential risk exists and to consider options in managing the road system if it does exist.

Forests are encouraged to share these resource risks with the public and allow people to suggest additional risks or risk indictors. Ultimately, the Forest will arrive at a set of risks to be addressed, some of which only exist at the local level. Recommended strategies for accomplishing this constructive interaction with local participants are described in the TAP guidebook and in Appendix G, "Public Engagement."

Risks to Recreation and Wilderness Resources

Adverse effects of Roads on Recreation and Wilderness

Roads can affect the quality of the recreation experience for individuals pursuing "quiet recreation" when visiting national forests; and directly affect the ecological conditions of Wilderness if roads persist within Wilderness boundaries. For the purposes of meeting Travel Management Rule, Subpart A requirements for identifying a minimum road system, the Travel Analysis Process should assess the NFTS's risk on quiet recreation for visitors using selected non-motorized trails of national importance; and the direct risk of roads in Wilderness areas.

Indicator of Disruption to Quiet Recreation: Proximity to Selected Trails

Possible Metrics:

- **number of complaints or other documented instances of adverse effects on quiet recreation**
- **effective sound mitigation distances**
- **occurrence of nationally designated non-motorized trails**
  During the implementation of Travel Management, Subpart B, a number of constituents raised questions regarding the effects of motorized vehicles on non-motorized recreation activities, such as hiking; and other activities centered on the pursuit of solitude and quiet. For the purposes of Travel Analysis Process, the presence of nationally significant non-motorized trails, which represent the top tier of non-motorized trails in the region, are deemed the priority for identifying segments of the NFTS that could place quiet recreation "at risk" for these trails.
  Use of a ½ mile threshold was established under the execution of the where it was determined that Travel Management Rule, Subpart B. a ½ mile e buffer (½-mile on each side of a trail) would mitigate the sound of motorized vehicles. This threshold was determined through a literature review of sound studies and reports. These include (1) Martin (2005) "California Off-Highway Vehicle Noise Study: A Report to the California Legislation as Required by Public Resources Code Section 5090.32(0);" (2) Pilcher and Turina (2006) Protecting Natural Sounds in National Parks: Soundscape Workshop Visitor Experience and Soundscapes; and (3) Ouren el al (2007), " Environmental Effects of Off-

Highway Vehicles on Bureau of Land Management Lands: A Literature Synthesis, Annotated Bibliographies, Extensive Bibliographies and Internet Resources." ***A ½-mile buffer is proposed as an indicator for Subpart A, applying only to the three classes of non-motorized trails described below.***

Pacific Crest National Scenic Trail (PCT) was designated a National Scenic Trail under the National Trails System Act of 1968. Spanning from Canada to Mexico, the PCT traverse some of the highest and most pristine landscapes in California. ***National Recreation Trails (NRTs)*** were authorized under the National Trails System Act of 1968 Public Law 90-543) specifically for existing trails that contribute to the United States' health, conservation, and recreation goals. ***National Historic Trails (NHTs)*** were authorized under the National Parks and Recreation Act of 1978 Public Law 95-625), and designated to protect the remains of significant overland or water routes to reflect the history of the nation.

Indicator of Wilderness Degradation: Road Intrusion in Wilderness

Possible Metrics:

- **Reported incidents of motorized public incursion into wilderness**
- **Occurrence of overlap between system roads and wilderness boundary layers**
  The Chief initiated the 10-Year Wilderness Stewardship Challenge in 2005. Under this challenge, units are to ensure that forest plan direction is adequate to prevent the degradation of the Wilderness resource; and that Wilderness character is protected or restored (Element 8). Since the information organized under this analysis could conceivably be used to inform the region's land management planning process, it is appropriate to include the risk that roads have upon Wilderness character. ***Therefore, it is proposed that the presence of roads within Wilderness boundaries be included as an indicator for the Travel Analysis Process.***

  Forest TAP Team Considerations: If the LRMP contains "Recommended Wilderness," it might be important to flag roads that intersect those polygons as well. Inventoried Roadless Areas (IRA's) can be included as another indicator.

Risks to Wildlife Resources

Adverse effects of Roads on Wildlife Resources

Roads can affect wildlife through direct effects to habitat and indirectly through disturbance. For the purposes of Travel Analysis leading toward identification of a forest-wide minimum road system, the primary analysis will focus on road effects to land areas managed especially for wildlife and indirectly through the potential for disturbance effects from roads.

Since the roads being analyzed are existing NFTS roads, the direct effects of habitat displacement are existing and will only be considered for federally listed threatened or endangered species where Recovery Plan action items recommend changes in the road system. In the future, proposals to add new roads to the minimum road system or changes in the Recovery Plans for federally listed species

will be evaluated at appropriate scales and updates to the National Forest Transportation System (NFTS) will be made as necessary.

The existing Land and Resource Management Plan (LRMP) may identify road-specific desired conditions or standards and guidelines for wildlife-focused land allocations or as general guidelines. The Travel Analysis risk assessment will identify situations that are in conflict with these desired conditions and guidelines. Forests that have done Plan Revision under the new Planning Rule may look to components of the LRMP other than standards and guidelines.

Indicators of Degradation and Disturbance based on Land Allocation: Roads in PACs

Possible Metrics:

- **Reported incidents of adverse road-related effects on wildlife within PACs**
- **Occurrence of overlap between PAC layers and road layers**

The LRMPs identify some wildlife-related land allocations that can be used as risk indicators. In particular, land allocations such as Protected Activity Centers (CA spotted owls, northern goshawks, great gray owls, etc.) should be mapped as risk indicators. Polygons that encompass large contiguous areas are less useful as risk indicators as they include too many roads to help focus the assessment. Land allocations such as the Southern Sierra Fisher Conservation Area are not a good risk indicator, but if fisher den sites are known they are a land allocation that can be mapped. Similarly, CA spotted owl home range core areas (HRCAs) are not a useful risk indicator because they cover large cumulative areas and do not help provide focus and there are no threshold road densities or road recommendations for these land allocations.

> ***Use PAC's for Spotted Owl, Northern Goshawk, Great Gray Owl, Yosemite Toad, or any species identified in the LRMP with discrete mapped polygons.*** Do not buffer these areas as the concern is the occurrence of roads within the mapped wildlife emphasis areas.

Forest TAP Team Considerations: Refer to the LRMP direction for these land allocations. Some land allocations have desired conditions or standards and guidelines directing that road impacts be mitigated or minimized. The team should consider opportunities to meet other LRMP objectives while reducing road impacts within these land allocations based upon expected impacts to the species or conditions that form the basis for the land allocations (e.g. Protected Activity Centers are designed to provide for breeding opportunities so road use and disturbance potential is highest in the spring and low in the late summer and fall).

Indicators of Disturbance: Roads in Critical Habitat and Recovery Plans Areas

Possible metrics:

- **Reported incidents of adverse road-related effects on wildlife within delineated areas**
- **Occurrence of overlap between roads and Critical Habitat or Plan layers**

Some federally listed species have Critical Habitat identified. These areas should be used as a risk indicator for each species. When Recovery Plans are developed, they may include recovery action items that address the road system, either specific to locations or in general.

For all species in the USFWS Critical Habitat database:

1. ***Use the Critical Habitat polygons.***
2. In some cases, Critical Habitat polygons may show no variance at the forest-level scale. If this occurs the team should consider more ***biologically relevant data sets*** if they exist, such as results from suitable habitat studies. Remember to document the rationale for selection of suitable habitat criteria and document whether the U.S. Fish and Wildlife Service reviewed and is supportive of the criteria (e.g. criteria have been used for project level analysis and consultation for other projects).
3. If road-related ***action items from Recovery Plans or Conservation Strategies or Conservation Agreements*** are available as polygons, they should be used as risk indicators as well.

4. Forest TAP Team Considerations: Remember, this analysis does not constitute a decision and does not require a biological assessment and consultation. The purpose for identifying risk polygons is to identify areas where there is a higher potential for roads to affect important areas for federally listed species. The need for consultation would be triggered by action taken to implement any recommendations from this analysis. In evaluating roads that overlap with Critical Habitat, consider if the physical presence of roads is identified as a factor affecting the species listing status. Roads should not automatically be considered for recommendation for decommissioning or conversion simply because of the mere overlap with Critical Habitat, unless the reduction and removal of roads is a specific recovery action. The Team should consider the potential impacts of roads on the particular species during critical life stages or seasons. For species with Recovery Plans, consider if there are road-related recovery action items. Some action items may be design criteria or mitigations that should factor into considering costs and opportunities to maintain the road system. Some of these actions may be too site-specific for consideration at the forest-wide scale and are more suitable for landscape and finer scale assessments. If Recovery Plan action items exist that are not explicitly addressed in the LRMP, consider developing recommendations for further assessments that would address the action items and allow for future refinements to the minimum road system as indicated by those future assessments.

Indicators of Current Disturbance: Proximity to Known Active Sites

Possible Metrics:

- **Reported road-related adverse effects near active wildlife sites**
- **Distance variations of road sensitivity among different species and situations**

This analysis acknowledges a distinction between known detected and active locations of a species, on one hand, and biological locational data like known breeding sites, roost or rest

sites, and general suitable habitat on the other. To indicate disturbance, the TAP should consider road proximity to known, detected, active species locations only. Although general biological site data is sometimes used in project level analyses and other TAPs, it is not a strong indicator for risk at the forest scale for determining the minimum road system for the following reasons:

- Most disturbance effects to wildlife at the individual road or animal territory level are not significant at the population level. This may not be true for species of extremely limited range or with limited local populations or limited distribution where disturbance effects from roads could affect overall species populations. See the discussion of buffers for federally listed species below.
- Disturbance related to roads is usually not the limiting factor affecting wildlife populations. Forests should evaluate if there are particular species or circumstances where disturbance from roads is likely a significant factor for that species or for particular locations or situations. These are more likely site-specific and not universally capable of being modeled at this coarse level. Examples might be instream road crossings near known amphibian breeding sites.
- The level of disturbance effect from a given road is dependent upon the quantity and types of road uses and seasons of use in relation to spatial and temporal sensitivity of each wildlife species. The level of detail required to assess this is beyond the scope of a broad, forest-wide assessment. As landscape and smaller scale assessments are conducted, this finer scale analysis should be used to update the overall national forest transportation system.
- Substantive disturbance impacts at individual locations can often be mitigated through engineering and design of the road system, management of screening, and by managing road uses. These considerations are appropriate at the project level, but these options cannot be meaningfully evaluated at the forest-wide scale.
- The special emphasis afforded federally listed species under the Endangered Species Act supports use of a buffer distance from Threatened, Endangered, Candidate, and Proposed species as a risk indicator. Buffer distances from known locations for other individual wildlife species of management concern (Sensitive species primarily) will generally not be used as individual species risk indicators. Instead of using individual species buffer distance maps, a composite risk map of areas of overlap between multiple species locations will be used to indicate areas of higher potential risk.

The special emphasis afforded federally listed species under the Endangered Species Act supports use of a buffer distance from Threatened, Endangered, Candidate, and Proposed species as a risk indicator. Buffer distances from known locations for other individual wildlife species of management concern (Sensitive species primarily) will generally not be used as individual species risk indicators. Instead of using individual species buffer distance maps, a composite risk map of areas of overlap between multiple species locations will be used to indicate areas of higher potential risk.

For ***known, recently active locations of Threatened, Endangered, Candidate, and Proposed Species:***

1. Consider the sensitivity of individual species. If road related disturbance is an identified risk factor for the species, then consider evaluating the indirect effects of road access within the buffer for that species. If a species is unaffected by roads, the polygons derived from its locations would be of no risk concern.
2. ***Buffer known locations by ¼ mile***. Other buffer distances can be used if there is a more supportable species-specific distance threshold or local information that defines a better general disturbance buffer distance. Remember, this is not to define absolute disturbance risk but to highlight areas to focus the assessment. The selection of alternate buffer distances should be documented and coordinated with the Regional Teams and TAP teams from adjacent units to ensure consistency.

   Forest TAP Team Considerations: For federally listed species, the sensitivity of the species to road disturbance should be considered when evaluating roads that overlap these buffer areas. The mere overlap of a road with these buffer areas does not imply that these roads are candidates for removal from the minimum road system. Road recommendations should be based upon actual risks, which may not be known at this scale of analysis and may need to be deferred to future smaller scale assessments. Consider the evaluations that occurred for those roads already considered during the Motorized Travel Management FEIS.

For any ***other sensitive species identified at the forest-level:***

1. Generate a ¼ mile buffer around known locations for each Forest Service sensitive species substantially affected by road disturbance.
2. For species particularly sensitive to roads, and where suitable habitat has been defined, consider importing the suitable habitat polygons (if they are meaningful at the forest-scale).
3. Define risk polygons by evaluating composite occurrence among these overlapping layers.

Forest TAP Team Considerations: Areas with a higher number of species overlaps are higher priorities for evaluation. When evaluating these risk areas, consider the individual species, the type and amount of expected road use and season of road use, and the sensitivity and permanence of the known location (e.g. spotted owl or goshawk nests that move over time versus pond used by frogs). In areas of high overlap, evaluate opportunities to identify a minimum road system that reduces the number of roads or extent of overlap of conflicting uses that contribute to disturbance. Again, consider the evaluations that occurred for those roads already considered during Subpart B.

Indicator of Road Density: Disturbance due to road concentration

Possible Metrics –

- **As specified in LRMP**
- **As used in other density calculations (Motorized Travel Management FEIS, WCF, etc.)**
- **Include other types of routes (motorized trails, county roads, etc.) when appropriate**

In some cases, road density is described as a proxy for concentrated use that represents disturbance risk to a species. For example, many forest plans identify a maximum road density for deer critical winter range and/or fawning habitat. Where these road density thresholds are identified in forest plans, they can be used as risk indicators. Note that in most cases, road density is a proxy for disturbance and not habitat fragmentation.

For ***species with identified road density thresholds in the LRMP or related documents***.

1. ***Calculate road density as described in the associated document***. If a specific method is not described, calculate road density at a biologically meaningful scale. For example, where deer critical winter range occurs in discrete geographically defined polygons, calculate road density over the entire polygon. Where polygons are extremely large or include large areas of wilderness or roadless areas, consider using subwatersheds to discriminate road density across portions of the winter range.
2. For the Motorized Travel Management FEIS, forests used a method described by Gaines et al 2003 that calculates a percentage of the deer range in road buffers. Forests may also use this approach used for Subpart B to identify potential risk areas.

   Forest TAP Team Considerations: Similar to above, when considering roads that overlap with this risk factor, consider the amounts, types, and season of use of the roads along with the sensitivity of the species to road-related disturbances. In particular, consider open versus closed roads and if motorized trails are included in the LRMP threshold. In areas identified with high road density, there may be many different opportunities to adjust the transportation system. Where site-specific information does not exist or reasonable assumptions on use cannot be made, these areas may carry forward as recommendations for landscape level or finer scale assessments.

Indicators of Connectivity: Roads in Essential Connectivity Areas (ECA's)

Possible Metrics:

- **Evidence of the disconnecting effect of roads in ECA polygons**
- **Occurrence of overlap between roads and ECA layers**

Forests should evaluate roads against the California Essential Habitat Connectivity (CEHC) assessment. In particular, Natural Landscape Blocks (NLBs) have been identified as areas with some regulatory management that supports and maintains higher levels of naturalness,

including lower road densities. Many areas of National Forests are included in these NLBs. Essential Connectivity Areas (ECAs) were identified to provide linkages between NLBs. These areas were coarsely defined for the entire state and the mapped polygons are not intended to define hard boundaries. The network of existing roads was considered in delineating these polygons; however, the data source was U.S. Census Bureau TIGER data from 2007.

1. Import the ***Natural Landscape Blocks from the CEHC data set*** using the feature class "NLB_gen". These indicate the mapped natural landscape blocks.
2. Import the ***Essential Connectivity Areas from the CEHC data set*** using the feature class "ECA". These ECA areas will overlap with portions of the NLBs and there is overlap within the ECAs.

Forest TAP Team Considerations: As with Critical Habitat, the mere overlap of a road and these connectivity areas should not drive an automatic consideration for recommendation for decommissioning or conversion. The team should first examine landscape patterns of roads in these areas. Higher risk focus areas would be areas with perpendicular roads that bisect ECAs and areas with patterns of higher road density with moderate to high use that could reduce the connectivity potential due to moderate to high disturbance levels. Other higher risk focus areas would be areas of higher road density where ECAs connect to NLBs. Higher use in these nexus areas could reduce the connectivity value. Since these connectivity areas are generic and not designed for a particular species, the considerations in these areas will necessarily be qualitative in nature.

Risks to Cultural/Heritage Resources

Adverse Effects of Roads on Cultural Resources

Roads can be a direct or indirect source for adverse effects to cultural resources. Road use and maintenance can adversely affect cultural resources by causing damage to fragile, non-renewable prehistoric and historic sites. Noise related to some road uses can also have an adverse effect on cultural resources that have values associated with contemporary traditional or ceremonial practices at sites important to Native American Indian tribes. Roads can also provide easy access to areas containing vulnerable prehistoric or historic sites where vandalism and illicit artifact collection can more easily occur.

Indicators of Damage to Cultural Resources: Threatened Sites

Possible Metrics:

- **Number of cultural resource sites bisected by road or within road prism.**
- **Number of cultural resource sites bisected by road or within road prism with known adverse effects.**
- **Number of cultural resource sites adjacent to (<50 meters) or accessed by road with documented past vandalism or illicit artifact collection, or characteristics that make them vulnerable to vandalism or illicit artifact collection.**
- **Road is a cultural resource or historic property.**

- **Road's proximity (<0.5 miles) to Traditional Cultural Properties or Native American Indian sacred sites where visual or audible effects of road use is known to have an adverse effect on associated traditional, religious, or cultural practices.**

Forests are encouraged to evaluate the metrics listed above and, if possible, develop forest-specific thresholds based on local knowledge and experience. This threshold will be a buffer distance inside of which roads will be flagged for risk to heritage resources. Information used in developing forest-specific thresholds should be documented.

The value of most cultural resources lies in their association with important historical or prehistoric patterns or event, relationship to important people, architectural characteristics, or the scientific information they contain. To retain these values, their location, association, design, materials, workmanship setting, and feeling are also important. Any actions that could destroy, damage, alter, or remove a property or its characteristics places it *at risk* of adverse effects (36 CFR 800.5) (36 CFR Part 800 – Protection of Historic Properties). Proximity to a road is probably the most reliable indicator to use in determining which cultural resources are or may be directly *at risk* of adverse effects associated with road use or maintenance. The mere co-occurrence of cultural resources and roads, however, does not necessarily mean a cultural resource is *at risk*. Soil type and characteristics (e.g., erosion risk and rutting capacity) and road surface (natural or hardened) can be useful secondary indicators in identifying whether a cultural resource is *at risk*. Some cultural resources may be *at risk* of being adversely affected in an indirect manner when roads provide easy access to areas containing cultural resources that have a history of vandalism or illicit artifact collecting (e.g., rock shelters, caves, prehistoric rock art, Gold Rush mining sites).

Therefore, indicators useful for assessing cultural resource impacts are based on road and cultural resource locations and characteristics that can be readily determined from remotely sensed and field data. Other data sources include cultural resources records, historic archives, cultural resource overviews, anthropological literature, and tribal relations program files.

Cultural resources are prehistoric, historic, archaeological, or architectural sites, structures, places, or objects and traditional cultural properties (FSM 2360.5).

Cultural resources that are vulnerable to vandalism include specific sites or areas where vandalism or illicit artifact collection or excavation has been documented in the past, and may include areas with site characteristics or features that may be attractive to vandals or illegal collectors (e.g., caves and rock shelters, prehistoric rock art, Gold Rush mining sites etc.).

Traditional Cultural Properties include all such properties identified and documented on cultural resource site forms, or in NRHP evaluation reports, LRMPs, or forest ethnographic studies or overviews.

Areas of traditional and cultural importance to Native American Indian tribes or traditional cultural practitioners have been identified by tribes or traditional practitioners, and recorded on Heritage Program site forms, or documented by forest Tribal Relations specialists, or documented in ethnographic studies or forest cultural resource overviews. Sacred sites are identified by Native American Indian tribes (Executive Order 13007 – Indian Sacred Sites).

Recommended Data Sources

GIS data layers, together with the INFRA database, provide the locations of cultural resources that can be buffered using the forest-specific threshold distances. If necessary, review cultural resource site records and monitoring forms for additional information about past or existing effects of road use and maintenance. Other information sources may include: historic maps and records in forest or Heritage Program archives, cultural resource overviews, anthropological literature, and tribal relations program files.

Risks to Watersheds and Aquatic Resources

Adverse Effects of Roads on Aquatic Resources, Aquatic Organism Passage, Floodplain Function, Erosion and Sedimentation, Large Woody Debris, Stream Temperature, Stream Channel, and Riparian Habitat

The impacts of roads upon watersheds, aquatic organisms, and their habitat include sediment delivery, channel and floodplain alteration, and reduced habitat connectivity. Other road-related impacts include reduced large woody debris delivery, increased water temperature, and impaired water quality. Roads also influence the routing of water from uplands to the stream channel. In addition, when placed near streams, roads often simplify channels and riparian and in-stream habitat, alter hydrologic processes, and prevent natural channel adjustments (Spence et al. 1996). At culverts, excessive flow velocities, insufficient water, excessive culvert heights, and the absence of pools all can impede migration of aquatic biota (Evans and Johnson 1980).

Furniss et al. (1991) concluded that forest roads contribute more sediment than all other forest activities combined on a per unit area basis. Summarizing results from nine different studies, they reported that mass wasting associated with roads produced 26 to 346 times the volume of sediment as undisturbed forests. Mass failures were attributed to poor road location, construction, and maintenance, as well as inadequate culverts. Surface erosion from roads also constitutes a significant source of chronic sediment inputs (Beschta et al. 1995, Best et al. 1995). The combined effects of mass wasting and surface erosion can lead to elevated sediment levels in streams even when only a small percentage of a watershed is roaded. For example, Cederholm et al. (1981) reported increased sediments in salmonid spawning gravels when roads exceeded 3% of the total basin area.

For the TAP, the analysis of roads and road impacts to watersheds and aquatic resources should occur in two stages: first, a consideration of the cumulative effect of roads in a watershed and second, the consideration of each individual road. (The term “watershed” is used in the following section in its generic sense of a land area draining to a point, rather than in reference to a specific

scale.) The watershed analysis could occur at multiple scales, generally HUC6 and finer.) For the watershed analysis, one should identify watersheds that are of particular concern because of their high resource value or high risk of cumulative road impacts. Second, individual roads should be analyzed for their specific impacts and risks.

Indicators of Watershed –level Issues: Cumulative effects of roads on aquatic and riparian resources and impact to priority and other high value watersheds

Possible Metrics:

- **Subwatersheds that are identified as proposed reintroduction areas in Recovery Plans for ESA-listed aquatic species**
- **Subwatersheds that contain designated or proposed critical habitat for ESA-listed aquatic species**
- **Subwatersheds that support one or more populations of Forest Service sensitive aquatic species**
- **Designated priority watersheds (WCF)**
- **High open road density (WCF)**
- **Environmental Protection Agency's (EPA) 303d listing**
- **High road maintenance risk (WCF)**
- **High road density in proximity to water (WCF)**
- **High stream crossing density (WCF)**
- **High density of roads with mass wasting risk (WCF)**

At the watershed scale, these factors provide indicators of risks and values to be protected. Because of the relatively coarse scale of the WCA (HUC 6) and some other analyses, where it is possible Forests should refine the analyses to a finer scale (HUC 7 or finer) in order to narrow the focus to more specific high risk or high resource value areas.

The watershed scale risk assessment takes into consideration existing watershed conditions and the potential for cumulative effects. All roads that intersect watersheds with high value or where factors exceed risk threshold (see below) will be flagged. Where there is potential for cumulative watershed effects or high values at risk, there would be a higher watershed "level of concern", and a greater inclination toward minimizing the overall road system. In watersheds where there is a low "level of concern", there would be less emphasis on decreasing the road system, leaving the focus on addressing any specific issues and risks at the road-scale.

Forest TAP Team Considerations: All roads that intersect one or more of these watersheds will be flagged. Of course, the overlap of a road and a high value or high risk indicator does not predetermine the outcome of the TAP. The team will examine landscape patterns of roads in these areas and use their local knowledge to focus on areas of higher actual risk, or areas of overlap with risk areas from other risk categories, and also document road benefits – before making a recommendation.

Calculations of road density should sometimes consider routes other than roads in the analysis data set. Motorized trails can have similar effects to roads and for the purpose of density calculations it can make sense to include them. Single track motorized trails could be weighted for their individual impact as appropriate.

Riparian zones include all designated riparian protection zones on NFS lands, including riparian reserves under the Northwest Forest Plan, riparian conservation areas (RCA) under the Sierra Nevada Framework Planning Amendment, riparian habitat conservation areas for QLG forests, and streamside management zones for other forests.

Thresholds and Watershed Level of Concern

Most of the indicators useful for assessing risks to watershed and aquatic resources have not been quantitatively analyzed to determine thresholds above which resource damage is likely. Those thresholds that have been established from research are mostly related to effects on peak flows and not water quality, and often do not segregate the effects of roads from effects of other land uses. However, the following road density thresholds available from scientific literature are provided in the table below as general guidance. We recommend that each forest evaluate the available information and consider one of the following three approaches:

1. Utilize thresholds from published research if they are applicable to the local geology, soil types, and climate.

2. Utilize thresholds that are applicable to the local area that were developed during the Sierra Nevada Framework Plan Amendment and the Northwest Forest Plan analyses.

3. Run the Core Indicator analysis and interpret the range of values obtained in relation to local knowledge and observations of road effects on watershed condition and aquatic resources.

Published Indicators, Thresholds, and References

Indicator	Threshold	Reference
Total road density	3% of total watershed area	Cederholm et al. (1981)
Total road density	0.84 km/km2	Dose and Roper (1994)
Total road density	0.7 mi/mi2	FEMAT (1993)

Forests are encouraged to determine appropriate local thresholds based on local knowledge and experience and variations in geology, soils, and geomorphology. Look at frequency distribution of the metrics used, and determine averages, outliers, and look for natural breaks and attainable goals for management. The information and rationale used in developing forest-specific thresholds should be documented.

Road-scale Analysis

Evaluate and identify specific issues with individual roads or road segments. This would include identification of impacts such as crossings with known aquatic organism passage problems, hydrologically -connected road and ditch segments, meadow crossings, a history of erosion or failure, or GIS-based analysis of risk factors such as excessive road grades or landslide-prone terrain.

Indicators of Degradation of Riparian Areas: Direct effects on channel and riparian habitat and function and impact to high value resources

Possible Metrics:

- **Stream crossings with aquatic organism passage problems**
- **Stream crossings in general**
- **Road-stream crossings with diversion potential**
- **Meadow crossings**
- **Road segments in riparian zones (riparian reserves, RCAs, SMZs, RHCAs)**
- **Hydrologically-connected road segments or inboard ditches that discharge to streams**
- **Road segments in areas of high mass wasting potential**
- **Fill volumes at risk of erosion**
- **Steep road gradients**
- **Native surface road in areas with soils that are highly erosive and/or that have high rutting potential**
- **Length or percent of road with ruts**
- **Length or percent of road with inadequate drainage features**

These metrics should be mapped and used in the final multidisciplinary evaluation of the roads.

References

Best, D.W., Kelsey, H.M., Hagans, D.K., and Alpert, Mark, 1995, Role of fluvial hillslope erosion and road construction in the sediment budget of Garrett Creek, Humboldt County, California, in: Geomorphic Processes and Aquatic Habitat in the Redwood Creek Basin, Northwestern California, Nolan, K.M., Kelsey H.M., Marron, D.C. (eds.), U.S. Geological Survey Professional Paper 1454: Chapter M.

Beschta, R.; Frissell, C.; Gresswell, R.; Hauer, R.; Karr, J.; Minshall, W.; Perry, D.; and J. Rhodes. 1995. Wildfire and Salvage Logging: Recommendations for Ecologically Sound Post-Fire Salvage Logging and Other Post-Fire Treatments on Federal Lands in the West. Corvallis, OR; Oregon State University. 14p.

Cederholm, C. J., L. M. Reid, and E. O. Salo. 1981. Cumulative effects of logging road sediment on salmonid populations in the Clearwater River, Jefferson County, Washington. Presented to

the conference Salmon-Spawning Gravel: A Renewable Resource in the Pacific Northwest? October 6-7, 1980. Seattle, WA. 35 pp.

Cover, M.R., May, C.L., Dietrich, W.E., and Resh, V.H., 2008, Quantitative linkages among sediment supply, streambed fine sediment, and benthic macroinvertebrates in northern California streams: Journal of the North American Benthological Society 27(1):135-149.

Evans, W.A. and B.A. Johnston. 1980. Fish Migration and Fish Passage: A Practical Guide to Solving Fish Passage Problems. U.S. Forest Service Report USFS-EM-71000-2.

Furniss, M.J.; Roelofs, T.D.; Yee, C.S. 1991. Road construction and maintenance. Pages 297-323 in Meehan, W.R.(ed). Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society.

Harr, R.D., Harper, W.C., and Krygier, J.T., 1975, Changes in storm hydrographs after road building and clear-cutting in the Oregon Coast Range: Water Resources Research 11(3):436-444).

McGurk, B.J., and Fong, D.R., 1995, Equivalent roaded area as a measure of cumulative effect of logging: Environmental Management 19(4):609-621.

Napper, Carolyn, 2008, Soil and Water Road-Condition Index - Field Guide, 0877 1806P, San Dimas, CA: U.S. Department of Agriculture, Forest Service, San Dimas Technology and Development Center, 104 pp. http://www.fs.fed.us/t-d/pubs/pdf/08771806.pdf

Schnackenberg, E.S., and MacDonald, L.H., 1998, Detecting cumulative effects on headwater streams in the Routt National Forest, Colorado: Journal of the American Water Resources Association 34(5):1163-1177.

Spence, B.C., G.A. Lomincky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR

Ziemer, R.R., 1981, Storm flow response to road building and partial cutting in small streams of Northern California: Water Resources Research 17(4): 907-917.

Risks to Wildfire Management Resources

Adverse effect of Roads in terms of Human-caused Fire

The only real risk from roads to the management of wildland fire is the fact that all roads deliver ignition sources (people) to the wildlands. They provide easy access for people who sometimes start fires. In Spain, Raul Romero-Calcerrada & C. J. Novillo* found that human caused wildfires are strongly associated with access to natural landscapes, with the proximity to urban areas and roads being the most important factor.

The indicator suggested below is recommended for all travel management analyses. Additional indicators may be selected by Forests based on other concerns and data availability.

Indicator of Human-caused Fire: Proximity to Known Human-caused Fire Origin Points

Possible Metrics:

- **Density of human-caused fires over the past 30 years per 1,000 acres.**
- **½ mile buffer of human-caused fire origins since 1980**

Forest TAP Team Considerations: Consider if the pattern of human activities related to ignitions is relevant. For example, local knowledge may indicate that some areas of human ignitions are primarily related to woodcutting uses, to hunting activities, or to roadside ignitions at pullouts. Consider if changes in management have or could affect the potential for human-caused ignitions to determine if the historic locations and rates of ignition are representative of the near-term future human-caused ignition risk.

References

Landscape Ecol(2008) 23:341–354: GIS analysis of spatial patterns of human-caused wildfire ignition risk in the SW of Madrid (Central Spain) Raul Romero-Calcerrada; C. J. Novillo; J. D. A. Millington, I. Gomez-Jimenez

Risks to Botanical Resources

Botanical Resource Indicators and Thresholds for Risk Assessment

Noxious Weeds and Nonnative Invasive Indicators and Thresholds for Risk Assessment

Roads can serve as a vector to spread nonnative invasive plant species (NNIS) and impact native plant communities and indirectly the plants and animals that depend on those plant communities. Roads can also impact populations of managed plant species and native plant communities through direct impacts from use, road-related erosion, fugitive dust impacts to populations. Also, similar to aquatic resources, roads can disrupt and change hydrologic flow and hydrologic characteristics and impact aquatic and wetland species, sometimes a substantial distance downstream of the road impact. Direct effects can extend beyond the road prism, for example during roadside management activities such as road brushing and hazard tree removal. In addition, roads can increase the risk of unauthorized collection of native plants.

The identification of a minimum road network through Travel Management Subpart A provides an opportunity to consider and reduce adverse impacts to rare plants and plant communities of concern. These guidelines are intended to provide a useful approach to adequately assess risks to rare plant species and native plant communities of concern from existing NFTS roads.

Botanical Resources should focus on those identified in the Forest Land and Resource Management Plan. Typically these include: Federally listed threatened or endangered species and designated critical habitat; species proposed for Federal listing or proposed critical habitat; Forest Service sensitive species; other plant species of concern such as forest endemics and watch list species. LRMP land allocations may include botanical research natural areas and botanical special interest areas. In addition, consideration should be given to native plant communities of concern. Some

examples of native plant communities of concern include: wetlands, vernal pools, seeps, springs, peatlands, fens, aspen stands and special soil types such as serpentine or carbonate soils. Finally, where known, areas important for cultural uses such as Native American collection sites should be considered, recognizing that disclosure of specific locations may be protected and will need to be coordinated with Heritage staff.

Botanical Resources Indicators

The following indicators can be used to identify roads or road segments that overlap botanical resources or contribute to a risk of adverse impact to botanical resources. For non-native invasive species, the risk is that roads can contribute to their spread. The extent of data for each indicator will vary by species and by forest.

Indicators for botanical resources:

- Roads within 100 feet of known federally listed or Forest Service Sensitive species occurrences and mapped potential or suitable habitat or mapped critical habitat;
    - Use of mapped potential or suitable habitat is only useful if it maps discrete habitat areas (e.g. actual areas of potential occurrences and not just a broad range map)
    - Note: Believe that 100 feet was a standard for SubPart B. Forests should consider using the same buffer distance used for SubPart B.
- Roads in or through native plant communities;
- Known occurrence next to a native surface road for species known to be ecologically sensitive to fugitive dust;
    - The local assessment should consider the amount, type and season of use and road surface when assessing this indicator. Focus on typically unmitigated risk (e.g. not related to planned projects where dust abatement can be a design feature or mitigation).
    - Note that this factor is based on local knowledge.
- Roads that access known rare plant occurrences or native plant communities of concern that have been identified as desirable to illegal plant collectors.

Indicators for Noxious Weed and Nonnative, Invasive Plants:

- Roads in or through known NNIS occurrences;
- Roads identified as risks in noxious weed or non-native, invasive species management plans or in sensitive species conservation or management plans.

Thresholds

Thresholds do not exist to allow a quantitative assessment of risks from roads. Forests are encouraged to evaluate the indicators listed above and, where possible, develop forest-specific and site-specific thresholds based on data, local knowledge, and experience. Information and data used in developing these thresholds should be documented.

Since impacts to botanical resources are highly variable and can vary by species and type and season of road use, the mere overlap of roads with these indicators does not inherently indicate an undesired conflict with botanical resources. The suite of indicators are intended to flag those roads with a risk potential for further consideration by knowledgeable local botanists and resource managers. Risk to botanical resources is highest where the potential for unmitigatable impacts exists.

Data Sources

No new field data will be gathered specifically for this assessment. The Forest Service corporate NRIS and FACTS databases will be the primary source for existing population and habitat GIS data. In addition, data from the California natural diversity database (CNDDB) should be evaluated for data not incorporated into NRIS. Where substantial data gaps exist, they should be disclosed and the implications on the risk assessment should be discussed.