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Research, part of a Special Feature on Understanding Adaptive Capacity in Forest Governance

Factors Influencing Adaptive Capacity in the Reorganization of Forest Management in Alaska

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ABSTRACT. Several studies of U.S. National Forests suggest that declines of their associated forest products industries were driven by synergistic changes in federal governance and market conditions during the late 20th century. In Alaska, dramatic shifts in the economic and political settings of the Tongass National Forest (Tongass) drove changes in governance leading to collapse of an industrial forest management system in the early 1990s. However, 15 years since collapse, the reorganization of Tongass governance to reflect 'new' economic and political realities has not progressed. To understand both the factors that hinder institutional change (inertia) and the factors that enable progress toward reorganization (adaptation), I analyzed how Tongass forest management, specifically timber sale planning, has responded to changes in market conditions, local industry structure, and larger-scale political governance. Inertia was evidenced by continued emphasis on even-aged management and large-scale harvesting, i.e., the retention of an industrial forestry philosophy that, in the current political situation, yields mostly litigation and appeals, and relatively few forest products. Adaptation was evidenced by flexibility in harvest methods, a willingness to meet local demand instead of political targets, and a growing degree of cooperation with environmental advocacy groups. New partnerships, markets, and political leaders at state and national levels can frame a new blueprint for reorganization of Tongass management toward a more sustainable future.

Key Words: *forest management; inertia; organizational change; rigidity traps; timber sale planning; Tongass National Forest*

INTRODUCTION

Several studies of U.S. National Forests suggest that declines of their associated forest products industries were driven by synergistic changes in political governance and market conditions during the late 20th century (Repetto 1988, Trosper 2003, Wilkinson 1997). This combination of factors has strongly shaped forest resources systems in many industrialized nations, most notably in Canada (Baskerville 1995) and northern Europe (Sweden, Norway, and Finland), but perhaps nowhere more significantly than in the United States (Repetto 1988, Trosper 2003). In Alaska, dramatic shifts in the economic and political settings of the Tongass National Forest (Tongass) resulted in a 50-year boom-bust cycle of industrial timber production that left behind a complex ecological, economic, and political legacy. Several historical accounts and scholarly articles have addressed the industrial forest management system of the Tongass from different viewpoints (Soderberg and DuRette 1988, Rakestraw 1989, Durbin 1999, Steen 2004, Nie 2006).

A recent case study of the Tongass by Beier et al. (2009) synthesized these accounts from a systems perspective, using the adaptive cycle (Holling and Gunderson 2002) as a diagnostic tool to understand the drivers, dynamics, and outcomes of Tongass governance during the 20th century (Fig. 1). Among the outcomes described in the case study, the emergence and persistence of 'rigidity traps' since collapse is perhaps the most relevant to current and future governance. The rigidity trap can be defined as a set of conditions that creates a stability domain in which adaptive capacity of the system is constrained, thus preventing 'escape' from a highly resilient but often undesirable state (Carpenter and Brock 2008). Because these traps tend to emerge

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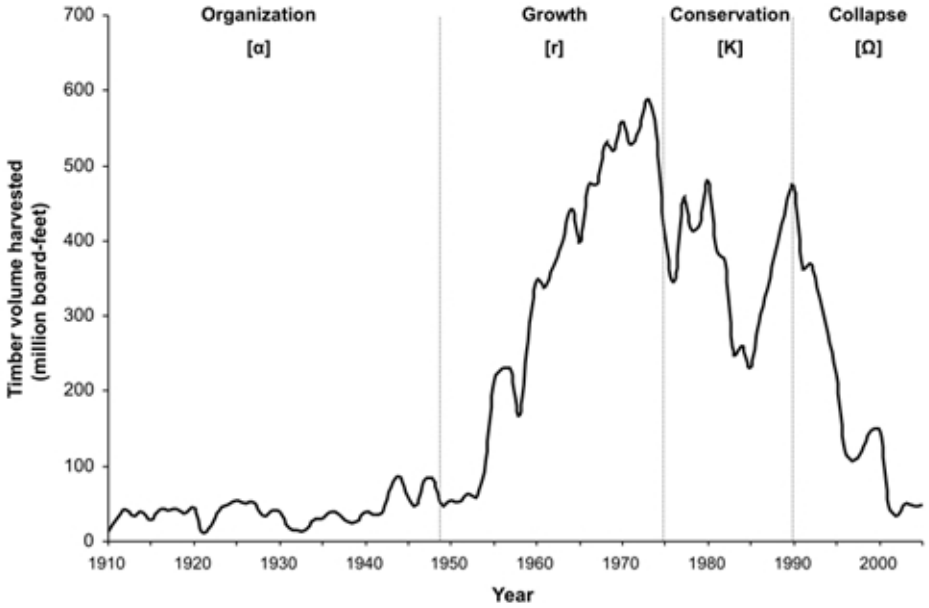
Fig. 1. Tongass National Forest harvest outputs from 1910-2005, divided into four stages of the adaptive cycle, as described in Beier et al. (2009).



from 'command and control' management approaches (Holling and Meffe 1996) that seek to rigidly stabilize the system in the face of multiple drivers of economic and political change (Hanna et al. 1997, Trosper 2003, Beier et al. 2009), they reflect both the failure and the legacy of maladaptive resource systems. In the case of the Tongass, the challenges of the current situation, including its rigidity traps, might have been avoided if the previous system had been adaptive, instead of inflexible, in response to change. Today, these challenges and their underlying causes must be addressed to foster reorganization toward more sustainable management practices and governance policies of the Tongass in the 21st century. To achieve this end, adaptive capacity is paramount for both the process and the outcomes of system reorganization (Holling and Gunderson 2002, Beier et al. 2009), which will largely dictate the degree of future institutional 'fit', or lack thereof, with the resource system and its social-ecological processes and dynamics (Berkes and Folke 1998, Young 2002).

To investigate institutional adaptive capacity in the reorganization of Tongass forest management, this paper examines both the factors that have hindered change, i.e., inertia, and the factors that have enabled progress toward reorganization under new conditions, i.e., adaptation. Using the Tongass timber sale program as a proxy for evaluating adaptive capacity in forest management, I analyzed how the system has responded to changes in its state factors since collapse, including market conditions, local industry structure, litigation/appeals, and larger-scale political and budgetary influences. I then synthesized and interpreted these findings to better understand the overall adaptive capacity of the Tongass forest management system.

To better characterize the Tongass situation in a way that may contribute to its reorganization, this study employs a framework for evaluating adaptive capacity based on the degree of 'fit' between changing regional conditions and institutional responses, or lack thereof. This framework does not contrast adaptation and adaptive capacity as some scholars have done (Hannan and Freeman 1989, Staber and Sydow 2002), but considers evidence of adaptation to change as a positive proxy of adaptive capacity, i.e., as an indicator of better institutional fit. Using this framework to gather, analyze, and

interpret data at multiple institutional scales, this case study represents an attempt to operationalize the concept of institutional fit with social-ecological system conditions and dynamics (Hanna et al. 1997, Berkes and Folke 1998, Brown 2003). Thus, the approach herein may be broadly useful for evaluating the factors that either constrain or contribute to adaptive capacity in the management of complex resource systems.

This case study evaluates data from Tongass forest management planning to address both the "misfit of institutions and ecosystems" and the "misfit of institutions and stakeholders" described by Brown (2003:480). Hence, the Tongass case may provide insights that are more broadly applicable and relevant to forest resource systems in industrialized nations, such as Canada and northern Europe (Scandinavia). At the same time, lessons from the Tongass case, as a system that more recently experienced adaptive cycle dynamics, i.e., boom-bust cycles, than those in Canada and Europe, may also be relevant for emerging and rapidly growing forest resource systems in rapidly developing nations, such as Chile, that are still in the process of establishing governance institutions and designing sustainable management standards and policies.

OBJECTIVES

The first objective of this study was to characterize the extant regional conditions, or state space, in which the Tongass presently exists, relative to historical conditions. In brief, the concepts of system state and state space as employed in this case study should be defined. 'System state' relates to its condition, function, processes, and internal controls, whereas 'state space' relates to the external factors and controls that form the environment in which a system exists (Holling and Gunderson 2002). The purpose of distinguishing between system state and state space in this study and others is to provide some insight on how the system, or its components, responds to changes in its state space, i.e., the conditions in which the components exist and function. For this case study, using the systems framework for the Tongass from Beier et al. (2009), this state space is defined by: the current conditions shaping the institutional subsystem, e.g., timber sale planning; the policy subsystem, e.g., federal budgets, environmental litigation; and the economic subsystem, e.g., forest products industry, markets. Insights on system state are based on how forest management activities have responded to changes in state space, as described below.

Based on the prior study, I hypothesized that the Tongass system exists in novel state space that is markedly different from conditions prior to system collapse. A number of new factors have emerged, most notably the existence of several rigidity traps that constrain progress by limiting adaptive capacity in institutional, economic, and political subsystems, and act to prevent system reorganization (Beier et al. 2009). In that prior study, these traps were described very briefly as emergent properties of the Tongass system following collapse. In this article, I delve more deeply into characterizing the postcollapse Tongass situation by evaluating changes in regional conditions during a period encompassing system collapse and its aftermath (1990-2005), and gathering evidence of institutional responses to these changes during the same time period. Using a framework and analysis designed to provide insight on institutional responses to change, the case study sought to reveal the interacting factors underlying the rigidity traps that currently exist on the Tongass, which include a nascent timber supply problem for the regional industry and a highly litigious forest decision making environment.

If the above hypothesis is correct, and if major shifts have occurred in the factors shaping the Tongass state space, the critical question is whether the objectives and practices of Tongass forest management, and related aspects of its broader governance, have shifted accordingly. In other words, how has the system responded to fundamental changes in its environment? In this study, the operations, outputs, and outcomes of the Tongass timber sale program, which includes the agency functions of sale planning, offering, bid selection, and harvest permitting, are used as a window into understanding adaptive capacity in forest management. Use of the timber program as a proxy for systemic adaptive capacity is justified because timber harvest is the most influential and contentious issue on the Tongass (Malmsheimer et al. 2004, Nie 2006), and because the current situation emerged as the legacy of the industrial forestry system that collapsed in the 1990s (Beier et al. 2009).

Therefore, to what degree has Tongass forest management, specifically its timber sale operations, demonstrated the capacity to adapt to better 'fit' the

current postcollapse conditions in southeastern Alaska? How have Tongass managers both contributed to, and made efforts to escape, the current rigidity traps?

To answer these questions, I conducted a comparative analysis that defined current conditions, i.e., state space, as explanatory variables and measures of Tongass decision making, i.e., system behavior, as response variables. For example, changes in regional pulp processing capacity, i.e., state space, were related to changes in the amount of pulp-grade timber offered for sale, i.e., system behavior. Based on this more detailed analysis of the current Tongass situation than previous studies (Nie 2006, Beier et al. 2009), my second objective was to understand the factors that either have constrained or contributed to adaptive capacity. Here the managers are the primary focus in evaluating adaptive capacity, but as integral components of a larger resource system, are not independent actors and are shaped by many internal, i.e., institutional, and external, i.e., ecological, political, economic, factors. In this case study, adaptive capacity is defined in terms of whether institutional forest management activities, as embodied in the Tongass timber program, have changed in directions consistent with recent changes in regional conditions such as stumpage prices, market demand, and mill processing capacity. This definition is based upon, and justified by, the purpose of forest management activities for timber production on the Tongass, which are "to meet market demand" and "support local economies" (USDA 2004:1).

To this end, where I found evidence of a poor fit between institutional responses and current conditions (Folke et al. 1998), I considered this as an example of inertia (Hannan and Freeman 1984, Gresov et al. 1993), also known as strategic persistence (Jansen 2004). In the specific context of the Tongass case, inertia provides stability in the current postcollapse phase and inhibits reorganization; or if it fosters reorganization, inertia will drive the system toward its earlier configuration of large-scale industrial forestry. In brief, the distinction between inertia and rigidity traps should be clarified; in this case study, inertia both emerges from, and helps to keep the system locked into, its current rigidity trap (Beier et al. 2009). Inertia can be conceptualized as a function/behavior of the system state (Hannan and Freeman 1984, Jansen 2004), whereas a rigidity trap is a characterization of the state space (Carpenter and Brock 2008).

By contrast, where I found evidence of a good fit between institutional responses and current conditions, or evidence of movement of timber planning in a direction in response to change, or "change-based momentum" (Jansen 2004:277), I considered this as an example of adaptation. In this sense, adaptation indicates the transformability of the system, as evidenced directly by observed changes in the Tongass timber sale program, driving reorganization toward a new system configuration.

Thus, in the framework used here, evidence of inertia suggests limits to adaptive capacity, while evidence of adaptation suggests this capacity exists and has shaped Tongass reorganization to better fit the new state space (Hannan and Freeman 1984, Berkes and Folke 1998, Young 2002) of southeastern Alaska (Beier et al. 2009). Because of the contentious debate over the Tongass between environmental advocacy groups, forest industry groups, and Tongass managers, among others, it is important to point out that this definition of adaptive capacity does not reflect the normative perspective of any particular group of actors or policy image, but reflects their current, and likely future, roles in the system, from the perspective of the institutional actors for whom adaptive capacity is being evaluated. For example, the capacity of environmental advocacy groups to influence decision making through litigation/appeals (Malmsheimer et al. 2004, Nie 2006) is, for better or worse, considered part of the Tongass state space that managers must now, and into the future, recognize and account for in their decision making processes. As with other political, ecological, and economic factors influencing the current Tongass state space, they are conceptualized as factors requiring adaptive responses if reorganization is to take place.

METHODS

Data analyzed in this study were acquired from the U.S. Department of Agriculture, Forest Service (USFS), Region 10 in Juneau, Alaska through a Freedom of Information Act (FOIA) request. These data detailed Tongass timber program operations including timber offers, sales, and harvests by sale type, species, stumpage price, and product type, e.g., sawtimber, pulp, from 1990-2005. All offer bids, including winning bid values, and sale status as of 2005 were included in these data.

Litigation was included in this case study because of its role in U.S. National Forest policy and decision

making following the passage of the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), and related judicial decisions that have provided a powerful venue for environmental advocates to appeal forest management decisions (Repetto 1988, Trosper 2003, Malmsheimer et al. 2004, Nie 2006). The role of legislation in management of public forestlands, while perhaps most important in the United States, is also significant in other countries, particularly Canada (Baskerville 1995). For Tongass-related litigation data, the USFS Region 10 does not make available any summary information of their expenditures, in effort or dollars, for NEPA-related research, appeals, and timber sale litigation on an annual or per-offer basis. Thus, the best estimate of appeals and litigation intensity was derived from summaries of NEPA-related actions in the Tongass from 1970-2004 (Malmsheimer et al. 2004); these data likely provide a slight overestimate because the vast majority of, but not all, appeals and litigation on the Tongass relates to timber management activities (USDA 2004).

Mill capacity and mill utilization data were derived from two USFS technical reports (Morse 2000, Brackley et al. 2006). These mill-related data included the three sawmills affiliated with the Ketchikan Pulp Co. and Alaska Pulp Co. pulp mills (see Beier et al. 2009), but not the actual pulp mill facilities in Sitka and Ketchikan. Data on timber offers, sales, and harvests excluded releases of timber under long-term contracts (only pertinent until 1997) for three reasons: (1) the long-term contract outputs are not the focus of this study; (2) the data has limited availability because of confidentiality; and (3) the long-term contracts were managed separately from the rest of the Tongass timber program (Morse 2000, Steen 2004, Nie 2006). Thus, the analysis of program outputs focused on the noncontract offers that became the entirety of Tongass timber sales after the cancellation of the final long-term lease (held by Ketchikan Pulp Company) in 1997.

I estimated quantitative and qualitative changes in the types of sales offered, species and advertised rate of stumpage, estimated logging-related costs, and fate of the offer, i.e., sold, unsold, under litigation. Most of the insights on pre- and post-collapse conditions, and examples of inertia and adaptation are drawn from analysis of these data. For broader-scale observations of Tongass governance, I expound upon insights from an earlier article that characterized the aftermath of the Tongass resource system collapse, as part of an adaptive cycle of change (Beier et al. 2009). As in that case study, the current article has drawn on several scholarly articles, from which I have cited results and discussion points but not utilized raw data, numerous Forest Service technical reports and documents, including press releases, and informal discussions with several Tongass officials. Selection of participants for unstructured interviews was not systematic, but reflected an attempt to identify individuals with expert knowledge on topics pertinent to the Tongass system and southeastern Alaska, as part of a doctoral dissertation (Beier 2007). Because formal permission to publish statements from these officials was not obtained, I have cited their comments anonymously to protect their identity.

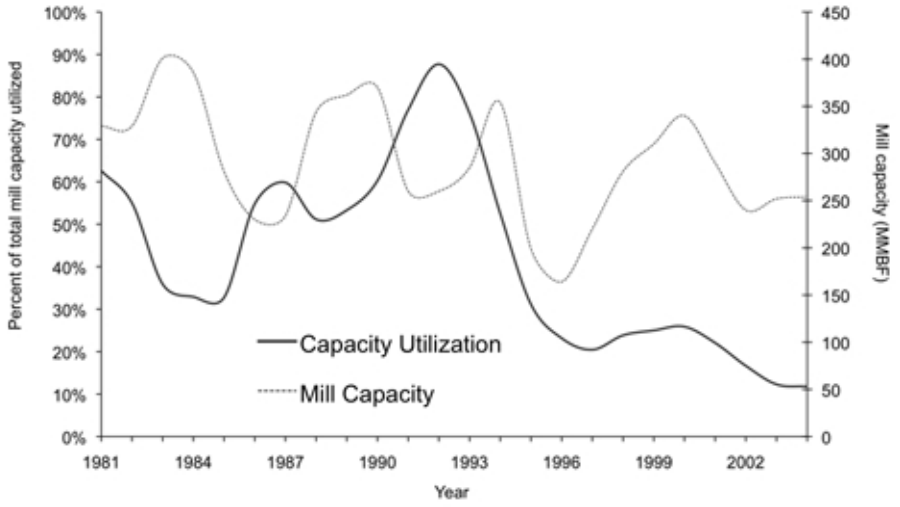
After describing the patterns of change in regional conditions and Tongass timber program outputs, I compared these dynamics using related pairs of variables. Because most of the information used in this study was not suitable for statistical analysis, a great deal of the resulting analysis is qualitative. Wherever possible, I have incorporated statistical measures, i.e., pairwise correlations, to support the qualitative insights. As a result, the analysis herein is not systematic in a traditional sense, but represents an attempt to synthesize the best available information.

RESULTS

Changes in system conditions pre- and post-collapse

Trends in mill capacity in southeastern Alaska fluctuated throughout 1981-2004 (Fig. 2), consistent with the frequent mill closures and reopenings during this period (Morse 2000, Crone 2004, Brackley et al. 2006). Permanent mill closures, including the Alaska Pulp Co. sawmill in Wrangell and the Ketchikan Pulp Co. mills in Ketchikan and Annette Island (for more detail on these operations, see Brackley et al. 2006) drove the overall decline of regional mill capacity during this time. Mill utilization, as a percentage of total mill capacity, exhibited a negative correlation with mill capacity until 1992, when it began a steady decline, and was uncorrelated with capacity, to reach less than 25% of capacity by 2004 (Fig. 2). Most of this decline occurred rapidly between 1992 and 1995.

Fig. 2. Trends in SE Alaska mill processing capacity and annual percentage utilization of that capacity, from 1981-2004.

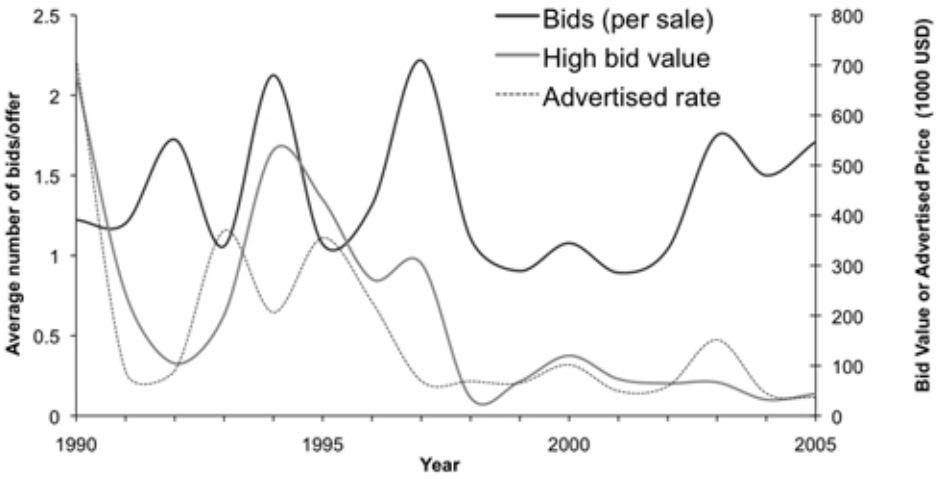


In subsequent years, mill utilization as a percent of capacity has exhibited a positive correlation with mill capacity, but overall utilization remains very low (Brackley et al. 2006). In 2003 and 2004, only about 10% of capacity was utilized for both small craft mills (9.1%) and larger industrial facilities (12.2%). Low capacity utilization may be the result of a variety of factors that are addressed further in the discussion.

The increasing importance of small craft mills during this time suggests structural changes in the regional industry, in addition to the larger scale changes driven by closure of the pulp mills in Sitka and Ketchikan (Crone 2004, Beier et al. 2009). From 1981-1998, approximately 10% of regional capacity was provided by a group of small sawmills, i.e., less than 15 thousand board feet (MBF)/yr capacity. By 2004 this proportion had increased to nearly one-third (32.4%). During the same period, the timber-sale bidding environment appears to have shifted into a different condition, or 'state', characterized by much lower advertised stumpage rates and lower winning bid values (Fig. 3). The number of bids per sale from 1990 to 2005 exhibited high interannual variability but no significant linear trend. Meanwhile, both the mean advertised price of stumpage and the mean winning bid amount declined to reach their low in 1998, and both variables have remained relatively stable near this minimum to the present day. The Tongass advertised rate for all species declined considerably from 1998 to 2005 (Fig. 4). Relationships among variables related to timber sale bidding shifted during this time as well. Based on a comparison of interannual variation between total bids and advertised stumpage rates (Fig. 3), the data suggest that their relationship shifted from a negative (r = -0.32 from 1990-1997) to a positive correlation (r = 0.67 from 1998-2005). This analysis indicates that prior to 1998 the higher priced sales had fewer bids, and after 1998 there were more bids for the high-value sales.

In recent years, appeals and litigation have become a primary method of stakeholder participation in Tongass decision making (Malmsheimer et al. 2004, Nie 2006, Beier et al. 2009). From 1997-2003, the USFS reports that 88% of all Tongass Environmental Impact Statements (EISs) and 26% of NEPA Environmental Assessments (EAs) were administratively appealed. Approximately half (20 out of 42) of Tongass EIS appeals since 1991 were challenged in federal courts; as of May 2005 there were 14 sales totaling 238 million board feet (MMBF) under litigation (Nie 2006). Studies

Fig. 3. Tongass National Forest timber sale bids, average winning bid values and mean advertised rate of sale offers, from 1990-2005. The left axis is the average number of bids per sale, per year. The right axis is the average winning bid value or the average advertised price, in USD (not adjusted for inflation).

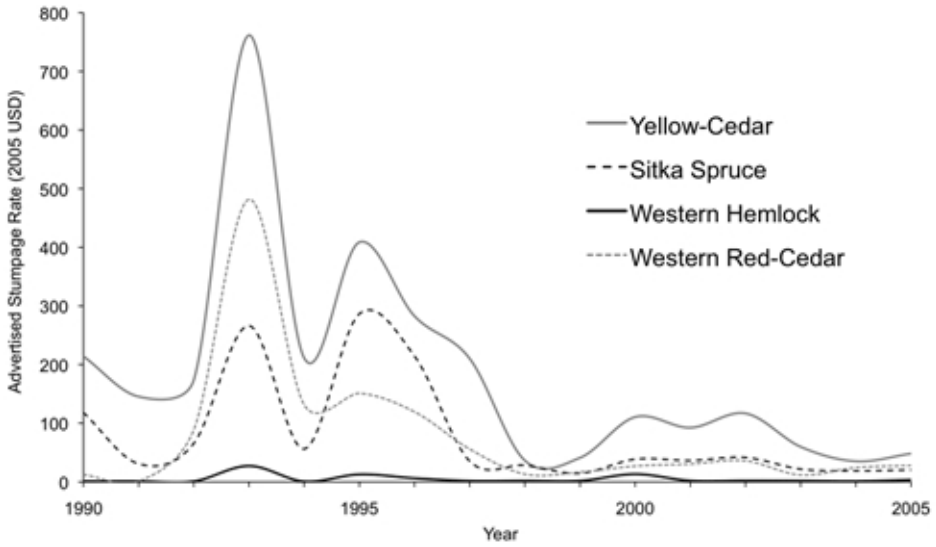


estimate a 45% success rate of litigants against the USFS under NEPA from 1970-2004 (Malmsheimer et al. 2004), while the proportion of sales challenged in court has increased dramatically since 1990 (Nie 2006). Nearly all appeals and litigation on the Tongass have pertained to timber sales, roads, and related activities [forest manager interview].

Tongass managers have estimated that NEPA compliance, EIS appeals, and litigation constitute over 75% of their expenditures for timber sale planning (USDA 2004). Tongass officials also frequently cite the increased effort and expertise needed to prepare their timber-related plans to withstand appeals and litigation (Williams and Tolle 2001, Nie 2006). Informal interviews with Tongass managers broadly confirmed the important role of appeals and litigation in planning and decision making, although relative estimates of litigation-related costs and effort were variable. Interviews also consistently indicated that costs and delays associated with the NEPA process contributes to a significant proportion of timber sales that are never harvested, although the precise number is unknown because of data limitations. For example, since 1997, the volume of offers, sales, and harvests has never met the allowable sale quantity, and planned harvest level, of 267 MMBF/year established in the 1997 Forest Plan (Table 1; USDA 2003). Although a number of economic factors, namely market prices and volatility, also lead to timber sales remaining unharvested (Morse 2000, Beier et al. 2009), the role of NEPA appeals and litigation has been discussed in detail by Nie (2006) and is consistent with both the perspectives of timber industry advocates (Soderberg and DuRette 1988) and the strategy of environmentalist advocates to prevent timber harvesting in the Tongass and other U.S. National Forests (Durbin 1999).

Other emergent changes have occurred that present specific issues, such as the widespread decline of Alaska yellow-cedar (*Chamaecyparis nootkatensis*), the most valuable tree species in Alaska. Potentially resulting from recent warming trends (Beier et al. 2008*a*), over 200,000 hectares of yellow-cedar forests are declining, leaving behind millions of dead trees, which often remain standing as snags for 50 years or longer. Because of its decay and insect-resistant properties and high market price, widespread dieback of yellow-cedar has emerged as both a challenge and opportunity. It is a challenge to understand the mechanisms of decline, which are important for understanding viability of yellow-cedar, both as a species and a valuable local resource. Yet the opportunity related to yellow-

Fig. 4. Mean advertised value of stumpage by species in Tongass National Forest timber sales from 1990-2005, in USD (not adjusted for inflation).



cedar is also readily apparent: salvageable cedar is widely available in declining stands, the Forest Service has funded efforts to demonstrate and market the unique and valuable properties of yellow-cedar wood, and local craft mills have a high demand for the wood. In addition, harvesting of dead yellow-cedar is overall a simpler proposition in the complex planning/appeals process required by NEPA EIS, because salvage harvests or 'sanitation cuts' are typically considered forest health improvement measures.

Evidence of inertia

Given the shifts in regional conditions described above, I found several examples where the activities of the Tongass timber program did not appear to change in directions dictated by changes in market demand, mill capacity, and related factors; in other words, evidence of an institutional lack of fit. I suggest these examples are indicative of inertia in the planning of timber sales and more broadly in the policies underlying Tongass forest management practices.

First, the species and product composition of timber sale offers did not shift to account for changes in local processing capacity. As of 2005, old-growth western hemlock (*Tsuga heterophylla*) continued to dominate the offered stumpage while the offer amounts of higher value species such as Alaska yellow cedar and Western red cedar (*Thuja plicata*), that can be fully processed by local mills, has remained relatively low (Fig. 5). With the exception of 2003 when Sitka spruce (*Picea sitchensis*), which is mostly higher-grade sawmill material, exceeded the volume of hemlock offered, Tongass timber managers continued to offer more of the low-grade, pulp-quality timber. Pulp-grade logs must be, at a minimum, preprocessed locally, into four-sided logs called 'cants', but must be exported elsewhere for the remainder of value-added processing steps, because the region lacks an operational pulp mill.

Second, from 1990-2005 the ratio of pulp logs to sawtimber material offered on the Tongass exhibited no significant trend, despite the closure of the regional pulp mills (Fig. 6). During this period, the pulp-to-sawtimber ratio of offered stumpage fluctuated around a stable mean, reaching its maximum (0.25) in 2004, while the ratio of pulp cants to sawtimber produced by southeastern Alaska mills (0.09) has remained much lower. Because these data only pertain to timber sales outside of the long-term lease structures (see Beier et al. 2009),

Table 1. Tongass National Forest microsale program offers, total volume, and average advertised stumpage rates, by species (2000-2005).

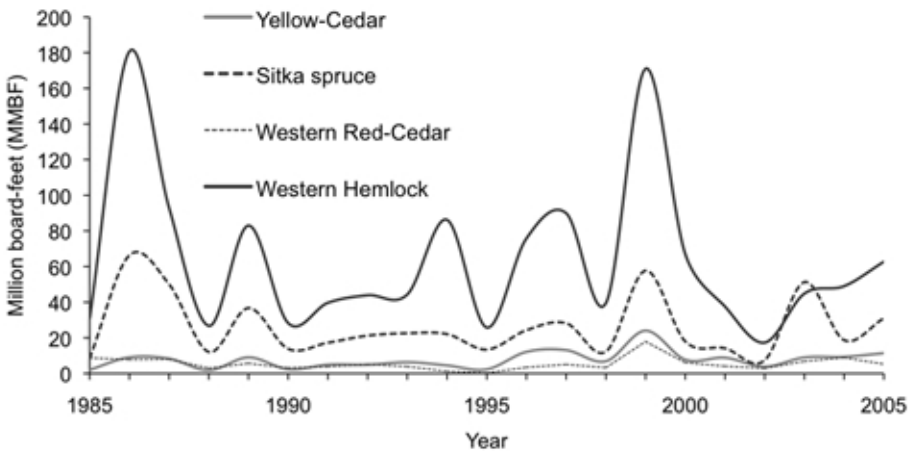
Species	Total Offers	Total Volume	Percent of Total Volume	Average Stumpage Rate
Yellow-Cedar *(Chamaecyparis nootkatensis)*	20	249.54	12.14%	145.29
Sitka Spruce *(Picea sitchensis)*	64	1130.27	55.01%	52.07
Western Hemlock *(Tsuga heterophylla)*	17	143.91	7.00%	7.63
Western Red Cedar *(Thuja plicata)*	52	531.07	25.85%	42.00

they greatly underestimate the amount of pulp-grade materials sold and harvested from the Tongass prior to the termination of these leases (in 1994 and 1997). Hence, the pulp-to-sawtimber ratio estimated here does not accurately reflect overall changes in the amount of pulpwood made available Tongass-wide, which almost certainly declined because of the termination of the lease contracts. Nonetheless, the observation that Tongass managers continued to offer a significant proportion of pulp-grade materials in sales, despite loss of local pulp-processing capacity, suggests inertia.

Of course, the composition of the old-growth Tongass timber base is a primary reason why pulp-grade materials continue to be a major component of timber offers, even after closure of the regional pulp mills. As it was when the first Tongass managers proposed timber management for industrial pulp production (Beier et al. 2009), much of the region's old-growth temperate rainforest is composed of Western hemlock and Sitka spruce of highly variable grade. As a result, nearly all timber sale units contain a significant proportion of low-value materials. The continued preference for large-scale clear-cutting, i.e., even-aged management, contributes greatly to this situation. Although it is often the most efficient practice from both an economic and silvicultural standpoint, even-age management requires the harvest of all trees within the sale unit. As a result, it is inherently difficult to design a clear-cut sale unit of sufficient size that contains mostly high-grade timber [forest manager interview]. Selection harvesting is more suited to this objective in southeastern Alaska, considering recent structural changes in the industry, the composition of old-growth stands, and the high value of certain species, e.g., western red cedar, Alaska yellow cedar. However, as of 2005, clear-cutting has dominated timber harvest on the Tongass, with the exception of a three-year period (2000-2002) when selection harvesting became a roughly equivalent method, based on total area harvested (Fig. 7).

The types of sales offered by Tongass managers provide another example of inertia. For example, salvage sales to remove dead trees may be more suited to current conditions in the Tongass for several reasons: they are generally simpler and less expensive to plan [forest manager interview], may involve lower logistical costs when utilizing the existing road system, can simultaneously serve forest health and timber production goals, are exempt from certain NEPA obligations, and are often less frequently appealed and/or subjected to extensive litigation. Despite these potential advantages, and the availability of high-value yellow-cedar snags for harvest, salvage sales have remained a low proportion of total sales offered throughout the reorganization period (Fig. 8).

Fig. 5. Tongass National Forest timber volume offered by species from 1985-2005

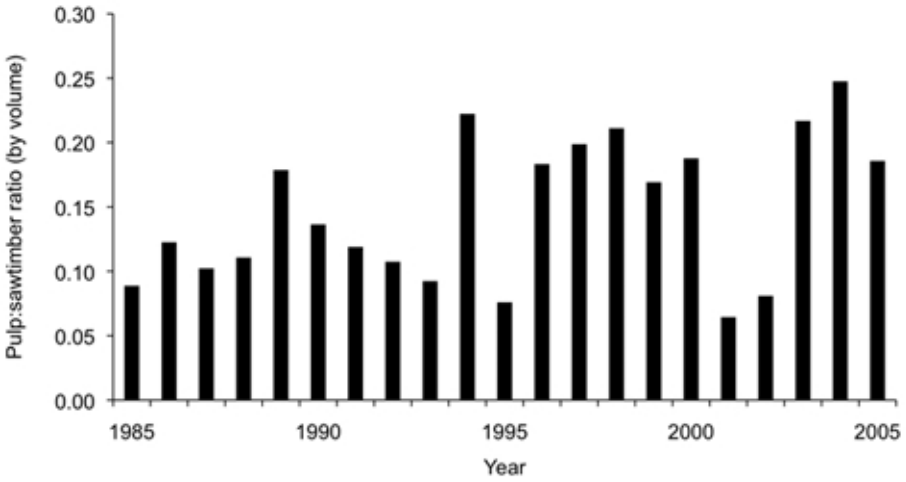


Lastly, at the broader scale of Tongass resource governance, a major source of inertia came from the former policy monopoly, the group of actors and institutions that established and maintained the industrial forestry system in the Tongass, that retained some control at the regional and national levels (Nie 2006, Beier et al. 2009). Although the Tongass policy monopoly no longer dominates key venues of debate and decision making, and its overall ability to affect the Tongass situation has diminished greatly, until 2009 it remained highly influential in the appropriations and budgetary responsibilities of the U.S. Congress (Farnham 1995). In 1995, all three members of the Alaska congressional delegation assumed powerful committee roles: (former) Sen. Frank Murkowski became Chairman of the Senate Energy Committee, (former) Sen. Ted Stevens became Chairman of the Senate Appropriations Committee, and Rep. Donald Young became Chairman of the House Resources Committee. In these leadership positions, these legislators exerted their influence through the frequent use of Tongass-specific, and even project-specific, riders on large federal omnibus bills, a series of over 20 hearings on Tongass timber harvesting and environmental policy from 1994-98, and an unsuccessful legislative attempt to transfer ownership of large portions of the Tongass National Forest to the State of Alaska (Nie 2006). Budget riders included a 1995 provision limiting the power of the Forest Service to set new logging limits and conduct new environmental studies required by NEPA, and a 1998 measure instructing Tongass managers to sell enough timber to support 2500 local jobs and prescribed a precise harvest amount and specific fiscal and legal penalties for Tongass noncompliance. From 1995-2008, these "appropriation politics" (Nie 2006) were the primary way in which actors in the former policy monopoly continued to govern the Tongass, although in a much more adversarial fashion than during the timber boom years (Farnham 1995, Nie 2006, Beier et al. 2009). As of 2010, this capacity to influence Tongass governance has declined rather dramatically, because none of these legislators have retained their offices and/or leadership positions on budget committees; Rep. Don Young is the only senior Alaskan legislator remaining in office.

Evidence of adaptation

In recent years, Tongass managers have exhibited adaptation as well, as evidenced by efforts to better align their timber management approach with current conditions in the region. First and foremost, the Tongass 'microsale' program represents a shift in timber sale planning to better suit the recent structural changes in the regional industry [forest manager interview]. The program offers very small quantities of high-grade timber, mostly Sitka spruce

Fig. 6. Ratio (based on volume) of pulp grade to saw grade materials offered in Tongass National Forest timber sales from 1985-2005.

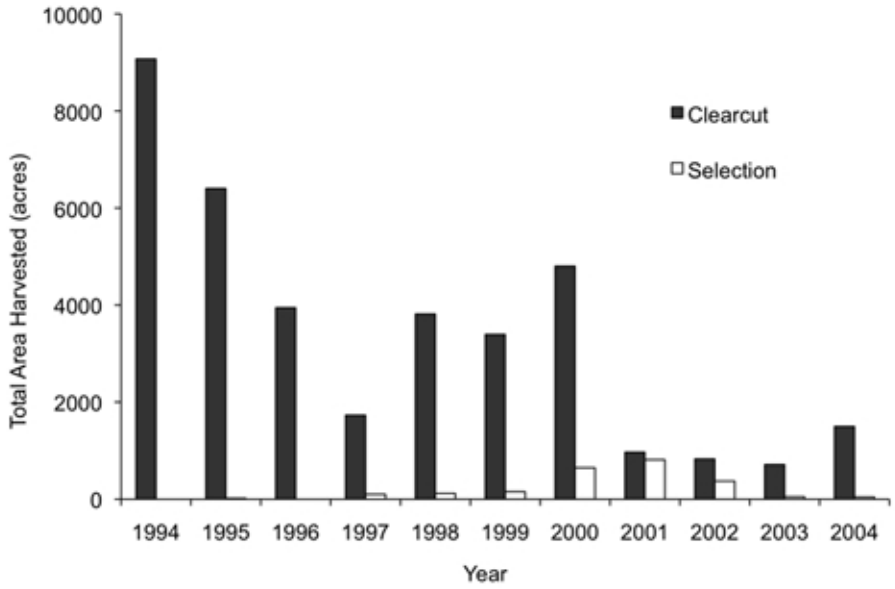


(55%) and Western red cedar (26%) for processing by local craft mills (Table 1). As of 2005, all of the microsales have been offered in two ranger districts on Prince of Wales Island, where an extensive road network, built by historical timber operations, and the existence of several local mills minimize logistical costs. Microsales can be harvested by the individual/group selection method and the logs removed by helicopter yarding, practices that have minimal environmental impacts compared to large-scale clear-cut harvesting operations that involve hundreds of acres and many miles of roads. For these reasons, microsales are partially exempt from certain planning requirements and NEPA related environmental impact studies, therefore reducing the effort and expense of Tongass planners. Most importantly, the cooperation between local environmental groups and the Forest Service in developing the microsale program has allowed Tongass managers to proceed with relatively few legal or administrative obstacles. By 2004, during its fifth year of operation, the microsale program grew to comprise one-third of all sales offered (Fig. 8). A very low level of capacity utilization, especially among small craft mills (9.1%) suggests that there is room for additional growth (Brackley et al. 2006).

Despite the early success of the microsale program, it has averaged only 0.23% of the total Tongass volume offered since it began in 2000. Thus, microsales contribute very little to the overall goal of Tongass managers to offer a volume of timber similar to the 267 MMBF Allowable Sale Quantity (ASQ) set in the 1997 Forest Plan; although the ASQ is defined as the maximum harvest allowable, it served as the de facto target harvest for Tongass managers during the 1990s (Nie 2006, Beier et al. 2009). Although this harvest target was not an accurate reflection of market demand for Tongass timber (*Nat. Res. Def. Council v USFS 2005*), the pressure to reach these harvest levels has remained strong from industry advocates, state officials, federal legislators, and appointees at the highest levels of the U.S. Department of Agriculture (Durbin 1999, Nie 2006).

Two further examples of adaptation emerged in 2006: (1) a redoubled emphasis on active management of second-growth stands, which invests USFS resources into future, not contemporary, commercial harvest yields; and (2) the signing of a 'Memorandum of Understanding' between the Tongass/U.S. Forest Service Region 10 (Alaska) and The Nature Conservancy (TNC), a well-respected, privately-funded conservation organization. First, the investment in second-growth management is a much-needed development, because the thinning of young second-growth forest accelerates growth rates, improves timber quality,

Fig. 7. Estimated land area harvested by clear-cut and selection methods in the Tongass National Forest, 1994-2004.



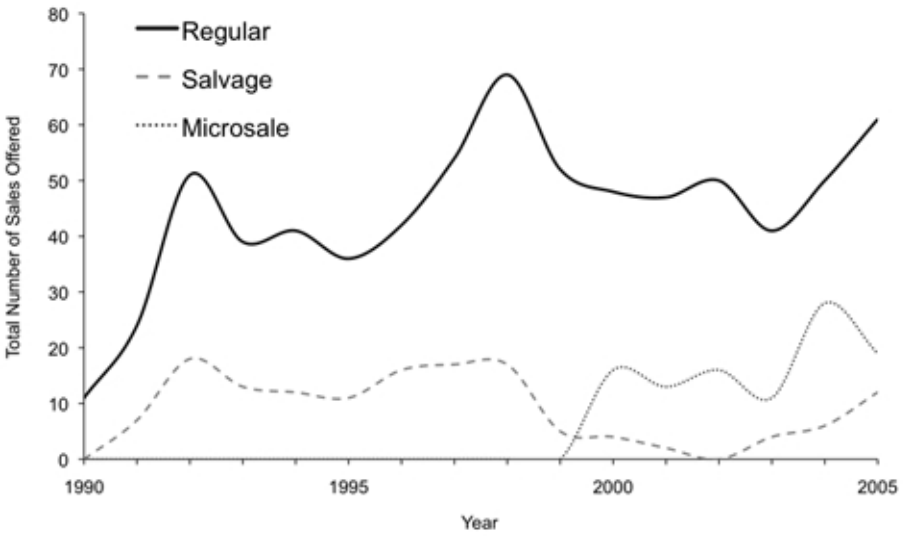
and hastens the development of forest structure to an old-growth condition. The latter benefit of thinning is critical for restoring habitats for wildlife and fish species of ecological, subsistence, and commercial importance in southeastern Alaska (Hanley et al. 2005, Beier et al. 2008*b*). Prior to the new initiative, the Forest Service funded thinning operations at an insufficient level on the Tongass. Budget data detailing the yearly expenditures on thinning were unavailable, but based on discussions with Tongass officials, the 2007 funding level supported the precommercial thinning of between 1,500 and 2,000 hectares each year [forest manager interview], relative to a total of roughly 325,000 hectares of second-growth forests across the Tongass. The renewed emphasis on second-growth management suggests recognition by Tongass managers that the future of the regional timber economy largely depends on management of second-growth forests.

Second, the 2006 memorandum with The Nature Conservancy symbolized the first significant public partnership in Tongass history between USFS administration and a conservation-oriented nongovernmental organization [forest manager interview]. As of 2007, the USFS-Tongass and TNC held a series of meetings and public seminars discussing a 'restoration economy' based on managing second-growth forests for joint ecological and economic goals. One of the projects discussed was the creation of jointly funded (TNC and USFS), community-based programs for commercial thinning of second-growth stands to provide improved wildlife habitat, product flows to local mills, and subsistence/recreational opportunities. Although this type of project is still in its early stages as of 2007, Tongass officials have become considerably more receptive to a vision of multiple-use in which timber management can work in concert with other goals.

DISCUSSION

Inertia and adaptation are both evident as factors influencing adaptive capacity at multiple scales in the reorganization of Tongass forest management. On balance, it appears that given the observed lack of progress toward reorganization since 1990 (Beier et al. 2009), the forces underlying organizational inertia remained dominant on the Tongass,

Fig. 8. Total number of timber sales offered by type (regular, salvage, microsale) in the Tongass National Forest, from 1990-2005; note that the microsale program began in 1999.



maintaining the precollapse status quo in many respects. However, several encouraging examples of adaptation, and the recent departure of key actors from the erstwhile Tongass policy monopoly (Beier et al. 2009), suggest the Tongass may be trending toward significant progress in reorganization over the next decade. To better understand this complex situation, it is helpful to describe the sources and interactions of inertia and adaptation, and their interactions, at multiple scales.

At the resource planning level, the 'regular' timber sales that comprise the vast majority of those offered still look much like the sales offered during the industrial years. Despite the loss of regional pulp mills and the legislative requirement to locally process nearly all Tongass timber, the ratio of pulp to sawtimber grade materials offered has not changed significantly. This is likely because the majority of Tongass timberlands are composed of pulp-grade materials, mostly old-growth western hemlock, and the practice of clear-cutting requires the harvesting of this material. The Forest Service can do little to change this ecological reality in the old-growth forests of the Tongass. However, forest managers remain bound by its constraints because they have not fully exercised their discretional authority to shift toward other harvest methods.

However, the use of clear-cutting practices on the Tongass is rational and appropriate under certain conditions. The method suited the initial conditions in southeastern Alaska (Taylor 1935) and the even-aged management objectives of the Tongass, which has its origins in the sustained-yield policy for managing timber resources in U.S. National Forests. This institutional philosophy was codified in the Sustained Yield Management Act of 1944 and was reaffirmed by the National Forest Management Act of 1976. From the economic perspective, clear-cutting was justified by the more diversified Alaskan timber industry of the past, which was capable of processing a wide range of grades. Moreover, the mandated 450 MBF/year harvest level established by the Alaska National Interest Lands Conservation Act (ANILCA; Beier 2008, Beier et al. 2009) left Tongass planners with few options; the only feasible manner to reach this target harvest was through large-scale clear-cutting. However, the logging practice has become a highly politicized issue, with the majority of national public opinion aligned strongly against its use, especially on public lands (Bliss 2000). The impacts of even-aged management practices on fisheries, wildlife, and recreational opportunities are often the basis upon which environmental groups challenge and successfully block timber sales under NEPA

EIS (Malmsheimer et al. 2004). For these reasons, the emphasis on even-aged forestry has been a key source of inertia in Tongass governance.

This inertia has constrained the capacity of Tongass managers to take advantage of emergent opportunities, such as yellow-cedar decline. Currently there are over 200,000 ha of declining yellow-cedar forests across southeastern Alaska, which remain highly valuable because of the unique decay-resistant qualities of yellow-cedar heartwood (Hennon and Shaw 1997). Salvage sales are more easily justifiable from a forest health perspective and can bypass many of the NEPA requirements for timber harvesting projects. Based on the data analyzed in this study, nearly all cedar salvage offers are competitively bid upon and sold, suggesting that there is a high local demand for the wood. The U. S. Forest Service has invested millions of dollars into research and marketing of the unique properties of yellow-cedar lumber, in an effort to increase its already high market premiums and to stimulate demand. As of 2005, yellow-cedar was almost three times more valuable than the next most valuable species in southeastern Alaska, Sitka spruce.

My findings suggest that Tongass managers have not taken advantage of the yellow-cedar opportunity by significantly increasing the availability of cedar via salvage sales. The principal reason, based on informal discussions with several Tongass officials, is because the removal of dead cedar would involve the 'high-grading' of stands that Tongass managers plan to harvest in the future; and to a lesser degree, because it involves logging in areas where development is not allowed, i.e., ANILCA wilderness. One Tongass manager who participated in discussions expressed a reluctance to extract a valuable resource that does not appear to be renewable in the near term, because most declining cedar stands are either regenerating very slowly, or not at all (Hennon and Shaw 1997). However, it appears there is room for expansion of cedar salvage while maintaining large unmodified areas of declining forest for research and management efforts.

However, Tongass managers have been willing to conduct 'high-grading', to some degree, in recent years, judging by the growth of the microsale program, which tends to operate by selection harvesting. In response to structural shifts in the regional industry and the growing importance of small craft mills, the Tongass microsale program has been initially successful. A minor yet growing component of timber planning, the microsale program and its success suggests a partial return to preindustrial practices in the Tongass, when timber sales were designed to meet local demand (Beier et al. 2009). The program is highly successful in this regard, based on data indicating that all microsales have been sold and harvested, compared with less than half of all 'regular' sales since 1990. Microsales are significant not only because they appear to serve local mill needs more flexibly, but also because they often involve alternative methods of harvesting, e.g., selection logging by helicopter, that have less severe environmental impacts. For this reason, and because the microsale program came about through cooperation between the U.S. Forest Service and a regional environmental advocacy coalition, the Southeast Alaskan Conservation Council, microsales have not been targeted by appeals or legal action.

As beneficial as the program appears to be, it comprises a miniscule fraction of the total volume offered and sold on the Tongass, and thus it does little to help forest planners meet the harvest targets designated in the 1997 Tongass Land Management Plan (TLMP) and its subsequent revisions (USDA 2003). For this reason, the microsale program may reflect a more fundamental shift in Tongass governance: a transition from a unilateral and highly prioritized effort to meet a politically determined timber harvest level, toward a cooperative effort to meet local demand and address the concerns of multiple local and regional stakeholder groups. The microsale program, although not a complete solution to the quandary imposed by environmental litigation and appeals, may suggest that Tongass governance has shifted, if only slightly, toward a greater degree of a priori cooperation with environmental groups. In other words, the Tongass system appears to be adapting to a new political landscape.

If this adaptation has been occurring, it has been constrained by powerful legislators that represent remnants of the Tongass policy monopoly (Beier et al. 2009). Throughout the collapse period and to the present day, Alaska's legislators have actively sought to re-establish industrial-scale timber production in the Tongass, and have used their seniority and committee leadership positions to influence the relative funding levels of different Tongass programs, e.g., timber, wildlife, subsistence, and recreation, creating larger budgets for timber planning and forest products utilization

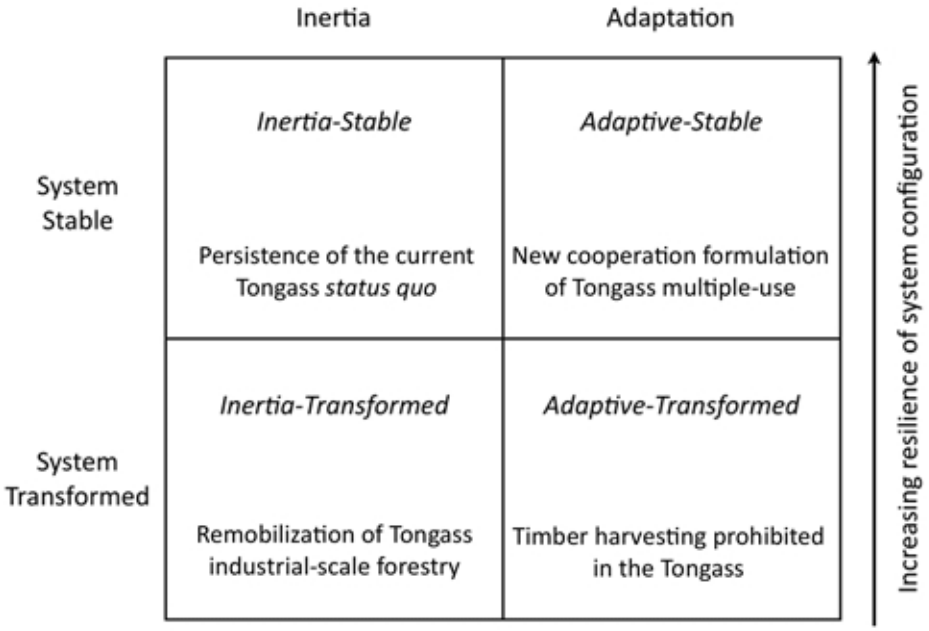
(Nie 2006) relative to wildlife and recreation, which are arguably more important resources in the post-timber economy of southeastern Alaska (Colt et al. 2007, Beier et al. 2008*b*). I suggest the political influence through budget appropriations has become a source of inertia in overall Tongass governance by keeping institutional resources focused on preparing timber sales that are rarely purchased or harvested. However, the post-timber economy of southeastern Alaska is strongly dependent on the ecosystems services of unmanaged ecosystems (Allen et al. 1998, Gilbertsen 2003), which support subsistence practices and commercial uses such as hunting and fishing (Beier et al. 2008*b*), as well as the nonconsumptive uses and amenity values associated with pristine scenery and remote recreation (Colt et al. 2007). Moreover, the lack of mill infrastructure and demand for large pulpwood sales of the industrial era, and the powerful and persistently successful legal opposition to this type of forest management, makes the prospect of returning to the 'old days' of Tongass timber seem highly unlikely. Despite this reality, as of 2005, the Forest planning, mostly timber sale planning, portion of the Tongass budget remains greater than all other programs combined (Nie 2006), and most of this expense is because of the costs of NEPA-related environmental impacts research, appeals, and legal defense (USDA 2004). Alaskan legislators have viewed their actions as a response to the "broken promises" of ANILCA (Stevens 2000:2) and as the best defense against the "economic vandalism" practiced by environmental groups (Soderberg and DuRette 1988:33). Environmentalists respond that continued funding for forest harvesting is a biased approach to multiple-use and an unfair subsidy to the timber industry (Durbin 1999). This debate, a microcosm of the broader debate over timber in all U.S. National Forests (Repetto 1988), has fostered the highly politicized climate of mistrust between Congress, environmentalists, private industry, local residents, and U.S. Forest Service in southeastern Alaska (Nie 2006).

I contend that this litigious atmosphere represents a fundamental source of inertia for the entire Tongass system. This hypothesis is based on the evidence herein, insights from prior research (Williams and Tolle 2001, Nie 2006, Beier et al. 2009), as well as informal interviews with Tongass managers; although because of methodological and data limitations, it is difficult to determine precisely how much litigation contributes to inertia beyond the organizational scale. However, this climate of mistrust is highly significant because it tends to prevent the a priori cooperation and collaborative participation of advocacy groups and stakeholders in forest planning and decision making, where most adaptive and/or new directions would either originate or be implemented. With the exception of some recent, and meaningful, cooperative efforts, most of the participation of advocates has occurred outside of the forest planning process, and instead occurs in the courts or in Congress (Durbin 1999, Malmsheimer et al. 2004, Steen 2004, Nie 2006).

As long as this degree of mistrust among parties remains pervasive, I contend that it maintains the Tongass in its current rigidity trap, therefore preventing its reorganization (Beier et al. 2009). Because the broader 'environment vs. development' debate will almost certainly not be resolved in the near term, its overarching influence on resource and public lands governance will continue into the future. Yet the Tongass has become a globally recognized icon of this conflict and is now a battleground for some of its most polarizing and vigorous advocacy coalitions (Cahn 1988, Wilkinson 1997, Durbin 1999, Nie 2006). As a result, Tongass managers are continuously involved in litigation and therefore are constrained from seeking policies and practices that reflect a compromise among opposing advocacy groups and the U.S. Forest Service mission.

However, there is significant evidence that this deadlock is weakening and new directions are emerging for Tongass reorganization. In other words, there is hope that the Tongass can escape the current rigidity traps and move on a more sustainable path. The renewed emphasis on second-growth management suggests that Tongass managers have recognized the importance of this resource to the future timber industry and its dependent communities. Moreover, it implies that Tongass managers have recognized that a remobilization of industrial forestry will have to wait until second-growth stands mature, because legal opposition to old-growth harvesting is too strong. In a key development that both addresses second-growth forests and may serve to ease tensions, an unprecedented degree of cooperation was initiated in 2007 between the Tongass and The Nature Conservancy of Alaska. The initial objective was to manage second-growth forests for a range of social and ecological benefits, in part through greater stakeholder participation and adaptive

Fig. 9. Four generalized system reorganization scenarios, based on drivers (inertia vs. adaptation) and dynamics (stable vs. transformed) of Tongass National Forest governance.



management techniques. On the ground, a large part of this effort would involve prioritizing and implementing best practices for forest thinning. Thinning of second-growth forests is essential for achieving the desired 80-150 year rotations of sustained yield forestry in most forests of southeastern Alaska. Thinning also simultaneously serves other purposes that have been considered mutually exclusive in the past, e.g., improvement of species habitat (Hanley et al. 1989) and local economic growth, through employment and local investment in thinning projects. Thus, the opportunities afforded by the 'restoration economy' demonstrate that forest management in the Tongass is not a zero-sum game; in other words, management efforts that benefit future timber values can also benefit nontimber values.

CONCLUSIONS

Looking forward, I suggest that there are four potential outcomes of the current postcollapse phase (Beier et al. 2009) of Tongass forest management: (1) persistence of the contentious 'deadlock' situation; (2) a remobilization of industrial-scale forestry; (3) a permanent prohibition of timber harvesting; and (4) a cooperatively determined balance among timber and other forest uses. In theory, these broadly defined outcomes can be characterized in terms of the dominant forces, i.e., inertia or adaptation, shaping the future configuration, and the system dynamics, i.e., stable or transformed, leading to that state (Fig. 9).

In the first generalized outcome (*inertia-stable*), inertia resulting from the current situation and its constraints on adaptive capacity will continue to stabilize the Tongass system in a highly resilient, but undesirable state, i.e., the current rigidity trap (Beier et al. 2009). If the system is transformed, it may occur in two categorically different ways: either via the forces of inertia leading to a large-scale remobilization of industrial forestry (*inertia-transformed*); or to the other extreme, transformation may occur via adaptation in response to political opposition to timber harvesting (*adaptive-transformed*). History suggests that neither of these system states will likely be resilient over the long term. We have already observed that the industrial forestry regime has not been sustainable, and conversely, it seems that a Tongass-wide

moratorium on timber harvesting would be unsustainable because of both political and economic interests, especially as second-growth forests regenerate to commercial size and become harvestable. The fourth outcome, in which the system remains largely stable but reorganizes to accommodate new conditions (*adaptive-stable*), involves reaching a flexible balance among resource uses, including timber, and stakeholders that serves to foster a settlement among multiple-use interests. Such a compromise would ostensibly ease tensions and thus serve to reconcile the contentious and mistrustful atmosphere surrounding Tongass planning. A cooperative and flexible compromise among multiple-use interests, managed by the Forest Service, can thus foster a resilient and more desirable state.

Although the timber issue remains highly contentious, the initial signs of cooperation among opposing parties are promising. I suggest that the reorganization of Tongass management ultimately hinges on the reconciliation of political and ideological conflicts, as well as the building of trust and respect among all parties. Reorganization also hinges on the willingness of Tongass managers to rethink some deeply entrenched management principles. As of 2007, the vast majority of Tongass timber management funds were focused on the preparation of timber sales and associated NEPA and litigation costs. The Forest Service could consider reallocating funds from timber planning activities to a variety of projects that improve second-growth forests and provide the necessary raw materials and technical support for today's forest products industry in southeastern Alaska. In all cases, the Tongass should continue to implement adaptive management principles for maintaining key flows of ecosystem services to residents and stakeholders and improve the level of a priori stakeholder involvement in its planning process.

In the words of U.S. Forest Service founder Gifford Pinchot, "[the] application of the conservation principle necessarily moved in different directions as one or another problem became important" (cited in Rakestraw 1989:32). At the most fundamental level, reorganization of Tongass National Forest management requires a creative renewal of the implementation of Pinchot's multiple-use philosophy in southeastern Alaska.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol16/iss1/art40/responses/

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LITERATURE CITED

Allen, S. D., G. Robertson, and J. Schaefers. 1998. Economics in transition: an assessment of regional and community economic conditions and trends in southeast Alaska. General Technical Report PNW GTR 417. U.S. Forest Service, Pacific Northwest Research Station. Portland, Oregon, USA.

Baskerville, G. L. 1995. The forestry problem: adaptive lurches of renewal. Pages 37-102 *in* L. H. Gunderson, C. S. Holling, and S. S. Light, editors. *Barriers and bridges to the renewal of ecosystems and institutions.* Columbia University Press, New York, New York, USA.

Beier, C. M. 2007. *Regional climate, federal land management, and the social-ecological resilience of southeastern Alaska.* Dissertation. University of Alaska, Fairbanks, Alaska, USA.

Beier, C. M. 2008. Influence of political opposition and compromise on conservation outcomes in the Tongass National Forest, Alaska. *Conservation Biology* 22(6):1485-1496.

Beier, C. M., S. E. Sink, P. E. Hennon, D. V. D'Amore, and G. P. Juday. 2008*a*. Twentieth-century warming and the dendroclimatology of declining yellow-cedar forests in southeastern Alaska. *Canadian Journal of Forest Research* 38:1319-1334.

Beier, C. M., T. M. Patterson, and F. S. Chapin III. 2008*b*. Ecosystem services and emergent vulnerability in managed ecosystems – a geospatial decision-support tool. *Ecosystems* 11(6):923-938.

Beier, C. M., A. L. Lovecraft, and F. S. Chapin III. 2009. Growth and collapse of a resource system: an adaptive cycle of public lands governance and forest management in Alaska. *Ecology and Society* 14(2): 5. [online] http://www.ecologyandsociety.org/vol14/iss2/art5/.

Berkes, F., and C. Folke, editors. 1998. *Linking social and ecological systems: management practices and social mechanisms for building social resilience.* Cambridge University Press, Cambridge, UK.

Bliss, J. 2000. Public perceptions of clearcutting. *Journal of Forestry* 98(12):4-9.

Brackley, A. M., D. J. Parrent, and T. J. Rojas. 2006. *Estimating sawmill processing capacity for Tongass timber: 2003 and 2004 update.* Research Note PNW-RN-533. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon, USA.

Brown, K. 2003. Integrating conservation and development: a case of institutional misfit. *Frontiers in Ecology and Environment* 1 (9):479-487.

Cahn, R. 1982. *The fight to save wild Alaska.* National Audubon Society, Washington, D.C., USA.

Carpenter, S. R., and W. A. Brock. 2008. Adaptive capacity and traps. *Ecology and Society* 13(2): 40. [online] URL: http://www.ecologyandsociety.org/vol13/iss2/art40/.

Colt, S., D. Dugan, and G. Fay. 2007. *The regional economy of southeast Alaska – final report.* Institute of Social and Economic Research, University of Alaska-Anchorage, Anchorage, Alaska, USA. [online] URL: http://www.iser.uaa.alaska.edu/Publications/SoutheastEconomyOverviewfinal4.pdf.

Crone, L. K. 2004. Southeast Alaska economics: a resource-abundant region competing in a global marketplace. *Landscape and Urban Planning* 72:215-232.

Durbin, K. 1999. *Tongass: pulp politics and the fight for the Alaska rain forest.* Oregon State University Press, Corvallis, Oregon, USA.

Farnham, T. J. 1995. Forest Service budget requests and appropriations: what do analyses of trends reveal? *Policy Studies Journal* 23:250-261.

Folke, C., L. Pritchard Jr., F. Berkes, J. Colding, and U. Svedin. 1998. *The problem of fit between ecosystems and institutions.* International Human Dimensions Programme on Global Environmental Change (IHDP) Working Paper 2. Bonn, Germany.

Gilbertsen, N. 2003. Sitka: an economic profile. *Alaska Economic Trends* 3:3-11.

Gresov, C., H. A. Haveman, and T. A. Oliva. 1993. Organizational design, inertia and the dynamics of competitive response. *Organization Science* 4 (2):181-208.

Hanley, T. A., C. T. Robbins, and D. E. Spalinger. 1989. *Forest habitats and the nutritional ecology of Sitka black-tailed deer: a research synthesis with implications for forest management.* General Technical Report PNW-GTR-230. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon, USA.

Hanley, T. A., W. P. Smith, and S. M. Gende. 2005. Maintaining wildlife habitat in southeastern Alaska: implications of new knowledge for forest management and research. *Landscape and Urban Planning* 72:113-133.

Hanna, S. S., C. Folke, and K.-G. Maler, editors. 1997. *Rights to nature: ecological, economic, cultural and political principles of institutions for the environment.* Island Press, Washington, D.C., USA.

Hannan, M. T., and J. Freeman. 1984. Structural inertia and organizational change. *American Sociological Review* 49(2):149-164.

Hannan, M. T., and J. Freeman. 1989. *Organizational ecology.* Harvard University Press, Cambridge, Massachusetts, USA.

Hennon, P. E., and C. G. Shaw. 1997. The enigma of yellow-cedar decline: what is killing these long-lived, defensive trees? *Journal of Forestry* 95 (12):4-10.

Holling, C. S., and L. H. Gunderson. 2002. Resilience and adaptive cycles. Pages 25-62 *in* L. H. Gunderson, and C. S. Holling, editors. *Panarchy: understanding transformations in human and natural systems.* Island Press, Washington, D.C., USA.

Holling, C. S., and G. K. Meffe. 1996. Command and control and the pathology of natural resource management. *Conservation Biology* 10:328-337.

Jansen, K. J. 2004. From persistence to pursuit: a longitudinal examination of momentum during the early stages of strategic change. *Organization Science* 15(3):276-294.

Malmsheimer, R. W., D. Keele, and D. W. Floyd. 2004. National forest litigation in the U.S. Courts of Appeals. *Journal of Forestry* 102(2):20-25.

Morse, K. S. 2000. *Responding to the market demand for Tongass timber: using adaptive management to implement Sec. 101 of the Tongass Timber Reform Act.* R10-MB-413. U.S. Forest Service, Alaska Region, Juneau, Alaska, USA.

Nie, M. 2006. Governing the Tongass: national forest conflict and decision-making. *Environmental Law* 36:385-480.

Rakestraw, L. 1989. *A history of the United States Forest Service in Alaska.* U.S. Forest Service, R10-ER-5, Washington, D.C., USA.

Repetto. R. C. 1988. Subsidized timber sales from national forest lands in the United States. Pages 353-379 *in* R. Repetto and M. Gills, editors. *Public policies and the misuse of forest resources.* Cambridge University Press, Cambridge, UK.

Soderberg, K. A., and J. DuRette. 1988. *People of the Tongass - Alaska forestry under attack.* Free Enterprise Press, Bellevue, Washington, USA.

Staber, U., and J. Sydow. 2002. Organizational adaptive capacity: a structuration perspective. *Journal of Management Inquiry* 11:408-424.

Steen, H. K., editor. 2004. *Jack Ward Thomas: The journals of a forest service chief.* University of Washington Press, Seattle, Washington, USA.

Stevens, T. 2000. Preface. *In* P. Tangen, editor. *A report to the people of Alaska on the land promises made in ANILCA.* Alaska Miners Association. Glacier House Publications, Anchorage, Alaska, USA.

Taylor, R. F. 1935. Available nitrogen as a factor influencing the occurrence of Sitka spruce and western hemlock seedlings in the forests of southeastern Alaska. *Ecology* 16(4):580-602.

Trosper, R. L. 2003. Policy transformations in the US forest sector, 1970-2000: implications for sustainable use and resilience. Pages 328-351 *in* F. Berkes, J. Colding, and C. Folke, editors. *Navigating social-ecological systems: building resilience for complexity and change.* Cambridge University Press, Cambridge, UK.

U.S. Department of Agriculture (USDA). 2003. *Tongass land management plan – supplemental environmental impact statement.* U.S. Forest Service, Alaska Region, Juneau, Alaska, USA.

U.S. Department of Agriculture (USDA). 2004. *Questions and answers: Tongass National Forest.* Press Release, 12 Feb 2004. U.S. Forest Service, Alaska Region. Tongass National Forest, Ketchikan, Alaska, USA.

Wilkinson, C. F. 1997. The national forest management act: the twenty years behind, the twenty years ahead. *University of Colorado Law Review* 68:659-665.

Williams G. W., and T. Tolle. 2001. USDA Forest Service: long-time leader in federal forest planning. *Proceedings of the Society of American Foresters National Meeting,* November 2000, Washington, D. C., USA.

Young, O. R. 2002. *The institutional dimensions of environmental change.* MIT Press, Cambridge, Massachusetts, USA.