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Supplemental Information

Wildfire frequency

To determine whether the frequency of lightning-caused or human-caused fires have changed during the past 70 years (1946-2015) in the Kenai Peninsula Borough, we analyzed the Wildfire Historical Database (AFS 2016). Only one lightning-caused fire was recorded in the first 50 years (1946-1995) of this dataset, but 46 lightning-caused fires were recorded during the last 20 years 1996-2015. This difference might be partially explained by incomplete data collection during the early years of the database, so we analyzed two subsets of the dataset with complete data coverage. The database includes a complete record of "large" fires (> 405 ha) since 1946 as well as "large and medium-sized" fires (> 40.5 ha) since 1988 (Calef et al. 2015); therefore we conducted separate tests for long-term trends in large fires from 1946-2015 and for short-term trends in large and medium-sized fires from 1988-2015. For each time period, we fit separate Poisson regression models to the frequency (fires / year) of both lightning-caused and human-caused fires. The frequency of lightning-caused fires increased significantly over time, both for large fires over the long term ($p < 0.05$) or large and medium-sized fires over the short term ($p < 0.05$; Figure 6C). In contrast, the frequency of large human-caused fires did not change over the long term ($p > 0.8$). The frequency of large and medium-sized human-caused fires increased over the short term, but this trend was not significant ($p = 0.07$; Figure 6C).

Human development

We quantified the concentration of development in the Kenai River watershed using high-resolution aerial photography from the 1950s (US Geological Survey), 1980s (Alaska High Altitude Photography), and 2013 (Kenai Peninsula Borough), as well as the National Land Cover Database (NLCD 2013). We digitized human footprint polygons, categorized them as either low (house lots > 1 acre)-, medium (treed neighborhoods with moderate-sized lots)-, or high-intensity (commercially developed urban areas, multiple unit residences with few trees) development or cleared land using a modified Anderson level II classification (Anderson et al. 1976), and attributed the linear road features present in each time step.

Economic gross value of Alaskan salmon fisheries

The commercial and recreational fisheries for Alaskan salmon support well over $1 billion in economic output annually, based on our analysis of available data. The ex-vessel value of commercially harvested Alaska salmon has ranged between $400-700 million annually over the last decade (ADFG 2016). Processing roughly doubles the value of these fish; the first wholesale value of Alaska salmon was $1.05 billion in 2007 (Northern Economics 2009). Further, the seafood industry provides additional indirect and induced benefits such as supporting jobs at shipyards and suppliers. These multiplier effects have not been estimated specifically for salmon, but they are substantial. In Southcentral Alaska, for example, the seafood industry generated $1.2 billion in total economic output annually during 2012-13. Most of this value was due to salmon, which accounted for 85% of first wholesale value of seafood produced in Southcentral Alaska during these years (McDowell Group 2015).

Alaska's recreational salmon fisheries also provide large economic benefits. Sport fishing provided $545 million of income and $1.6 billion of total economic contribution to the Alaska economy (including multiplier effects) in 2007 (Southwick Associates et al. 2008). Approximately three quarters of all sport fishing and related spending occurred in Southcentral Alaska, mostly in the Cook Inlet region. Salmon account for most of Alaska's recreational fisheries harvest and are the target of over 60% of sport fishing trips (Haley et al. 1999; Jennings et al. 2015). Assuming conservatively that salmon account for half of the total economic value of sport fishing, then that would translate to $273 million in income and $800 million in total economic contribution in 2007. Comparable economic analyses are not available for years after the Great Recession. For reference, total harvest and participation in sport fisheries increased among Alaska residents but decreased among non-residents from 2007-2011 (the most recent data available) (Jennings et al. 2015). Current economic studies are not sufficient to compare the relative value of salmon harvested in the commercial vs. recreational fisheries, due to differences in methodology, but both sectors are clearly major contributors to Alaska's economy. Further, cost and expenditure information is insufficient to determine the net economic value of Alaska's commercial and recreational fisheries.

Northern Kenai Peninsula Fisheries Harvest

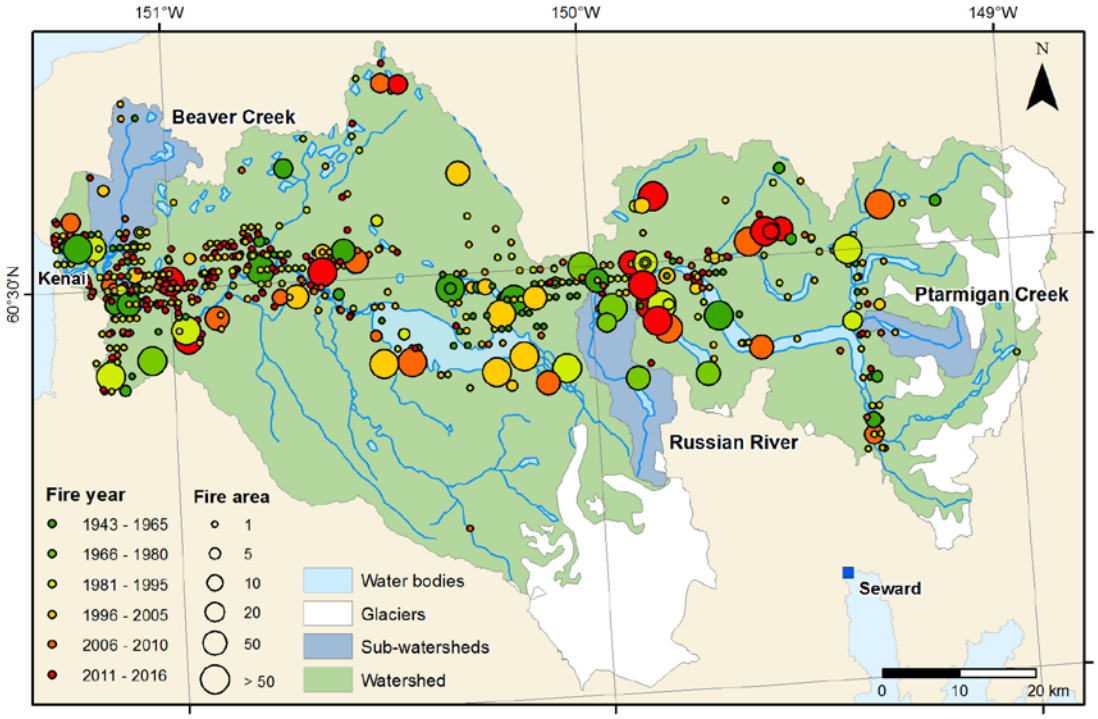
Harvest and effort data are reported differently for the commercial, recreational, and personal-use fisheries in Upper Cook Inlet, such that it is not possible to calculate the harvest and effort of salmon produced specifically by the Kenai River (including its tributaries) by each fishing sector. To make comparisons within a common geographic area, we aggregated harvest and effort data from the northern Kenai Peninsula, ranging from the Kasilof River in the south to Ingram Creek in the north. The Kenai River is the predominant salmon-producing river in this

area. We aggregated harvest and effort data from the following fisheries: Commercial: Central District drift gill net and east-side set gill net (Shields and Dupuis 2016); Recreational: Northern Kenai Peninsula Management Area (Begich et al. 2013); Personal-use: Kenai River dip net, Kasilof River dip net, and Kasilof River set net (Fall et al. 2015; Shields and Dupuis 2016). ADF&G also reports harvest and effort for an "unknown" personal-use fishery in Upper Cook Inlet. This harvest and effort was reported on permits on which the fishery was left blank. We allocated this harvest and effort to each known fishery based on the proportions of accurately reported harvest and effort in each year.

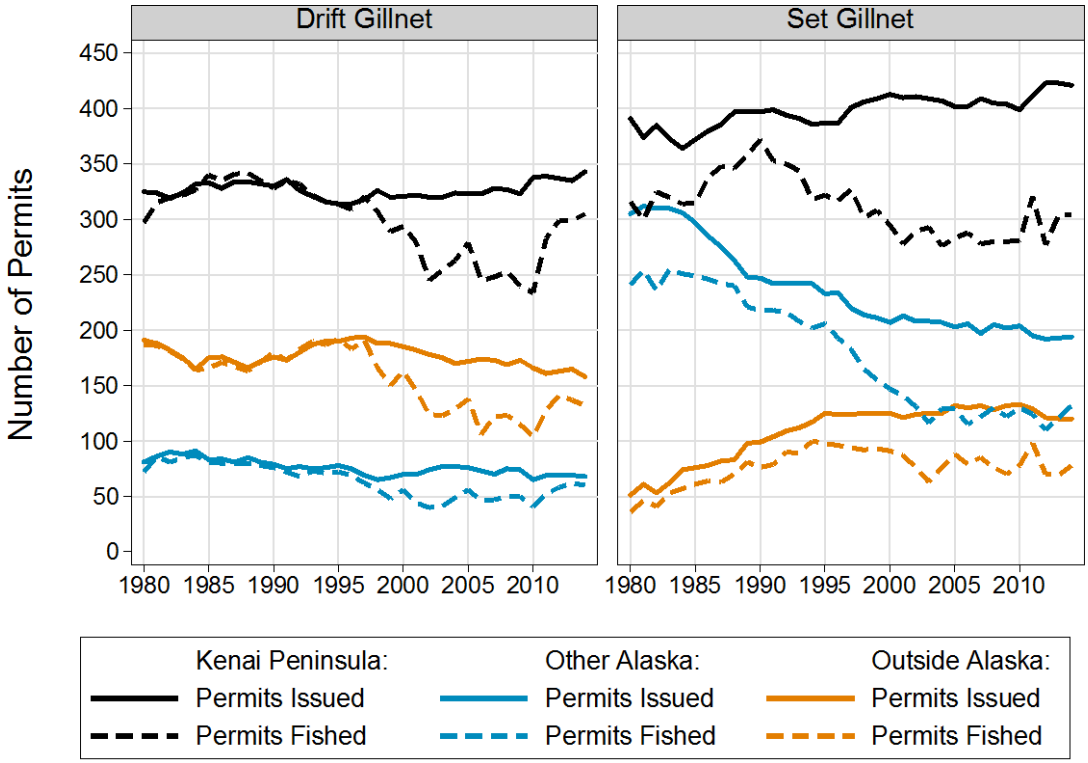
Commercial Fishing Permit Portfolios

The number of permits owned by residents of the Kenai Peninsula has stayed relatively constant over time in both the drift- and set-net fisheries; in contrast, permits have generally migrated from other Alaskan communities to non-Alaskan communities, particularly in the set-net fishery (Supplemental figure S2). In the early years of the limited entry programs, the drift-net fishery was almost at full capacity, with nearly all permits being fished in any given year. In contrast, the set-net fishery has never been fully prosecuted, and has always had a sizeable amount of "latency" in permit use. Permit usage in both fisheries underwent a sharp decrease in the mid 1990s, likely due to a combination of declining returns (Figure 8) and ex-vessel prices (not shown) for nearly all salmon species, starting in the early 1990s.

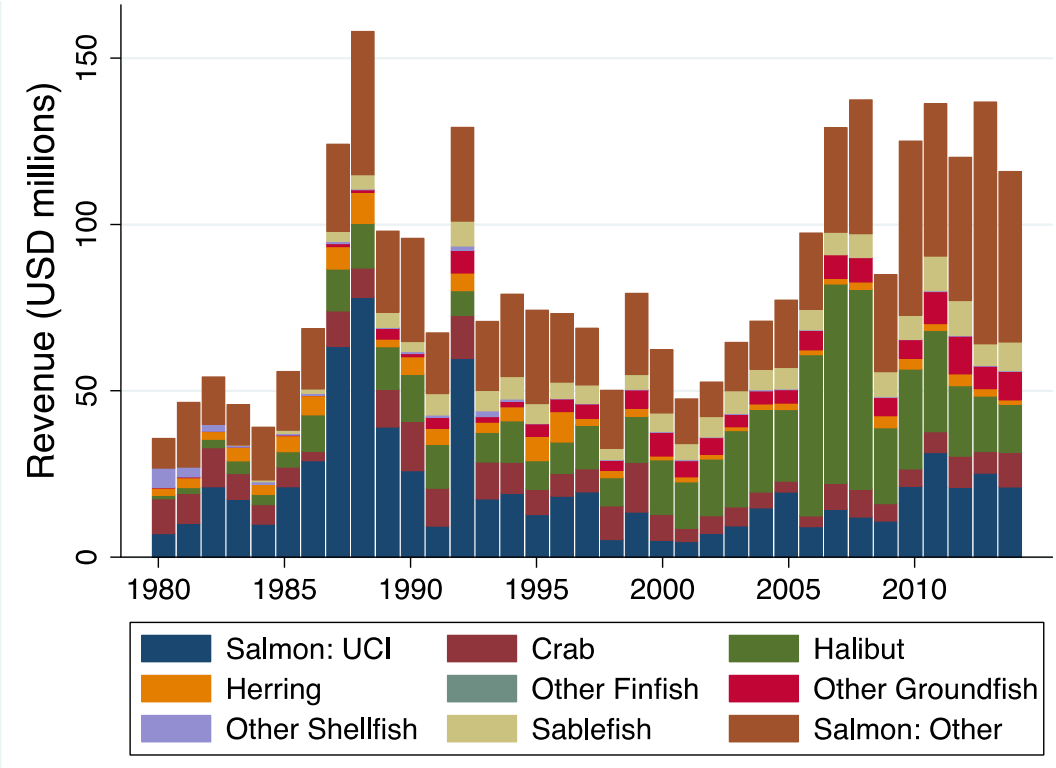
Supplemental Figures



Supplemental figure S1. Wildfire locations in the Kenai River watershed during 1943-2016 (data from AFS 2016). Symbol size represents fire area in acres (0.4047 ha).



Supplemental figure S2: Number of permits issued (solid) and fished (dashed) for the two Upper Cook Inlet commercial salmon fisheries (drift gillnet and set gillnet), by residency of permit holder (source: CFEC).



Supplemental figure S3: Commercial fishing revenues earned by residents of the Kenai Peninsula Borough, by type of fishery (source: CFEC). "Salmon: UCI" refers to the Upper Cook Inlet drift and set gillnet salmon fisheries; "Salmon: Other" refers to all other salmon fisheries in the State of Alaska.

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