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First name: Chris
Last name: Frissell
Organization: Frissell & Raven Hydrobiological and Landscape Sciences
Title:
Comments: Comments on the 2019 Alaska Roadless Rule DEIS

Please accept the attached PDF file, which contains my comments on fishery and water quality concerns in the DEIS. Thank you.

Chris Frissell

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Frissell & Raven Hydrobiological and Landscape Sciences LLC

Polson, MT USA

Science isn't a slot machine, where you drop in facts and get out truths. But it is a special kind of social activity, one where lots of different human traits-obstinacy, curiosity, resentment of authority, sheer cussedness, and a grudging readiness to submit pet notions to popular scrutiny-end by producing reliable knowledge. --Adam Gopnik, The New Yorker, 30 Nov 2015

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Comments on Fisheries and Water Quality Issues in the US Forest Service Draft Environmental Impact Statement for the Alaska Roadless Rule, December 2019.

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1. Introduction

1.1 Scope and Importance of Review

I was commissioned in November and December 2019 by The Wilderness Society to review the US Forest Service's Draft Environmental Impact Statement for the Alaska Roadless Rule (https://www.fs.usda.gov/nfs/11558/www/nepa/109834_FSPLT3_4876629.pdf) (herein after, "DEIS"). The Society asked me to prepare comments on water quality and fisheries effects on the Tongass National Forest, as they are addressed, or not addressed in the DEIS, based on best available scientific information and my professional opinion as an aquatic scientist with expertise in freshwater ecology, fish conservation, watershed processes, environmental impact assessment and land and water resource planning. The observations and opinions in this document are expressly my own.

The resource at risk from logging and road construction on roadless lands of the Tongass National Forest is considerable at a regional and national scale (Byrant 2011, Halupka et al. 2003, Bryant and Everest 1998, Everest et al. 1997). Freshwater habitat on the Tongass National Forest produced roughly 25% of Alaska's commercial salmon catch in the past decade, with an average annual dockside landed value of US$88 million (Johnson et al. 2019). Despite recognized harms to salmon habitat in some watersheds from past timber harvesting and road construction, the Tongass National Forest produces more wild salmon by far than any other national forest in the nation. This globally

impressive productivity is in large part attributed to the extensive area of unlogged, roadless watersheds on the national forest, where ecological integrity water quality, biophysical diversity, and the productive capacity of freshwater habitat for salmon remain high (Halupka et al. 2003, Bryant and Everest 1998, Everest et al. 1997).

The proposed Alaska Roadless Rule would exempt the Tongass National Forest from the 2001 Roadless Area Conservation Rule and thereby remove that rule's prohibitions against road construction and timber cutting on all of the 9.2 million acres of inventoried roadless areas in the Tongass. The DEIS evaluates several other alternatives that provide varying levels of protection for Tongass roadless areas, but none are as protective as the No Action alternative.

The Forest Service's evaluation of impacts to fish habitat and salmon harvest are summarized as follows: "Overall effects to fish habitat are expected to be negligible under all alternatives, because of the strong protections to fish habitats provided by Forest Plan LUDs, Forest-wide standards and guidelines including the riparian management strategy, and the lack of old-growth harvest or associated road construction allowed in the T77 watersheds and TNC /Audubon Conservation Priority Areas" (DEIS ES-15). The DEIS further states that "localized effects on fish habitat may occur, but these are expected to be minimal overall" (DEIS ES-15). Consequently, according to the DEIS, "None of the alternatives are expected to have a significant change to the commercial fishing or fish-processing industries" (DEIS ES-13).

For reasons discussed below, these erroneous assumptions and conclusions in the DEIS are based on a grossly inadequate consideration of the best available science regarding the effects of road construction and logging on aquatic ecosystems.

1.2 Qualifications

I am a consulting aquatic ecologist and watershed scientist with expertise in land management and conservation and restoration strategies for fishes and amphibians, with extensive experience with Pacific salmon, native trout and charr. I also serve as Affiliate Research Professor at Flathead Lake Biological Station, the University of Montana. My expertise is outlined in my CV, which is appended to this declaration.

My education is as follows. I hold a Bachelors degree in Zoology from the University of Montana, and Masters and PhD degrees in Fisheries Science from Oregon State University, where the focus of my graduate research was the cumulative effect of land use and watershed disturbance on freshwater ecosystems and fish populations.

I have 30 years of experience as a research scientist in the field of aquatic ecology, fishery and conservation biology, and watershed science, having held research faculty positions at The University of Montana and Oregon State University. I have more than 40 scientific and technical publications in aquatic ecology, fishery and conservation biology, and watershed science, in professional journals, symposia, books, and book chapters, and also am author of more than 30 research reports for various institutions and agencies. I have served as peer reviewer or reviewing editor for more than a dozen professional journals and government research publications. I have served on 13 professional and government panels that provided technical guidance about stream and river protection to state and federal wildlife and forest management agencies in three states, including technical panels that advised Oregon state agencies on water temperature standard development, and forestry landslide prevention rulemaking. I later served on Montana governor's scientific panel to inform that state's restoration strategy for threatened bull trout, and participated in Forest Service expert panels assessing the efficacy of regional plans for conservation of freshwater species, including amphibians. I have commented or served as an expert witness in litigation of numerous national forest plans and federal forest project and programmatic NEPA efforts since about 1980. In Alaska, I sponsored a PhD student who studied ecology and conservation headwater trout populations in southeast Alaska (Hastings 2005); contracted with USEPA to evaluate impacts of roads and pipelines in possible mine development in Bristol Bay; and reviewed environmental impact statements for mine and mine road development in Bristol Bay and the Ambler Mining District of the Brooks Range.

While on the faculty as a researcher at Oregon State University, I was funded to lead a 6-year research project on salmon habitat protection in Oregon coastal rivers. In 1992 I completed my doctoral dissertation on the cumulative effects of land use on salmon habitat in Oregon South Coast rivers. That research focused on the full spectrum of threats to physical habitat of salmon in coastal watersheds, including water temperature, sediment conditions, landslides and road erosion, large wood, and channel dynamics. As the dominant land use in the region, forestry was a primary topic of that research.

For ten years I was a full-time Research Assistant Professor and Research Associate Professor at the University of Montana's Flathead Lake Biological Station, where I continued to conduct research on salmon ecology and freshwater habitat conservation. For 11 years I held the positions (alternately) of Senior Staff Scientist or Conservation and Science Director with the Pacific Rivers Council, where I worked specifically on the interface of scientific information and land management, with considerable involvement in forest management policy development for stream protection and salmon and trout recovery, including in coastal Oregon. My work in particular has focused on the scientific adequacy of federal forest land planning and aquatic conservation policies, and I have special expertise in the manifold impacts on freshwater habitat and salmonid fishes of roads and road development in roadless forested watersheds.

1.3 Overview of Documents Reviewed

In preparing these comments I reviewed relevant portions of the DEIS and other Forest Service planning documents and other reports and articles from the scientific literature, as cited in the text below. In particular in the DEIS, I reviewed material in section 1 on aquatic habitat, soils, and water quality impacts; in section 2 on expected change in

salmon harvest and fish habitat; and in section 3 on soils and water, salmon harvest, fisheries, and transportation and roads.

2. Priority Watersheds and the Long-Term Conservation of Salmon Ecosystems

Although salmon in southeast Alaska represent five relatively widely distributed species, homing to natal habitats in combination with a diversity of habitat configurations and conditions has provided a ripe evolutionary field for the emergence of many distinct, locally adapted ecotypes within these species in southeast Alaska (Halupka et al. 2003). This diversity of habitats and locally adapted ecotypes is the very basis of salmon species productivity (Brennan et al. 2019, Schindler et al. 2010). This diversity of habitats and populations serves in turn as the basis of the large trophic and ecological roles that salmon play in ecosystems (Armstrong et al. 2019). This means the conservation of salmon and the manifold roles of salmon in the natural ecosystem and the human economy of southeast Alaska are directly dependent on protection and, where past degradation has occurred, restoration of the full natural diversity of aquatic habitats across the region.

Loss of diversity through increased footprint of human disturbance of watersheds will inexorably reduce the productive capacity of southeast Alaska, and especially the pristine, now roadless watersheds of the Tongass National Forest, for salmon. This fact is well-recognized in the scientific literature (see many aspects of the problem reviewed and cited in the text below), but it is obscured, if not overtly denied, in this DEIS. It seems the DEIS is premised on a covert, unstated, and utterly undocumented assumption that road-building and logging can occur in currently roadless watersheds with no risk of significant harm to aquatic habitat and fisheries. History and the available scientific literature establish clearly that this assumption is wholly untenable. The assumption is also at complete odds with Forest Service planning and policy documents of the past three decades, yet this departure is not explained or reasonably defended in the DEIS.

2.1 Protection of Priority Watersheds is in Question

In recent years the conservation of salmon in the Tongass National Forest has been strategically pinned to the concept of strict protection of a subset of watersheds in the region that are known to have high ecological and fishery values. One iteration is the Tongass National Forest Priority Watershed Classification (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd622074.pdf), and another is the so-called "T77" watershed network proposed by a coalition of public interest and fishing industry groups (http://www.americansalmonforest.org/the-details.html,http://ak.audubon.org/sites/default/files/t77_subsection_seak_atlas_ch07_human_uses_20 0dpi.pdf). The DEIS falls short in failing to adequately account for the potential effect of removal of roadless area conservation protections and reclassification of timber suitability on road building and logging in these watersheds, which are heavily keyed to existing roadless areas where habitat, water quality, and watershed conditions remain

optimal. Habitat losses and fish populations impacts in these watersheds could disproportionately affect near term salmon production. Other than stating that old-growth harvest will continue to be disallowed in T77 watersheds under the 2016 Tongass Plan, the DEIS is wholly unclear as to the level and kind of protections these priority watersheds would receive under the alternatives. It appears the DEIS is designed to allow new road construction within the boundaries of conservation priority watersheds in order to access timber in adjacent areas, which could be highly detrimental to salmon habitat in these watersheds (see review of the impacts of roads below).

That said, in my opinion the shifting spatial distribution of salmon productivity demonstrated in recent "salmon portfolio" research (e.g., Brennan et al. 2019) calls into question whether a conservation strategy based primarily on protection of these selected watersheds is tenable in the long term. Watersheds that are productive for a given salmon species at the present time may not be those most productive for that species in past decades or centuries, and may not be those that will be most productive in future decades. A triage-based strategy that prioritizes a subset of extant habitat for conservation is warranted when one is considering a tattered landscape with few remaining productive habitats and populations, and the managing agency is in restoration mode. But when the subject is a relatively intact region, and the planning is to program actions that bring intrinsic risk of highly persistent adverse impacts to that habitat (e.g., roadbuilding and logging of primary and old growth forest), protection or restoration will not be the outcome. In fact, the outcome will explicitly be a net loss of habitat and population productivity--with possibly less loss of habitat and populations than if no protection priorities at all had been in place. And the shifting productivity/portfolio research on salmon ecosystems all points to our fundamental inability to anticipate where future production will come from, at least across relatively ecologically intact landscapes such as southeast Alaska.

The portfolio research tells us ultimately that a fixed reserve subset is not a viable means of protecting an existing productive salmon ecosystem, and that characterization certainly applies to the Tongass National Forest. Effective conservation of salmon on those forests will require comprehensive protections that assure no net loss of watershed condition relative to current conditions. That is plainly not the policy put forth in this DEIS, though the DEIS does not make that clear. Rather, the proposed action would risk degrading many watersheds that are currently in pristine roadless condition, while offering no reasoned assurance or defensible evidence that such widespread degradation would be compensated by habitat improvement or restoration elsewhere. Despite efforts in the DEIS to minimize effects through omission and tacit denial, the proposed action is in fact a massive, regional-scale step backward from the level of conservation that salmon enjoy under present forest plans, including the regulatory protection provided by the Roadless Rule.

3. Insufficiency of Riparian Management Areas to Protect Streams from Logging and Roads

While somewhat tacit and not stated in a plain way that could be subject to scrutiny and review, it is clear to an informed observer that the DEIS rests on an unfounded grand underlying assumption that logging and roadbuilding can be pursued in roadless areas with no significant or systematic impact on watershed processes, water quality, fish habitat and fish populations. One rationale for this vague and broad assumption is presumably that riparian protections offered in the Tongass forest plan are themselves sufficient or more than sufficient to fully mitigate any harms that might arise from road building, road use and maintenance, and logging. This is the context within which I evaluate the relevant literature in the following section. Virtually all of the following information is not considered in the DEIS; therefore, these potential and known impacts of logging and roadbuilding are not disclosed to the public therein[mdash]despite that they are widely documented in the Forest Service's own research (as cited below, and further within the reference sections of many of the papers and reports cited) and in the agency's own past planning documents.

Leaving unlogged riparian forests is insufficient to mitigate for the effects of upland logging on streams, contrary to the implications in the DEIS. In the sections below I discuss edge effects on windthrow or blowdown, mass erosion and channel erosion resulting from hydrologic changes caused by logging, the effects of roads altering hydrology and erosion processes, and alteration of groundwater temperature by logging. Each of these categories of impact poses consequences for fish habitat and water quality that need to be analyzed on a regional scale to account for potential cumulative impacts of multiple logging projects that we know, from past experience and common sense, can result from a systematic forest plan policy change, such as proposed removal of roadless areas from protection forest-wide. The DEIS arbitrarily and capriciously dismisses, and fails to substantively and accurately address, the environmental effects I discuss below.

3.1 Soils and Water Quality: Unreasoned Assumptions Wholly Inconsistent with Past NEPA Assessments, Plans and Policies.

The DEIS identifies aquatic habitat and the fisheries supported by that habitat as a "key issue" (DEIS 1-7). However, the document proceeds immediately to eliminate soils and water quality from detailed analysis (DEIS

1-8), with only sparse and grossly inadequate explanation. DEIS takes this inexplicable step despite that the mechanisms by which road construction, road use and management, and logging adversely affect soil erosion and water quality are well understood, and are the very mechanisms that in turn impact aquatic habitat and fish populations. This is the first of many inexplicable and wholly unreasoned skips of logic that allow the Forest Service to skirt the issues of risk of impact to salmon habitat and populations of the proposed action and alternatives in the DEIS. I offer a more detailed review of science pertaining to how salmon habitat is affected by alterations of vegetation, soil and water quality that occur when roadless areas are logged.

Specifically, the DEIS (1-8) states that a "preliminary review" of potential soil impacts found that Alternative 6 would increase the amount of land with "high hazard" soils that would be open for commercial logging by 38 percent. This is consistent with a nationwide pattern of relatively high concentrations of "high hazard" or high-erosion risk soils in national forest roadless areas. Indeed, vulnerability of soils to erosion and landsliding is among the major reasons the Forest Service has deferred road construction and logging and in these areas in the past. It is among the principal reasons they remain roadless today. Neverthess, the DEIS fails to address the environmental consequences of the increased area of "high hazard" terrain in lands allocated for logging on the Tongass. Inexplicably, the Forest Service simply claims that "From a broad standpoint, the impacts to soil characteristics and composition from the proposed alternatives would be the same as disclosed in the 2016 Forest Plan Amendment FEIS due to similar harvest levels and Forest Plan standards and guidelines" (DEIS 1-8), then capriciously denies that further analysis is needed. This claim in the DEIS stands in direct contradiction to the increase in "high hazard" soils in the commercial timber base. In my opinion it is near certain any increase in "high hazard" soils within areas open for commercial logging substantially increases the likelihood of damage to water quality and fisheries from post-logging soil erosion and sedimentation, as further described in my comments below.

The fact that the PTSQ remains unchanged, the reason given by the Forest Service as to why environmental effects related to soil erosion will ostensibly not increase under any alternative (DEIS 1-8) does not mitigate against potential increases in mass failure and soil erosion, for several reasons. One reason is that PTSQ is a "soft target" that does not in fact cap the total area logged in any given time period. For example, the same volume of timber can be drawn from a smaller area of concentrated larger trees, or a larger area of lower-volume and lower value trees. Another is that neither the PTSQ nor any other forest-level timber volume target regulates the specific areas logged within the overall area allocated to timber production. By knowingly including more high-hazard soils in the commercial timber base, the Forest Service inexorably increases the likelihood of triggering and increasing the incidence of erosion and landslides through errors of identification of erosion-prone sites and inadequate implementation of necessary mitigation measures (those being primarily avoidance of logging in high-hazard locales, see comments below).

For the reasons above, and because soil erosion hazard (including surface erosion, mass failure, and debris flows propagated by landslides) are central causal factors in the harms done by forestry operations to water quality and fishery resources, in my opinion it is arbitrary and utterly indefensible for this DEIS to fail to analyze, consider, and disclose the effects of commercial timber land reallocation and loss of roadless area protection on Tongass National Forest soil, water, and fishery resources.

3.2 Windthrow in Riparian Forests

Logging adjacent to riparian management areas alters the disturbance regime of riparian forests and streams in ways that can adversely affect fish habitat and populations (Moore and Richardson 2012). Logging adjacent to riparian forests often results in increased windthrow of tree within riparian areas (Tongass National Forest Annual Monitoring Report 2007, Tongass National Forest Annual Monitoring Report 2013, Moore and Richardson 2012, Bahuguna et al. 2010, 2012, Rollerson and McGourlick 2001, Everest et al. 1997). Windthrow increased over natural background rates can result in exposure of channels to solar insolation and increased summer temperatures (Macdonald et a. 2003), reduction of future large tree recruitment, and increased channel bed and bank erosion, including landsliding and debris flows (Bahuguna et al. 2010, 2012, Lewis 1998, Mcdonald et al. 2003).

3.3 Landslides Originating from Upslope Cutting Units

Mass failures, including both shallow rapid landslides and deeper, often slower-moving slump-earthflow failures, are common across the Tongass National Forest, and it is well-established that the incidence of landslides is magnified by logging (Johnson et al. 2000, Everest et al. 1997, Swanston and Marion 1991, Wu and Swanston 1980, Wu et al. 1979). Logging not only directly disturbs soils, but associated vegetation removal renders soils vulnerable to mass movement and mass failure by reducing canopy interception and dispersion of rain and snow, by greatly reducing evapotranspiration and causing

increased soil moisture conditions, and by destroying root strength that contributes to soil cohesion on forested slopes. The DEIS fails to consider and disclose how logging in currently protected roadless areas will impact mass-erosion-prone slopes, hence altering the frequency, magnitude, and distribution of landslides relative to salmonid habitats across the Tongass National Forest.

It is important to recognize that vegetation removal by logging[mdash]whether by clearcutting or thinning-[mdash]not only causes many landslides on recognized high-erosion risk terrain (which generally includes the steepest part of the landscape) but also increases the incidence of landslides on parts of the landscape that are usually considered to be of moderate or even relatively low risk of landslide erosion (most often because they are not as steeply sloping). This is a critical point, because the only effective means of preventing large increases in landslide occurrence is by identifying locations prone to failure and prohibiting vegetation removal on those sites, and in up-slope areas that contribute drainage to those sites. Some landside-prone sites occur on areas of the forest with moderate slopes and that are typically not mapped as highly landslide-prone. In many cases no clear surface evidence exists in the field that allows such sites to be identified prior to logging. Because complete avoidance of sensitive sites is impossible, logging will inevitably and cumulatively increase the incidence of landslides in salmon watersheds. The only question is how large the magnitude of increase in landslide erosion will be relative to unlogged watersheds. Previously unlogged roadless areas are likely to show the highest rates of landslide erosion increase if they are logged, because for the most part slopes in those areas have not previously experienced deforested or low-tree-density conditions in recent decades or centuries.

3.4 Headward Channel Expansion Caused by Altered Hydrology

Expansion of headwater channels has been an often-observed cause of post-logging erosion, but has been seldom quantified in Pacific coast watersheds (Frissell 2012). The one study I know of that focused comprehensively on this phenomenon, Reid et al. (2010), makes clear this is a seriously unexamined and too-often overlooked source of sediment delivery to Pacific Coast streams. Reid et al. (2010) reported that second-growth logging of a redwood-dominated forest in Caspar Creek, north coastal California, was followed by a substantial headwater expansion of stream channel density and coalescence of pre-existing discontinuous channels in headwater swales. Despite "robust" riparian buffer strips left in the second round Caspar Creek logging during this study, suspended sediment yields in instrumented tributaries increased significantly after logging. Channel expansion was caused by headward migration of existing channel knickpoints and subsequent channel incision and enlargement, as well as sapping and collapse of subsurface flow macropores and pipes. Acceleration of surface and subsurface channel-forming processes was apparently associated with increased antecedent moisture conditions, soil saturation, and runoff caused by the abrupt reduction of forest canopy interception and evapotranspiration following logging. In addition, back erosion of extant channels increased in linear extent, possibly reflecting increased channel-forming flows possibly coupled with impingement of hillslopes that could have been creeping at faster rates in the years immediately following logging (e.g., see Swanston et al. 1988). Reid et al. (2010) found that channel expansion led to stream density increasing by about 28 percent after logging.

Given that logging of any dense forest cover greatly reduced evapotranspiration of soil water, it is extremely likely the same processes drive erosion, channel expansion and sedimentation of streams after logging of forests of southeast Alaska. Expanded channel networks are associated with persistent increases in peak flow magnitude, which may result from more rapid translation of slower subsurface to rapid surface flow during storms. Erosion, both primary and secondarily associated with expanding or expanded channel networks, may be responsible for sustained elevation of suspended sediment yield and turbidity in Caspar Creek (reported in Reid et al. 2010, Keppeler 2012, Klein et al. 2012, and discussed as a regional concern in the review by Gomi et al. 2005). Expanded channel networks increase surface water connectivity to and sediment delivery from pre-existing erosion sources like landslide scarps and roads, and can itself initiate additional mass erosion through bank collapse and triggering of channel-adjacent landslides.

Reid et al. (2010) observed that boles and living tree roots in riparian forest buffers can partially hinder, but not entirely prevent, channel expansion. Fully controlling channel expansion effects on streamflow, erosion, and sedimentation would require limiting the overall rate of logging within small catchments over time, moderating silvicultural treatments to promote more rapid hydrologic recovery (e.g., via partial cutting rather than clearcutting), and careful consideration of past and future natural events, including wildfire, windthrow, and disease which, independent of or interactively with logging, also alter the hydrologic effects of vegetation.

Roadless areas preserve natural vegetation dynamics and disturbance regimes that maintain catchment hydrology and stream networks within a natural range of variability. Logging as an exotic disturbance in roadless areas is highly likely to alter hydrology such that accelerated stream erosion and stream network expansion result, over a larger area and larger number of watersheds than would occur if roadless areas are protected from logging.

Post-logging fluvial erosion, gullying and channel expansion is a scientifically recognized cumulative impact of logging that affects sediment supply and could potentially degrade salmonid habitat quality in connected waters downstream of headwaters if roadless areas of the Tongass National Forest are logged. This environmental impact has not been addressed or disclosed in the present DEIS.

3.5 Effects of Roads on Hydrology, Erosion and Sedimentation

Roads are well known to alter hydrology and erosion regimes in watersheds of the Tongass National Forest (Everest et al. 1997), just as they do elsewhere (Wemple et al. 2001, Luce and Black 2001, Jones et al. 2000, Trombulak and Frissell 2000). Landslides and gulley erosion initiating at or associated with the hydrological alterations caused by roads and landings not only can penetrate and deliver sediment through even very wide riparian forest buffers, they often initiate debris flows that can travel and directly impact aquatic and riparian habitat a great distance downstream from the point of origin. In either case, riparian forest buffers only confer limited protection against the harmful effects of road-caused mass failures, and in larger events, mass failures can virtually obliterate riparian forests, exposing streams to extremes of summer solar insolation and winter freezing, as well as redistributing large wood, scouring existing habitat structure away or burying it under large sediment deposits, and simplifying habitat structure in runout zones.

It is important to recognize that roads not only cause many landslides on recognized high-erosion risk terrain (which generally includes the steepest part of the landscape) but roads and landings often trigger landslides on parts of the landscape that are considered to be of moderate or even relatively low risk of landsliding under natural conditions. This results from the inexorable distortion of flow paths of both surface water and subsurface water caused by distortions of natural slopes and soils by road construction, use, and maintenance. The result is that road system expansion will inevitably expand both the number and area of occurrence of mass failures and associated debris flows and sediment deposits that adversely affect downstream fish habitat on a large scale. The DEIS utterly fails to consider, explain or disclose what the impact will be of road system expansion into currently roadless areas, many of which contain extensive areas of landslide-prone terrain.

Roads also cause chronic, on-going delivery of sediment at road crossings of small and large streams (Wemple et al. 2001, Jones et al. 2000), and sediment delivered even in the

smallest headwater streams can be rapidly transported downstream to harm salmonid spawning and rearing areas (Trombulak and Frissell 2000, Everest et al. 1997, Furniss and others 1991). Seldom can sediment discharges at road crossings be completely eliminated; to do so requires extreme care in crossing design and intensive, frequent within-season road maintenance. In fact, some road maintenance activities that are necessary to reduce the risk of catastrophic failure of forest roads, as well as actions to decommission or remove existing forest roads, themselves generate sediment runoff that can impact streams (Switalski et al. 2004, Luce and Black 2001b). Variability in the cause-effect relations between forest roads and stream sedimentation complicates both remedial practices and preventative practices in road construction and management, resulting in continuing high level of uncertainty about the effectiveness of so called "best management practices" (Al-Chokhachy et al. 2016). In contrast to this recognized uncertainty, the DEIS purports, while offering virtually no evidence, that the impacts of new roads on water quality and fisheries in and downstream of roadless areas will be somehow nonexistent.

The widespread, systemic failure or inadequacy of existing road maintenance resources to mitigate harm from sediment pollution (see Gucinksi et al. 2001), especially at road crossings and other near-stream road segments, is one of the major reasons the US Forest Service implemented the Roads Policy and Roadless Rule nationally (USDA Forest Service 2000). All national forests, including the Tongass, remain unable to adequately maintain the existing road system to reduce its ongoing and future harmful impact on aquatic resources and fisheries. It is clear on the face of it that proposed elimination of Roadless Rule protection on the Tongass, and potentially the Chugach National Forest, is intentionally designed to allow expansion of the existing road network. The DEIS offers no rationale for how harms to the overall road system will be reduced in the face of road system expansion that is supported by the proposed suspension of the Roadless Rule.

Roads may be correlated with watershed condition, but it is important to recognize that such a correlation does not necessarily mean that "fixing" roads will alleviate all of the correlated effects (Al-Chokhachy et al. 2016, Frissell 2012, McDonald and Coe 2007). Road density integrates at least two major and separate categories of phenomena that contribute to erosion and sediment delivery (Trombulak and Frissell 2000). The first is erosion and sediment entering surface waters that is generated by the road itself and operations on the road. This category includes secondary hydrophysical effects of roads, including landsides and gullies that initiate because roads disturbed natural drainage pattern, and maintenance-related runoff. This first category is targeted by road remediation and mitigation measures that reduce erosion or sediment delivery to streams from roadways (Al-Chokhachy et al. 2016, Switalski et al. 2004). The second category is indirect: the erosion and sedimentation that are generated by land use actions and practices that are either supported by or incidental to the road network, as discussed above. Those phenomena in the second category are direct ground disturbance from timber felling and yarding, accelerated windthrow around cutting unit margins, and channel extension, gullying, and bank erosion initiating as a consequence of extensive vegetation removal in the catchment. These erosion and sediment sources are not mitigated by road management measures.

The spatial arrangement of road networks on the landscape relative to slope stability, soil erosion proneness, and stream network locations act to codetermine the extent of impairment of downstream fish habitat by road-generated erosion and sedimentation (Al-Chokhachy et al. 2016, MacDonald and Coe 2007, Jones et al. 2000, Trombulak and Frissell 2000). Within the Pacific Coastal mountains and the Pacific Northwest more broadly, existing roadless areas are often associated with the highest-quality fish habitat, in part because of the limited spatial extent of road impacts and relatively few road crossing locations in their catchments. As a result, watersheds with a high proportion of roadless area tend to be relatively high in fish abundance, salmonid diversity and production, and roadless areas thus are of extreme value in the long-term conservation of salmon and trout populations throughout their ranges (Dellasala et al. 2011, Frissell and Carnefix 2007, Hitt and Frissell 2004, Loucks et al. 2003, Trombulak and Frissell 2000, Baxter et al. 2000). Despite that the proposed suspension of the Roadless Rule is explicitly intended to allow the expansion of the logging road network into presently roadless areas in Tongass National Forest watersheds, the DEIS utterly fails to explain how road system expansion will not be associated with more widespread impacts of salmon streams and more extensive deterioration of high-quality salmonid habitat.

Because road systems span multiple watersheds across large areas of national forest, because their adverse impacts cannot be completely avoided or remediated, and because harms to aquatic ecosystems accrue over many decades and are often triggered or exacerbated by natural events like winter storms and summer drought, as well as by climate change that affects storms and drought at regional scales, the cumulative impacts of expansion of road systems must be addressed at the scale of the national forest or a major portion of a national forest. That is, the cumulative effects of road system expansion into presently roadless areas on fish habitat and fisheries simply cannot be adequately analyzed, disclosed, or effectively remediated at the scale of individual timber or road construction projects (Selva et al. 2015, Hitt and Frissell 2004, Trombulak and Frissell 2000). For example, in many cases existing Forest Service roadless areas act in concert with National Parks, Wilderness, or other permanent land protections to secure fish habitat and other conservation values in a larger downstream stream and river network (e.g., Frissell and Carnefix 2007, Hitt and Frissell 2004, Loucks et al. 2003, Martin et al. 2000, Noss et al. 1999). This fact is a major underlying reason for the Forest Service's decisions to implement the Roadless Rule (Turner 2006, Martin et al. 2000, USDA Forest Service 2000) and Roads Policy as directives systematically augmenting national forest plans and planning procedures across the nation.

3.6 Water Temperature Alteration from Upslope Logging

Logging alters the evapotranspiration demand by directly removing vegetation. At least for the initial decade after logging, until vigorously growing second-growth trees attain significant cover, soil and groundwater tend to increase because vegetation is using less water. Moreover, the removal of canopy cover can expose soils to direct solar heating,

and areas of shallow groundwater may warm to a greater degree than they did under full forest cover.

Pollock et al. (2009) found that mean and summer mean and maximum temperature across 40 small streams on the Olympic Peninsula in Washington was substantially higher in streams draining watersheds with a higher proportion of cumulative logged area catchment-wide. The catchment area logged relationship was significantly stronger than the relationship to riparian forest removal by logging. Many streams with high canopy shade warmed substantially when more than half of their catchment area was logged. The results strongly suggest that factors other than direct canopy shade over the stream can drive water temperatures; these may include canopy opening from landslides and debris flows, or may indicate warming of shallow groundwater after extensive loss of soil canopy cover, or both. In either case, riparian buffers failed to protect streams from substantial temperature changes associated with logging.

Macdonald et al. (2003) found that headwater tributaries in BC logged with buffer strips of a wide range of widths all warmed 4-6 degrees C in summer compared to streams in unlogged watersheds. Part of this warming was associated with shade loss and post-logging windthrow, but a significant fraction of warming was unexplained by canopy shade, and is thought to have been associated with catchment-scale changes in shallow groundwater temperature or flow rates.

Research especially in long-term paired watershed studies in BC has shown that putative modest changes in daily mean, maximum, or minimum stream temperature associated with logging can result in biologically significant changes in cumulative thermal exposure. These in turn result in shifts in development rates of and timing of fish population life history events, such as time of emergence of young-of the-year from streambed gravels (Macdonald et al. 1998, Holtby 1988, Holtby and Newcombe 1982). Such developmental rate changes are known to alter salmon survival rates, and can result in population decline or collapse (Bryant 2009, Holtby 1988, Holtby and Newcombe 1982).

The DEIS ignores and fails to consider or disclose these known relationships between logging and alteration of temperature regime in streams that can cause substantial adverse cumulative effects on fish life history and population productivity, especially in Pacific salmon.

4. Climate Change and Resilience of Roadless Watersheds

Watersheds with a large proportion of primary forest and roadless area are likely to be among the most resilient salmonid habitats to the stresses imposed by ongoing and future climate change (Bryant 2009, USDA Forest Service 2000). One principal category of recurring and lasting impact from roads and logging is to introduce stressors that reduce resilience and increase the volatility of watershed responses to climatic stresses like flood and drought. Examples include the increased incidence of landsliding in the face of

winter storms or rain-on-snow events, and the potential depletion of stream base flows by a combination of increased water demand by second growth forest and increased drought stress. Another major and extensive source of impact from climate change is likely to be the marine inundation of current estuaries from rising sea level (although in a few cases new estuaries may be created or existing estuaries expand in the face of sea level increases).

The dominant vectors of expected change in climate (Bryant 2009) and the effects of road development and logging in roadless watersheds inexorably increase the vulnerability of freshwater habitats, and the fish populations dependent upon them to recurring climatic stresses like floods and drought. Their inherent resilience to climate variability and extreme weather events is one of the reasons that watersheds associated with roadless areas are considered "safe havens," refugia, or core areas for conservation of salmonid fishes and other sensitive species (Bryant 2011, Dellasala et al 2011, Frissell and Carnefix 2007, Baxter et al. 2000, USDA Forest Service 2000, Bryant and Everest 1998).

Despite the recognized imperative that climate changes places on land managers of coastal and northern regions (Bryant 2009), the DEIS critically fails to consider or analyze the likely effects of road development and logging on the response of currently roadless watersheds to future climate change.

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Curriculum Vitae 19 June 2018

CHRISTOPHER A. FRISSELL

Research Ecologist & Freshwater Conservation Biologist

39625 Highland Drive

Polson, Montana 59860

Phone: 406.883.3891/Mobile 406.471.3167

e-mail: leakinmywaders@yahoo.com

WWWeb:https://www.researchgate.net/profile/Christopher Frissell/

Birth: 1 December 1960, Chehalis, Washington

Education: Ph.D. in Fisheries Science, Oregon State University, 1992

M.S. in Fisheries Science, Oregon State University, 1986

B.A. with High Honors in Zoology, University of Montana, 1982

Professional Appointments:

Principal Scientist and founder, Frissell & Raven Hydrobiological and Landscape

Sciences, LLC, Polson, MT, 2012-present (affiliated with Kier & Associates, M. Scurlock & Associates, and Pacific Watershed Associates).

Affiliate Research Professor and summer field course instructor, Flathead Lake Biological Station, The University of Montana, 2016-present

Director of Science and Conservation and Senior Staff Scientist, The Pacific Rivers Council, 2000-2012

Research Associate Professor, The University of Montana, Flathead Lake Biological Station, 1998-2000

Research Assistant Professor, The University of Montana, Flathead Lake Biological Station, 1993-1998

Research Assistant Professor, Department of Fisheries and Wildlife, Oregon State University, 1994-1997

Postdoctoral Research Associate (Faculty), Department of Fisheries and Wildlife, Oregon State University, 1992-1994

Research Assistant (Faculty), Oak Creek Laboratory of Biology, Department of Fisheries and Wildlife, Oregon State University, 1985-1992

Fields of Interest:

* Land-aquatic ecosystem linkages and cumulative impacts of natural processes and human activities on stream habitat and stream biota.
* Ecology, biogeography, and conservation biology of fishes and freshwater biota in relation to landscape and hydrologic change.
* Aquatic ecosystem conservation and restoration strategies.
* Geomorphic, hydrophysical, and landscape ecology considerations in design of integrated conservation reserves.
* Restoration and recovery planning and design for freshwater ecosystems and species.

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Theses and Dissertations:

Frissell, C.A. 1992. Cumulative effects of land use on salmon habitat in southwest Oregon coastal streams. Doctoral dissertation, Oregon State University, Corvallis.

Frissell, C. A. 1986. A hierarchical stream habitat classification system: development and demonstration. M.S. thesis, Oregon State University, Corvallis.

Frissell. C. A. 1982. Colonization and development of community structure in coexisting Ephemerellid mayflies (Ephemeroptera, Ephemerellidae). Senior Thesis, Watkins Scholarship Program, The University of Montana, Missoula.

Professional Societies:

Society for Conservation Biology, 1991-present
American Fisheries Society, 1985-present
Ecological Society of America, intermittent

North American Benthological Society, intermittent
Graduate Students Mentored

Cavallo, B.J. M.S. in Organismal Biology and Ecology, The University of Montana, 1997. Thesis title: Floodplain habitat heterogeneity and the distribution, abundance, and behavior of fishes and amphibians in the Middle Fork Flathead River Basin, Montana.

Adams, S. B. Ph.D.in Organismal Biology and Ecology, The University of Montana, 1999. Dissertation title: Mechanisms Limiting a Vertebrate Invasion: Brook Trout in Mountain Streams of the Northwestern USA.

Hitt, N.P. M.S. in Organismal Biology and Ecology, The University of Montana, 2002, Distribution and potential invasion of introduced rainbow trout in the upper Flathead River drainage.

Carnefix, G. M.S. in Organismal Biology and Ecology, The University of Montana,

2002. Thesis title: Movements and ecology of bull trout in Rock Creek, MT.

Hastings, K. Ph.D.in Organismal Biology and Ecology, The University of Montana, 2005. Dissertation title: Long-term persistence of isolated fish populations in the Alexander Archipelago.

Reviewer for Journals and Agency Publications:

Canadian Journal of Fisheries and Aquatic Sciences, Conservation Biology, Ecological Applications, Environmental Management, Fisheries (AFS), Freshwater Biology, North American Journal of Fisheries Management, Oikos, Transactions of the American Fisheries Society, Fundamental and Applied Limnology, USDA Forest Service General Technical Reports

Member of Board of Editors for Journals:
Conservation Biology, 1996-2000

Appointments to Review Panels and Scientific Advisory Committees:

USEPA Bristol Bay Watershed Assessment Team, Subcontractor on road and pipeline impacts, through University of Alaska Anchorage and NatureServe, 2011-2012.

Independent Expert Review Panel for King County Water and Land Resources Division's Project Scoping and Implementation Practices. 2011-12. Subcontractor to MWH (Montgomery Watson Harza) for King County Dept.

of Natural Resources and Parks, Seattle, WA. http://www.kingcounty.gov/environment/dnrp/publications/wlrd-expert-review-report.aspx

Umpqua Watersheds Science Advisory Council, Sponsored by Umpqua Watersheds, Inc., 16-17 November 2010, Roseburg, OR.

Wychus Creek Restoration Monitoring Plan Review Panel, sponsored by Upper

Deschutes Watershed Council and Bonneville Environmental Foundation. 2 October 2009, Bend, OR.

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Science Review Team, King County Normative Flow Studies Project. 2002-2005,

Seattle, WA. http://dnr.metrokc.gov/wlr/BASINS/flows/science-review-team.htm Science Advisory Panel, Westside. Governor's Salmon Restoration Funding Board,

Washington State, February 2000.

Ecological Work Group, Multi-species Framework Process and Subbasin Assessment Process, Northwest Power Planning Council 1998-2000.

Peer review panelist for U.S. Environmental Protection Agency/National Science Foundation Water and Watersheds Grants Program for 1997. 7-9 May 1997. Scientific Group for the Governor's Bull Trout Restoration Team, State of Montana, 1994-2000

Oregon Department of Environmental Quality, 1992-95: Temperature Standards Review Subcommittee of the Technical Advisory Committee, Triennial Water Quality Standards Review

Scientific Assessment Panel for amphibian species, Eastside Oregon-Washington and Upper Columbia Basin EIS, US BLM and US Forest Service, 1994

Oregon Department of Forestry, 1990-93: Technical Advisory Group for the Forest Practices Monitoring Program; Wetlands Technical Group; Stream Protection Advisory Panel.

Peer-Reviewed Articles Published in Scientific Journals:

Hand, B.K., C. G. Flint, J. A. Stanford, C. A. Frissell, C. C. Mulhfeld, S. P. Devlin, B. P. Kennedy, R. L. Crabtree, W. A. McKee, Gordon Luikart. In Press. The Importance of a Social-Ecological Perspective for Riverscape Management in the Columbia River Basin. Frontiers in Ecology and the Environment.

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Selected Papers and Seminars Presented Since 1993, continued:

Frissell, C.A. 2008. Ecological impacts of roads in an era of climate change

(Abstract). Watershed Restoration and Forest Roads Symposium, Pacific Rivers Council, 4 April 4, Tacoma, WA.http://pacificrivers.org/conservation-priorities/land-management/roads/watershed-restoration-and-forest-roads-symposium

Frissell, C.A., and G, Carnefix. 2007. (Abstract) Spawning abundance of bull trout (Salvelinus confluentus) in relation to geomorphology, temperature and roads in tributaries of Rock Creek Basin (Missoula and Granite Counties), Montana, US. Annual Meeting of the Montana Chapter of the American Fisheries Society, 13-16 February, Missoula, MT. http://www.fisheries.org/units/AFSmontana/2007%20MCAFS%20Annual %20Meeting%20Program.pdf

Frissell, C.A. 2007. Setting regional priorities for watershed restoration. 25th Salmonid Restoration Conference, Salmonid Restoration Federation, 9-10, Santa Rosa, CA.

Frissell, C.A. 2006. Post-fire management effects on streams. NCSSF Disturbance, Management, and Biodiversity Symposium, National Commission for Science and Sustainable Forestry, 26-27 April, Denver, CO.

Frissell, C.A., and G. Carnefix. 2005. (Abstract) Indicators of landscape pattern for freshwater ecosystems. 20th Annual Symposium of the US-International Association for Landscape Ecology, 12-16 March, Syracuse, NY.

Frissell, C.A. 2004. Managing risk and uncertainty: National Forest management and freshwater conservation. Regional Centennial Forum: The Forest Service In the Pacific Southwest Region. US Forest Service, 5-6 November, Sacramento, CA.

Williams, J.E., D.A. DellaSala, J. F. Franklin, C,D.Williams, and C. Frissell. 2004. Scientific findings require a new vision for successful wildlfire preparation. News briefing at the Society for Conservation Biology Annual Meeting, Aug. 2, 2004., Columbia University, New York, NY. http://www.conbio.org/Media/Fire/

Frissell, C.A. 2001. (Abstract) What to do first with limited time, money, and staff. Watershed Restoration Workshop: Integrating Practical Approaches. Oregon Chapter of the American Fisheries Society, 13-15 November, Eugene, OR.

Ebersole, J.L., Colden V. Baxter, Hiram W. Li, and William J. Liss, and Frissell, C.A. 2001. (Extended abstract) Detecting temporal dynamics and ecological effects of smallmouth bass invasion in northeast Oregon streams. In: Proceedings, American Fisheries Society Special Symposium: Practical Approaches for Conserving Native Inland Fishes of the West. Montana Chapter and Western Division of the American Fisheries Society, 6-8 June, The University of Montana, Missoula, MT.

Selected Papers and Seminars Presented Since 1993, continued:

Carnefix, G., C. Frissell, and E. Reiland. 2001. (Extended abstract) Complexity and stability of bull trout (Salvelinus confluentus) movement patterns in the Rock Creek drainage, Missoula and Granite counties, Montana. In: Proceedings, American Fisheries Society Special Symposium: Practical Approaches for Conserving Native Inland Fishes of the West. Montana Chapter and Western Division of the American Fisheries Society, 6-8 June, The University of Montana, Missoula, MT.

Frissell, C.A. 1999. (Abstract) Groundwater processes and stream classification in the montane West. Invited paper, Symposium #7: Aquatic Classification Schemes for Ecosystem Management: Making the Transition from Methods Development to Application and Validation. Annual Meeting of the Ecological Society of America 7-12 August, Spokane, WA.

Frissell, C.A. 1999. Fisheries and watershed processes: strategies for protection and restoration. Invited paper, Annual Meeting of the Cal-Neva Chapter of the American Fisheries Society, 24-27 March, Redding, CA.

Frissell, C.A. 1999. Surface-subsurface flow linkages in rivers and their importance for river flow conservation. Invited paper, Symposium on Water Quality and Hydropower Re-licensing, Annual Meeting of the Cal-Neva Chapter of the American Fisheries Society, 24-27 March, Redding, CA.

Frissell, C.A. 1999. Dams, uncertainty, and the salmon ecosystem. Keynote Address, Annual Meeting of the Idaho Chapter of the American Fisheries Society and The Wildlife Society, 4-6 March, Boise, ID.

Frissell, C.A. 1998. Climate forcing of thermal habitat in Pacific Northwest rivers: Buffering effects of floodplain forests and hyporheic processes. (Abstract) Symposium on Climate Change Impacts to Freshwater Fish Habitats, Annual Meeting of the American Fisheries Society, 23-27 August, Hartford, CT.

Frissell, C.A. 1998. Ecosystem concepts in large-scale restoration. (Abstract). Montana Chapter of the American Fisheries Society, 3-5 February, Helena, MT.

Frissell, C.A. and B.J. Cavallo 1997. Aquatic habitats used by larval western toads (Bufo boreas) on an intermontane river floodplain and some landscape conservation implications (Abstract). Annual Meeting of the Ecological Society of America, 10-14 August, Albuquerque, NM.

Stanford, J.A. (presented by C.A. Frissell). 1997. Conservation and enhancement of alluvial rivers: the importance of hyporheic linkages. (Abstract). Symposium on Ecological Effects of Roads, Society for Conservation Biology, 7-10 June, Victoria, British Columbia, Canada.

Frissell, C.A., and G.C. Poole . 1997 Management of Riparian Zones in Western Montana: Present Issues and Emerging Challenges. (Abstract). Annual Meeting of the American Fisheries Society, 23-28 August, Monterey, CA.

Frissell, C.A., and J.T. Gangemi. 1997. Roads and the conservation of aquatic biodiversity and ecological integrity. (Abstract). Society for Conservation Biology, Victoria, British Columbia, Canada, 7-10 June.

Frissell, C.A. 1997. Spatial assessment of biological status and biodiversity loss.

Invited seminar, National Research Center for Statistics and the Environment, University of Washington, Seattle, WA, 14 January.

Frissell, C.A., and B.J. Cavallo 1996. Thermal and hydrologic diversity of aquatic habitats mediated by floodplain complexity and hyporheic flow exchange in an alluvial segment of the Middle Fork Flathead River, Montana, USA. (Abstract). Annual Meeting of the N. Am. Benthological Society, Kalispell, MT, 3-8 June.

Frissell, C.A. 1995. Ecological principles for watershed restoration. (Abstract). Invited paper for Workshop on Watershed Restoration: Principles and Practices, Annual Meeting of the American Fisheries Society, Tampa, FL, 27-31 August.

Frissell, C.A. 1995. Managing native fish and their ecosystems: let's get (spatially) explicit! (Abstract). Invited panel presentation at Montana Chapter of the American Fisheries Society, Chico Hot Springs, MT, 6-10 February.

Frissell, C.A. 1995. Birth in the fast lane: sediment transport, human disturbance, and reproductive strategies of salmonid fishes in Pacific Northwest streams. (Abstract). Invited paper for Symposium on Influence of

Geomorphic Processes on Terrestrial and Aquatic Ecosystem patterns and Processes, Annual meeting of the Ecological Society of America, Snowbird, UT, 31 July-3 August.

Frissell, C.A. 1995. Resource management impacts on bull trout populations. Invited panel presentation for Searching for Solutions: Solving the Bull Trout Puzzle Science and Policy Conference, Andrus Center for Public Policy, Boise State University, Boise, ID, 1-2 June.

Frissell, C.A. 1995. Watershed dynamics: natural pattern and process and some consequences for ecosystem management. Invited presentations at Managing Terrestrial Ecosystems Relative to Past and Present Disturbances: A Workshop Integrating Fire, Range, Fish and Wildlife Habitat and the Practice of Silviculture in the Northern Region. U.S. Forest Service, Missoula, MT, 14-16 March.

Ebersole, J.L., C.A. Frissell, and W.J. Liss (co-presenters). 1995. Invasion of non[shy]native fishes in northeast Oregon and western Montana streams: potential impacts of climate change. (Abstract). Oregon Chapter of the American Fisheries Society, Ashland, OR, 15-17 February.

Frissell, C.A. 1994. Watershed restoration strategies. (Invited presenter and session convenor) Watersheds '94 Expo, US Environmental Protection Agency and Center for Streamside Studies, University of Washington. Bellevue, WA, 27-30 September.

Frissell, C.A. 1994. A hierarchical approach to restoration of riverine ecosystems. Invited paper at Symposium on Aquatic Habitat Restoration in Northern Ecosystems, Alaska Chapter of the American Fisheries Society, Girdwood, AK, 20-22 September.

Selected Papers and Seminars Presented Since 1993, continued:

Frissell, C.A. 1994. An integrated, biophysical strategy for ecological restoration of large watersheds (Abstract). Annual Conference of The Universities Council on Water Resources, Big Sky, MT, 3-5 August.

Frissell, C.A., and J.A. Stanford. 1994. Designing a watershed reserve network to protect and restore aquatic biodiversity in the northern Rocky Mountains (Abstract). Annual meeting of the Montana Chapter of the American Fisheries Society, Billings, Montana, Billings, MT, 9 February.

Frissell, C.A. 1994. The Endangered Species Act: principles for the protection and recovery of fishes. Invited panel presentation, annual meeting of the Idaho Chapter of the American Fisheries Society, McCall, ID, 24-26 February.

Frissell, C.A., W.J. Liss, B. Doppelt, and D. Bayles. 1993. A new, ecologically based restoration strategy for Pacific salmon in the Pacific Northwest (Abstract). Annual meeting of the American Fisheries Society, Portland, OR, 29 August-2 September.

Technical Workshops Organized (selected):

Lead organizer and facilitator, New Science Implications for the Aquatic Conservation Strategy of the Northwest Forest Plan. Sponsored by the Coast Range Association, 2-3 December 2013, Portland, OR.

Co-organizer, with M. Scurlock and R. Kattelmann: SNEP Plus 15 Years: Ecological & Conservation

Science for Freshwater Resource Protection & Federal Land Management in the Sierra Nevada. Sponsored by Pacific Rivers Council, Sierra Forest Legacy, UC Berkeley School Environmental Design, UC Davis Center for Watershed Science, and CaliforniaTrout; 12-13 December 2011, Davis, CA.

Organizer and facilitator, Workshop on Science for River and Watershed Conservation. Sponsored by Campaign for Montana's Headwaters, 7 October 2010, Flathead Lake Biological Station, Polson, MT.

Co-convener, with M. Scurlock and Kristen Boyles: Technical Workshop on Science for Forest Planning. Sponsored by Pacific Rivers Council and Earthjustice, 29 June 2010, Seattle, WA.

Organizer and panelist, Umpqua Independent Science Council. Sponsored by Pacific Rivers Council, 2010-2011.

Co-organizer and panelist, with Deanne Spooner and David Bayes: Workshop on Economics of ESA Critical Habitat Policy, sponsored by Pacific Rivers Council and San Francisco State University, October 4-5, 2007, San Francisco, CA.

Organizer and coordinator of Science Panel on Roads and Watersheds, sponsored by Pacific Rivers Council, 10-11 November 2006, Forest Grove, OR.

Organizer and coordinator of the Recovery Science Panel for the Western Native Trout Campaign. Sponsored by Pacific Rivers Council, meeting 2-3 March 2002, Portland, OR.

Organizer and coordinator of Biodiversity Workshop, Consortium for the Study of North Temperate Montane Ecosystems. A cooperative research venture of The University of Montana and Montana State University, supported by the NSF EPSCoR program. 4 February, 1997 Missoula, MT.

Scientific Workshop on Large Basin Restoration: Grande Ronde River (co-organizer).

21-22 March 1993, La Grande, OR. Sponsored by The Pacific Rivers Council. Scientific Workshop on Large Basin Restoration: South Umpqua River. 16-18

September 1992, Roseburg, Oregon. Sponsored by The Pacific Rivers Council. Scientific Workshop on Large Basin Restoration: Lower Rogue River. 21-23 October

1992, Gold Beach, OR. Sponsored by The Pacific Rivers Council.

Other Panels and Workshops Attended by Invitation since 1994 (selected):

Invited Review Panelist, Workshop on Linking Habitat Characteristics to Salmon Data. 29-30 September 1999, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA.

Invited participant, Yellowstone to Yukon Aquatic Conservation Science Workshop. 20-22 August 1999, Flathead Lake Biological Station, The University of Montana, Polson, MT.

Invited Panelist, Workshop on Options for Restoring Salmon Habitat in the Mainstem Snake and Columbia

Rivers. Pacific Northwest National Laboratory-Battelle, 19 August 1999, Kennewick, WA

Panelist at State of Oregon/National Marine Fisheries Service Memorandum of Agreement Committee Workshop: Cumulative Effects of State and Private Forest Practices on Salmon Habitat. 21April 1998, Salem, OR.

Invited participant in a scientific workshop, Multiple Stressors in Ecological Risk

Management. Sponsored by the Society for Environmental Chemistry and Toxicology and the USEPA, 13-18 September 1997, Pellston, MI.

Society for Conservation Biology Workshop: Communicating with the Media (panel member). 9 June 1997, Victoria, British Columbia, Canada.

Invited speaker for a workshop, Continuing Education in Ecosystem Management. Sponsored by the University of Idaho. Catchment scale processes and linkages between landscape and stream conditions. 31 January 1997, Moscow, ID.

The Nature Conservancy, Aquatic Classification Workshop (invited presenter). 9-11 April 1996, Cedar Creek Farm, MO.

Kenai River Community Forum (keynote speaker and panelist). The Nature Conservancy of Alaska, USEPA and USFWS, 19-21 April, Soldotna, AK.

Conservation Biology and Management of Interior Salmonids (invited presenter and session co-moderator). USDA Forest Service Intermountain Research Station and Utah State University, 4-5 October 1995, Logan, UT.

Eastside Ecosystem Planning Workshop. Sierra Club Legal Defense Fund, 16 December 1994, Portland, OR.

Co-instructor at workshop series on Watershed Restoration and the "Rapid Biotic Response Strategy" for Riverine Ecosystem Restoration, sponsored by The Pacific Rivers Council, 1993-95, California, Oregon, and Washington.

Fire/Salvage and Aquatic Ecosystems Policy Workshop. The Pacific Rivers Council, 15 December 1994, Portland, OR.

Panel on Forest Health Issues, Native Forest Network annual conference, 13 November 1994, Missoula, MT.

Workshop on Watershed/Fisheries Cumulative Effects Analysis, sponsored by Headwaters, The Pacific Rivers Council, USDA Forest Service, and Bureau of Land Management. 29 September-2 October, 1994, Ruch, OR.

Boise Funders' Scoping Meeting, sponsored by Bullit, Harder, and Lazar Foundations, 30-31 August 1994, Boise, Idaho.

Scientists Briefing for U.S. Senate staff on post-fire logging and forest management and freshwater resources.

Washington, D.C., 18-19 September 2006.

Other Presentations and Outreach (Selected):

Invited testimony on federal land management and the future of salmon and aquatic biodiversity in the Pacific Northwest, to the U.S. House of Representatives, Subcommittee on National Parks and Public Lands, Washington, D.C., 11 March 1993.

Briefing for Congressional representatives and staff on federal lands management and conservation and recovery of salmonid fishes and riverine ecosystems, Washington, D.C., 22 January 1993.

Invited testimony to the 1991 Oregon State Legislature, on panel representing the Oregon Chapter of the American Fisheries Society, on the status of native fishes, impacts of forest practices on fish habitat, and the need or changes in environmental regulation.

Invited testimony to the Oregon Board of Forestry Forest Issues Forum, December 1990, on cumulative impacts of forest practices on native aquatic species and the need for changes in forest management.

Worked with Oregon Public Broadcasting to describe our research project and its

significance in a 15-minute segment of the television program, Oregon Field Guide, first aired in June 1990.

Presented seminars, informal presentations, lectures, and discussions at research review meetings, as guest speaker in classrooms and public interest

[Position]