RESEARCH ARTICLE

*J. For.* 111(2):115–125
http://dx.doi.org/10.5849/jof.12-087


policy

# Escaping the National Forest Planning Quagmire: Using Public Participation GIS to Assess Acceptable National Forest Use

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The appropriate role of the "public" in the planning and management of national forests in the United States is both statutorily vague and socially dynamic. Should forest management be consistent with public values and preferences for these lands? And, how should "consistency" be defined and evaluated? In 2012, a public participation geographic information systems (PPGIS) study was completed for the Chugach National Forest (CNF) in Alaska (United States) that measured public values and preferences to assist future forest plan revision. Place-based public preferences were assessed for consistency with existing CNF national forest plan (2002) prescriptions and to identify areas of potential conflict over forest management direction. Public use preferences were largely consistent with forest plan prescriptions but with some exceptions. Larger-scale analysis of PPGIS preference data provides more detailed information about potential forest conflict and indicates that large-area forest management prescriptions may be too general to guide place-specific forest planning needs. We discuss the use of PPGIS methods for future forest plans, given the release of a new regulatory planning rule for the USDA Forest Service in 2012.

**Keywords:** public participation GIS (PPGIS), forest planning, spatial analysis

The right of the public to be *informed* about significant decisions involving national forests in the United States is a well-established principle under the National Environmental Policy Act of 1969 (NEPA). Less clear is the appropriate role and *influence* of the "public" in the actual planning and management of national forests. Lurking behind the legal and regulatory requirements for public consultation is the vexing question about whether and how far participatory democracy principles should extend to the planning and management of national forests. Should national forest management be consistent with public values and preferences, and, if so, how can this principle be achieved in practice?

The USDA Forest Service is the federal agency responsible for developing and implementing forest plans (called Land and Resource Management Plans) under the National Forest Management Act of 1976 (NFMA). The national forest planning process prescribed by NFMA and its associated code of federal regulations (CFR) has been controversial from the beginning, leading to early calls for reform or even repeal (Behan 1981). In the absence of congressional intervention to revise national forest management statutes, the Forest Service has attempted on multiple occasions to revise the regulations that guide the national forest planning process. Substantive changes to forest planning regulations (originally codified at 36 CFR 219 in 1982) were published by the agency in 2000, 2002, 2005, and 2008 (USDA Forest Service 2012a). Controversy and litigation surrounded each proposed revision of the planning rule. In 2009, a US District Court decision forced an agency retreat from the 2008 planning rule back to the 2000 rule. In April 2012, the agency published its latest planning rule in the *Federal Register* (US Department of Agriculture 2012).

The Behan (1981) prophecy predicting that national forest planning and management would become a legal battleground largely materialized over time (Malmsheimer et al. 2004). Litigation or the threat of litigation continues to be a dominant theme of national forest planning outcomes. For example, every one of the 96 national forest plans completed through 1996 had been administratively appealed (Kaiser 2006), the first step toward a lawsuit. However, the Behan (1981) alternative of

Received October 4, 2012; accepted January 30, 2013; published online February 21, 2013.

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Acknowledgments: *The authors acknowledge the Institute of Social and Economic Research at the University of Alaska Anchorage for providing funding to support the data collection for this project and thank Dr. Pat Reed for his insightful and constructive comments in the preparation of this article.*

relying "on the willingness of Forest Service to listen to opinions from the public, where local land managers should resolve conflicts locally, through bargaining, compromise, and negotiation" (p. 802) also appears problematic. The agency may lack the tools and organizational capacity to work in these "wicked" and "messy" planning contexts that are characterized by multiple and competing goals, little scientific agreement on cause-effect relationships, limited time and resources, lack of information, and structural inequities in access to information and political power (Lachapelle et al. 2003). The difficult external forest planning environment confronting the Forest Service is further compounded by internal organizational challenges of low employee morale resulting from a reduction in workforce, an exodus of employee technical expertise, declining resource budgets, reorganization initiatives, and the ascendancy of fire management (Brown et al. 2010). Further, the capacity of the agency to learn and adapt as an organization is significantly less in the division of the agency responsible for national forest planning (Brown and Squirrell 2010).

With these formidable external and internal barriers to effective national forest planning, is there a path forward for the agency? The existing public participation process for forest planning required under NEPA that accompanies the development of forest plans has been insufficient to mediate the conflict over diverse preferences for the national forest system. Observers of the national forest planning process have suggested a goal wherein knowledge from technical experts (the agency) can inform the citizen participants, whereas knowledge from citizen participants informs the technical experts (Steelman 2001). However, it is arguable how truly bidirectional the flow of national forest planning information has been, with expert knowledge appearing to dominate national forest participatory processes.

## Public Participation (PPGIS) for Forest Planning

In response to the perceived imbalance between technical and citizen participation in forest planning, researchers have evaluated the potential for PPGIS to assist national forest planning (Clement-Potter 2006, Brown and Reed 2009). PPGIS is a field of GIS that seeks to enhance public participation and empower nongovernment organizations, grassroots groups, and local communities (for a review of PPGIS applications, see Sieber 2006). Although the formal definition of PPGIS remains "nebulous" and inconsistent across applications (Tulloch 2007), PPGIS generally describes the practice of having nonexperts or the lay public identify spatial information to augment expert information. PPGIS methods have been pilot-tested by academic researchers on national forests in Alaska, Arizona, Oregon, California, and Colorado, as well as Canadian forestlands (Beverly et al. 2008).

The historical focus of PPGIS for national forest planning has centered on the mapping of landscape values that identify the spatial location of important public values on national forestlands. Landscape values are an operationalized form of place value used for natural resource and environmental planning (Brown 2005), which evolved from a typology of forest values developed by Rolston and Coufal (1991). These place-based values can be used in a decision support system called values compatibility analysis (VCA) that evaluates the compatibility of different forest management activities with the values identified by the public (Reed and Brown 2003, Brown and Reed 2012a). In VCA analysis, the compatibility of a particular national forest use, such as motorized recreation with place-based values such as aesthetic, biological, or spiritual values, is determined by an analyst or the Forest Service interdisciplinary planning team (IDT) responsible for the forest planning process.

The most critical step in VCA is the determination of which particular national forest uses or activities are compatible with particular forest values recognized by the public. This often involves subjective judgments by the IDT. For example, for some individuals, motorized recreation may be consistent with aesthetic value because it permits them to get to scenic areas. For others, the opposite conclusion may be reached because the use of motorized vehicles may be perceived as reducing forest aesthetics. Still, others might not see any relationship between this forest use and value. Consequently, the IDT must assess multiple value/use relationships for compatibility, which can lead to spirited differences within the IDT (often mirroring the same public debate). These judgments must ultimately be defended by the agency when forest plan *prescriptions* are identified and mapped in national forest plans. Prescriptions provide direction on the forest uses allowed, not allowed, or allowed subject to specific conditions. In the case of the Chugach National Forest Plan (2002), each prescription has a theme (major purpose), a management intent (desired future conditions), activities table (allowable/nonallowable activities within the prescription), and standards and guidelines (specific management direction for activities that are conditionally allowed in the prescription). A map of forest prescriptions was published with the final 2002 Chugach National Forest Plan (USDA Forest Service 2012b).

The collection and use of landscape value attributes in PPGIS provides the IDT with information to assist in the determination of forest value/use compatibilities and the forest areas to be assigned to various forest management prescriptions. However, forest value/use relationships can be ambiguous, resulting in IDT uncertainty and lack

### Management and Policy Implications

In 2012, the USDA Forest Service revised its national forest planning rule. The new rule encourages but does not require the agency to be proactive and use contemporary tools such as the Internet to engage the public in forest planning. We evaluated the use of public participation geographic information systems (PPGIS) to assist forest planning under the new rule. Although not a panacea for future national forest litigation, PPGIS engages the silent majority of national forest stakeholders, locates place-specific public *values* and forest use *preferences* to inform forest management direction, and identifies areas in which conflict over multiple uses is likely to be most intense. Mapping potential forest conflict using PPGIS has practical implications for national forest planning: agency resources can be directed toward areas where they are most needed; the agency can show the location, nature, and intensity of potential conflict to seek place-specific solutions from the public and stakeholders; and special management areas may be designated in forest plans to manage the conflict. To achieve these benefits, the Forest Service will need a constructive, precedent-setting ruling from the Office of Management and Budget, which reviews and approves information collection requests such as PPGIS under the Paperwork Reduction Act.

of confidence in the conclusions and plan implications. Because PPGIS systems are flexible in their design and implementation, it is possible to collect spatial attributes from the public that directly identify the spatial locations of preferred (and nonpreferred) forest uses within a national forest. Identifying the spatial locations of acceptable (and unacceptable) forest uses provides a direct measure of forest plan compatibility with public preferences. The purpose of this article is two-fold: demonstrate how public forest values and use preferences collected with PPGIS methods can augment national forest planning using the Chugach National Forest (CNF) as a case study; and discuss the content of the 2012 USDA Forest Service planning rule relative to its support for new participatory forest planning methods such as PPGIS.

## Case Study: The Chugach National Forest Plan (Alaska)

Under the NFMA, the Forest Service is required to revise individual national forest plans every 10–15 years. The agency began to revise its 1984 CNF plan in 1997. As part of the public participation process accompanying plan revision, the CNF was the first to experiment with PPGIS. In 1998, academic researchers collaborated with CNF staff to implement a PPGIS process wherein randomly sampled households in 12 communities proximate to the CNF, as well as a statewide sample of Alaska residents, identified the location of CNF forest values. The 1998 study design was a self-administered survey for which individuals placed mnemonically coded sticker dots on a color map of the CNF provided in a mail packet with a cover letter. The study resulted in the identification of more than 16,839 landscape value points for analysis (for details of the 1998 PPGIS study, see Brown and Reed 2000, Crone et al. 2002, Reed and Brown 2003). The PPGIS data were available to the IDT for the development of the revised forest plan but had little direct influence on decisions allocating areas to management prescriptions in the final plan. The use of PPGIS data for forest planning was perceived as too novel to be trusted by the IDT for place-based decisions. The Forest Service released an environmental impact statement and draft CNF plan in September 2000. After an extended public comment period, the agency released its final environmental impact statement, record of decision, and final CNF forest plan in 2002.

After a decade, the CNF will begin revising its national forest plan again as required by the NFMA. The CNF was identified as one of eight national forests that will be the first to revise their forest plans using the new national forest planning rule (USDA Forest Service 2012c). The proposed planning rule (USDA Forest Service 2012d) does not specifically indicate that PPGIS methods be used in public involvement and collaboration but does encourage the agency to be "proactive and use contemporary tools, such as the Internet, to engage the public…." (§219.4), while continuing to require that the agency identify the presence and consider the importance of various physical, biological, social, cultural, and historic resources on the plan area (§219.7) in the plan revision. The announcement that the CNF would be one of the first to revise its forest plan under the new planning rule provided an opportunity for academic researchers to apply PPGIS methods for two broad purposes: to identify how landscape values have changed since the last PPGIS study in 1998 and to provide more current spatial data for the forthcoming CNF plan revision. The results of longitudinal changes in CNF forest values are reported elsewhere (Brown and Donovan 2013).

This article presents an analysis of the 2012 PPGIS data that included national forest use *preferences* for the first time, in addition to forest values. The CNF plan (2002) prescriptions are used as a baseline to identify how PPGIS can provide spatial decision support to the IDT. Specifically, we sought answers to the following three research questions: How are acceptable/unacceptable forest uses spatially distributed within the Chugach National Forest Plan (2002) prescriptions and is the distribution consistent with the management intent of these prescriptions? Can public mapping of forest use preferences in PPGIS help identify potential forest planning conflicts? How can the mapping of acceptable/unacceptable forest uses contribute to more effective forest planning under the new forest planning rule?

## Methods

### Study Location

The CNF is located in southcentral Alaska and covers approximately 5.4 million acres (23,000 $km^2$), making it the second largest national forest in the United States. The forest covers the mountains surrounding Prince William Sound and includes the eastern Kenai Peninsula and the Copper River Delta. Approximately one-third of the area of the forest is rock and ice with strips of temperate rainforest occupying the zones between the ocean and alpine regions. The largest population centers proximate to CNF include Valdez (population 3,976) and Cordova (population 2,239) in the east and the Kenai Peninsula communities of Soldotna (population 4,163) and Seward (population 2,693) in the west. Other small communities (populations less than 1,000) proximate to CNF include Cooper Landing, Hope, Moose Pass, Whittier, and the Alaska native villages of Tatitlek and Chenega Bay. The largest city in Alaska, Anchorage (population 291,826), is approximately 80 km from the national forest. Although the CNF is largely wild, with only 90 miles (140 km) of Forest Service roads, none of it is currently designated as legal wilderness (although a significant portion is designated as Wilderness Study Area and is managed so as to protect its wild character for potential formal designation in the future as legal wilderness).

### Data Collection Process

To conduct the 2012 PPGIS study, we sampled two groups of participants. The first group was individuals who participated in the 1998 PPGIS study. By consulting Internet address databases, we were able to identify $n = 512$ individuals still living in Alaska who participated in the 1998 study. This group was the longitudinal panel of our study. The second group of participants were randomly selected individuals living in communities proximate to the CNF. The names and addresses were provided by a commercial vendor based on zip codes matching desired communities. In the 1998 study, we had randomly sampled individuals from 12 communities in close proximity to the CNF (Anchorage, Cooper Landing, Cordova, Girdwood, Hope, Kenai, Moose Pass, Seward, Soldotna, Sterling, Valdez, and Whittier). In 2012, we sampled the same communities from the 1998 study and invited $n = 2{,}335$ individuals to participate. This sampling group represented the 2012 cross-section group.

We mailed letters of invitation to both the panel and cross-section groups inviting them to the PPGIS study website.[1] Each letter of invitation contained a unique access code to be entered by the

**Table 1. Operational definitions for acceptable/unacceptable uses in the 2012 Chugach National Forest PPGIS study.**

| Acceptable use | Operational definition | Nonacceptable use | Operational definition |
|---|---|---|---|
| Timber harvest | This area is acceptable for timber harvest. | No timber harvest | This area is NOT acceptable for timber harvest. |
| Forest gathering | This area is acceptable for gathering forest products such as berry picking, mushroom hunting, and firewood gathering. | No forest gathering | This area is NOT acceptable for gathering forest products such as berry picking, mushroom hunting, and firewood gathering. |
| Mining | This area is acceptable for commercial mining activity. | No mining | This area is NOT acceptable for commercial mining activity. |
| Marine facilities | This area is acceptable for building boat ramps, docks, and other marine support facilities. | No marine facilities | This area is NOT acceptable for building boat ramps, docks, and other marine support facilities. |
| Subsistence hunting/fishing | This area is acceptable for subsistence hunting or fishing use. | No subsistence hunting/fishing | This area is NOT acceptable for subsistence hunting or fishing use. |
| Roads | This area is acceptable for building new roads. | No roads | This area is NOT acceptable for building new roads. |
| Motorized recreation | This area is acceptable for motorized recreational use (e.g., snowmachines, all-terrain vehicles, and motorboats). | No motorized recreation | This area is NOT acceptable for motorized recreational use (e.g., snowmachines, all-terrain vehicles, and motorboats). |
| Recreation facilities | This area is acceptable for developed recreation facilities (e.g., campgrounds, cabins, toilets, parking areas, trails, trailheads, and whistle-stop sites). | No recreation facilities | This area is NOT acceptable for developed recreation facilities (e.g., campgrounds, cabins, toilets, parking areas, trails, trailheads, and whistle-stop sites). |
| Commercial tourism | This area is acceptable for commercial tourism activity (e.g., helicopter skiing and dog sledding) or development (e.g., tourism lodges). | No commercial tourism | This area is NOT acceptable for commercial tourism activity (e.g., helicopter skiing and dog sledding) or development (e.g., tourism lodges). |
| Wilderness/wild and scenic river | This area is acceptable for designation as Wilderness or a Wild and Scenic River. | No wilderness/wild and scenic river | This area is NOT acceptable for designation as Wilderness or a Wild and Scenic River. |
| Vegetation management | This area is acceptable for vegetation management to reduce risk from fire or wind through fuels treatment (e.g., tree thinning and controlled burns). | No vegetation management | This area is NOT acceptable for vegetation management to reduce risk from fire or wind through fuels treatment (e.g., tree thinning and controlled burns). |
| Energy development | This area is acceptable for energy development either fossil or nonfossil fuel-based. | No energy development | This area is NOT acceptable for energy development either fossil or nonfossil fuel-based. |
| Other development | Please indicate what use or development would be acceptable here. | No development any type | This area is NOT acceptable for ANY new development. |

participant on the website that allowed us to track responses as well as minimize the potential of any single respondent from making multiple responses. The study website consisted of an opening screen for the participant to enter his or her access code, followed by an informed consent screen for participation, and then a Google maps interface that allowed the participant to drag and drop different digital markers representing 13 landscape values, 13 *acceptable* forest uses, and 13 parallel *unacceptable* forest uses onto a digital map of the CNF. The choice of forest uses to include in the PPGIS application was made in consultation with CNF staff and consisted of the most common and controversial potential uses of the CNF.

The instructions requested the participant to "use the map markers on the left to identify the places you value and your forest use preferences. Place as many (or few) markers on the map as you like…." The different types of markers placed and their spatial locations were recorded for each participant on the Web server in a database, along with other information including a timestamp of when the marker was placed, the Google map view at time of placement, and the Google map zoom level (scale) at which the marker was placed. Participants could place as few or as many markers as they deemed necessary to express their forest value and use preferences. The forest use markers and definitions, the primary focus of this study, appear in Table 1.

After completion of the mapping activity (placing markers), participants were directed to a new screen and provided with a set of text-based survey questions to assess nonspatial forest management preferences and to measure respondent sociodemographic characteristics. Study participants had the option to return to the PPGIS website later to use their access code to add new markers or adjust previously placed markers. To increase participation, two additional mail reminders were sent to nonrespondents after the initial mail invitation.

## Analyses

***Respondent Characteristics.*** For this study, we combined the panel and cross-section responses to provide the largest data set for analysis. There were no significant differences in the responses of the two groups that would materially affect the aggregated results (Brown and Donovan 2013). We provide descriptive characteristics of the respondents below on the variables of age, gender, level of formal education, and number of visits to the CNF. The 2012 study also included 18 variables that measured nonspatial attitudes toward various forest management uses such as "commercial logging" and "motorized recreation." These items were measured on a 5-point Likert scale ranging from "strongly favor" to "strongly oppose." We report these nonspatial use preferences to triangulate the spatial preference results.

***Distribution of Acceptable/Unacceptable Forest Uses by Management Prescription.*** A total of 9,324 locations were mapped inside in the CNF administrative boundary by study participants, of which 3,501 loca-

tions were acceptable/unacceptable forest use markers. We intersected the marker locations with 2002 forest management prescription boundaries to generate counts and proportions of preferred uses by prescription. The most frequent preference (either acceptable or unacceptable) was then assessed against the 2002 plan prescriptions to determine whether current public preferences were consistent with the forest plan prescriptions.

***Social Landscape Metrics by Prescription.*** We calculated several *boundary* social landscape metrics for prescriptions described by Brown and Reed (2012b) including the dominant value metric (D), the value diversity index (D3), and a conflict potential index (C).

Boundary metrics are calculated by quantifying the distribution of mapped PPGIS attributes that fall within bounded, spatial areas of interest such as watersheds, administrative areas, recreation sites, or, in this case, prescription areas. The dominant value metric is the spatial attribute with the largest point count (most frequent) within a prescription area whereas the diversity index metric is the Shannon diversity index commonly used in ecological studies. The Shannon diversity index accounts for both the abundance and evenness of different types of points mapped within the prescription area. As calculated, Shannon index values typically fall within the range of 1.5–3.5 with higher index values indicating greater diversity of spatial attributes. To assist interpretation, the diversity index value was normalized to a scale ranging between 0 and 1 for which higher index values indicate greater diversity. The conflict potential index was calculated by summing the ratios of acceptable/unacceptable use pairs (e.g., acceptable timber harvest and unacceptable timber harvest) within each prescription area and multiplying this sum by the number of landscape values in the area. Numerically, the index increases with greater public disagreement over potential forest uses within a prescription; this quantitative disagreement is weighted and amplified by the intensity or number of values the public identified in the prescription. Larger index numbers represent greater potential conflict within the prescription. A map was generated to display potential conflict by prescription.

For the CNF, some prescriptions cover large areas of the National Forest where there were few mapped PPGIS data. Imputing preferred uses and conflict potential by prescription area can be misleading at this scale. We adjusted the spatial analysis by displaying the potential for conflict in areas in which spatial attributes were actually mapped by PPGIS participants. We did this by overlaying a 2-km grid over the CNF and then calculating the difference between acceptable/unacceptable uses within each grid cell. We normalized these differences on a scale ranging from +3 (most acceptable uses) to −3 (most unacceptable uses). This type of analysis reveals areas of public consensus or disagreement that may be masked by whole prescription area analysis. We generated individual maps for nine forest uses, displaying areas of acceptable or unacceptable forest uses at the larger 2K resolution that may be more useful for future management prescriptions.

**Table 2. Mean attitudinal responses to forest management preference survey items ranked from most to least favorable.**

| Survey item | 1998 ($n$ = 834) | 2012 ($n$ = 244) | Public position |
|---|---|---|---|
| Fish and wildlife habitat | 1.44 | 1.43 | Favorable |
| Camping and picnicking | 1.62 | 1.55 | Favorable |
| Wildlife viewing/observing | 1.69 | 1.57 | Favorable |
| Nonmotorized recreation | 1.69 | 1.60 | Favorable |
| Gathering forest products | 1.74 | 1.68 | Favorable |
| Providing fresh water | 1.81 | 1.72 | Favorable |
| Sport fishing | 1.88 | 1.90 | Favorable |
| Sightseeing | 1.93 | 1.79 | Favorable |
| Wilderness areas | 2.10 | 1.84 | Favorable |
| Sport hunting | 2.15 | 2.29 | Favorable |
| Subsistence hunting/fishing | 2.16 | 2.14 | Favorable |
| Helicopter skiing/hiking | 2.78 | 2.62 | Favorable |
| Communication sites and utility easements | 2.82 | 2.66 | Favorable |
| Commercial outfitting/guiding | 2.84 | 2.70 | Favorable |
| Motorized recreation | 2.84 | 2.79 | Favorable |
| Commercial logging | 3.26 | 3.54 | Opposition |
| Oil/gas drilling | 3.40 | 3.62 | Opposition |
| Commercial mining | 3.46 | 3.78 | Opposition |

Scale: 1, strongly favor; 2, favor; 3, neither favor or oppose; 4, oppose; 5, strongly oppose.

## Results

### Response Rate and Respondent Characteristics

Of the 2,335 letters of invitation mailed to the cross-section sample, there were 215 full or partial responses. A full response is an individual who maps one or more point locations and completes the survey questions at the end; a partial response is an individual who maps one or more locations but does not answer the survey questions after the mapping activity. After accounting for known nondeliverable letters, the 2012 Internet-based PPGIS cross-sectional response rate was 10.1%. For the panel group, of the 512 invitations mailed, there were 80 responses, yielding a response rate of 19.1% after accounting for known nondeliverable letters. The combined response rate for the cross-section and panel groups was 11.6%. This response rate is less than desirable by survey research standards but is empirically consistent with other Internet-based PPGIS methods involving general public random samples that averaged 13% across five studies (Pocewicz et al. 2012).

The 2012 respondents had an average age of 48.1 years and were 58% male; 67% had a bachelor's degree or higher. Participants were very familiar with the CNF with 84% reporting more than five visits to the national forest. In a question that asked participants' self-assessed knowledge of places in the Chugach National Forest, almost 60% rated their knowledge as "good" or "excellent." Only 2% of participants rated their knowledge of CNF places as "poor." About 32% of PPGIS participants were from Anchorage with the remainder from rural communities proximate to the CNF.

### Nonspatial Attitudes Toward Potential National Forest Uses

The mean responses to 18 replicated survey items measuring attitudes toward potential CNF use are presented in Table 2. Respondents oppose resource development activities in the CNF including timber, mining, and energy but favor a variety of uses, especially sightseeing, wildlife viewing, gathering forest products, and

**Table 3. Consistency of public values and use preferences (2012) with Chugach National Forest Plan (2002) prescriptions.**

| Prescription name | Theme | Results from PPGIS | | |
|---|---|---|---|---|
| | | Dominant value(s) | Dominant acceptable use | Dominant unacceptable use |
| ANILCA 501(b)-1 | Emphasize the conservation of fish and wildlife and their habitats and provide a variety of recreational opportunities for backcountry activities. The areas with this prescription will be managed to retain their wild and natural character. | Economic[1] | Subsistence | No roads |
| ANILCA 501(b)-2 | Emphasize the conservation of fish and wildlife and their habitats, while providing opportunities for backcountry recreational activities in a natural appearing landscape. | Recreation | Motorized | **No mining**[2] |
| Backcountry | Emphasize a variety of recreational opportunities for backcountry activities in natural appearing landscapes. This management area prescription was developed to address the "nonmotorized access" and "recreation opportunities" interests. | Recreation | Motorized | No timber |
| Brown Bear Core Area | Manage selected landscapes and their associated habitats to meet population objectives for brown bears and to reduce dangerous encounters between humans and brown bears. | Recreation | Motorized | No commercial tourism<br>No development<br>No timber |
| Research Natural Area | Emphasize nonmanipulative research, monitoring, education, and the maintenance of natural diversity, allowing natural, physical, and biological processes to prevail without human intervention. | Biological | Insufficient data | Insufficient data |
| EVOS fee | Maintain the land in perpetuity for the maintenance of conservation values while restoring or enhancing injured resources from the Exxon Valdez oil spill. | Recreation | Subsistence | No timber |
| Fish & Wildlife Conservation Area | Emphasize the conservation of specific fish and wildlife habitats. | Recreation | Subsistence | No timber |
| Fish, Wildlife & Recreation | Manage to provide a variety of habitats for fish and wildlife species and year-round recreational opportunities in both developed and dispersed settings. | Recreation | Motorized | **No mining**[3] |
| Forest Restoration | Manage for multiple-use with an emphasis on managing and/or restoring plant communities. | Recreation | Forest gathering | **No mining**[3] |
| Primitive | Emphasize natural ecological processes while providing primitive recreational opportunities in natural, unmodified landscapes. | Recreation | Insufficient data | Insufficient data |
| Recreation River | Managed to maintain, enhance, and protect the free-flowing character and outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural, or other similar values for the benefit and enjoyment of present and future generations. | Aesthetic<br>Recreation | Insufficient data | No energy<br>**No mining** |
| Scenic River | Maintain, enhance, and protect the free-flowing character and outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural, or other similar values for the benefit and enjoyment of present and future generations. | Recreation | Motorized | No timber |
| Wild River | Maintain, enhance, and protect the free-flowing character and outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural, or other similar river-related values for the benefit and enjoyment of present and future generations. | Recreation | Forest gathering | No development |
| Wilderness Study Area | Maintain presently existing wilderness character and potential for inclusion into the National Wilderness Preservation System. | Recreation | Recreation facilities[4] | No timber |

Regular font indicates consistency with theme and allowed uses; bold font indicates potential inconsistency.
[1] Many economic uses are allowed (e.g., minerals, fisheries, and tourism) but commercial timber harvest is not allowed.
[2] Mining activities are conditionally allowed.
[3] Mining activities are allowed.
[4] Recreational cabins are conditionally allowed, but developed recreation sites such as campgrounds, day-use facilities, and viewing sites are not allowed.

nonmotorized recreation. Items with a mean value close to the scale midpoint of 3.0 such as commercial outfitting/guiding (2.70) and motorized recreation (2.79) indicate greater public ambivalence about the prospective forest use.

## Distribution of Acceptable/Unacceptable Forest Uses by Management Prescription Area

We generated counts and proportions of acceptable/unacceptable uses by area prescription in the 2002 CNF plan. Energy development and mining uses were perceived as unacceptable on the CNF in all management prescriptions. Energy development was not directly addressed in the forest plan as a separate activity, but the public unacceptability of mining contradicts four 2002 CNF forest plan prescriptions that nominally allow commercial mining in the following areas: Fish, Wildlife & Recreation, Forest Restoration, Recreation River, and Alaska National Interest Lands Conservation Act of 1980 (ANILCA)[2] 501(b)-2 (see Table 3 for prescription themes).

Commercial timber management was perceived as unacceptable in all CNF prescriptions except for the Forest Restoration prescription, for which acceptable timber management use markers exceeded unacceptable use. This result is interesting as Forest Restoration occupies a relatively small area of the CNF but suggests participant awareness of forest vegetative conditions that would support active timber management. Most of the CNF, by area, does not contain sufficient forest resources for commercial activity.

**Table 4. Forest values and boundary metrics by management prescription.**

| Prescription name | Value count[1] | Dominant value (D) | Value diversity (D3)[2] | Acceptable use counts | Dominant acceptable use (D) | Acceptable use diversity (D3) | Unacceptable use counts | Dominant unacceptable use (D) | Unacceptable use diversity (D3) | Conflict potential index (C)[3] |
|---|---|---|---|---|---|---|---|---|---|---|
| ANILCA 501(b)-1 | 33 | Economic | 0.86 | 28 | Subsistence | 0.73 | 25 | No roads | 0.62 | 19 |
| ANILCA 501(b)-2 | 269 | Recreation | 0.88 | 71 | Motorized | 0.79 | 14 | No mining | 0.78 | 719 |
| Backcountry | 1,159 | Recreation | 0.75 | 596 | Motorized | 0.92 | 378 | No timber | 0.82 | 5676 |
| Brown Bear Core Area | 157 | Recreation | 0.71 | 78 | Motorized | 0.74 | 61 | No commercial tourism<br>No development<br>No timber | 0.82 | 236 |
| Research Natural Area | 5 | Biological | 0.54 | 4 | Multiple | 0.56 | 2 | Multiple | 0.28 | 5 |
| EVOS fee | 87 | Recreation | 0.78 | 43 | Subsistence | 0.76 | 42 | No timber | 0.74 | 328 |
| Fish & Wildlife Conservation Area | 192 | Recreation | 0.77 | 94 | Subsistence | 0.84 | 79 | No timber | 0.80 | 710 |
| Fish, Wildlife & Recreation | 1,013 | Recreation | 0.79 | 450 | Motorized | 0.95 | 173 | No mining | 0.84 | 4458 |
| Forest Restoration | 248 | Recreation | 0.78 | 112 | Gathering | 0.85 | 41 | No mining | 0.64 | 590 |
| Primitive | 4 | Recreation | 0.42 | 3 | Multiple | 0.44 | 4 | Multiple | 0.56 | 4 |
| Recreation River | 22 | Aesthetic Recreation | 0.66 | 2 | Multiple | 0.28 | 8 | No energy<br>No mining | 0.70 | 22 |
| Scenic River | 40 | Recreation | 0.70 | 27 | Motorized | 0.79 | 7 | No timber | 0.59 | 50 |
| Wild River | 55 | Recreation | 0.83 | 24 | Gathering | 0.66 | 16 | No develop | 0.60 | 44 |
| Wilderness Study Area | 461 | Recreation | 0.87 | 154 | Recreation facilities | 0.80 | 128 | No timber | 0.78 | 1948 |

[1] The total number of "value" points placed inside the prescription.
[2] The diversity index is calculated using Shannon's diversity index normalized to a scale ranging between 0 and 1 for which higher index values indicate greater value diversity.
[3] The conflict index is calculated by summing the ratios of acceptable/unacceptable use pairs within each prescription and multiplying this result by the number of values in the zone. Larger numbers represent greater potential conflict within the prescription.

Motorized recreation is an activity that has generated management controversy on the CNF, in part, because it is associated with forest access. The expanded use of motorized recreation in the summer (all-terrain vehicles/off-highway vehicles) and winter (snowmobiles) is perceived by some individuals and groups as having a negative impact on fish and wildlife while being anathema to quiet recreation. The nonspatial, attitudinal results confirm this public polarization. The spatial results indicate that motorized recreation was more acceptable than unacceptable in seven of the nine prescription areas, the exception being the Wild River and Forest Restoration prescriptions. The results may also explain why the management of motorized access on the CNF has been historically controversial. The prescription categories of Fish, Wildlife & Recreation, Fish & Wildlife Conservation Area, and Backcountry had relatively large proportions of both acceptable and unacceptable markers, highlighting public perceptions of potential negative impact to fish and wildlife and the potential incursion on quiet recreational experiences in the backcountry. All the forest plan prescriptions allow or conditionally allow administrative and permitted motorized access with the exception of the Primitive prescription. There was insufficient marker data in this Primitive prescription to know whether public preferences were consistent with the prohibition.

## Social Landscape Metrics by Prescription

The dominant (D) landscape value in the majority of CNF prescriptions was *recreation* value, whereas *economic* value was dominant in the ANILCA 501(b)-1 prescription and *biological* value in the Research Natural Area prescription (Table 4). The two ANILCA prescriptions contained the greatest diversity (D3) of forest values.

The boundary metrics for forest use preferences were more variable than those for forest values. For acceptable forest uses, five prescriptions were dominated by *motorized* use, three were dominated by *subsistence* use, and *forest gathering* was dominant in two forest prescriptions. The dominant acceptable use in the Wilderness Study Area prescription was *recreation facilities*, a result that is potentially inconsistent with the stated purpose of the prescription. However, it is likely that many respondents associated recreation facilities with public recreation cabins, which are popular and acceptable uses within wilderness study areas in Alaska. The greatest diversity (D3) of acceptable uses was located in the Backcountry and Fish, Wildlife & Recreation prescriptions, whereas the least diverse was the Wild River prescription.

The boundary metrics for unacceptable forest uses indicate that *mining* and *timber management* were least acceptable in most CNF forest prescriptions. The unacceptability of *new roads* in the ANILCA 501(b)-1 prescription is an interesting outcome because the dominant value for this prescription was economic value. Economic activities are often associated with road-building to achieve access, but, in this case, the results suggest that economic development not requiring the addition of new roads would be a preferred outcome for this prescription.

Arguably, the most important boundary metric is the conflict potential metric. This metric is an index calculated by summing the ratios of acceptable and unacceptable use pairs within each prescription and then multiplying this sum by the number of landscape values in the area. This index mathematically increases when there is greater public ambivalence over the acceptability of various forest uses and when there is greater perceived value for the area. According to the calculated index values, the greatest potential for controversy over future forest management exists in the Backcountry, Fish, Wildlife & Recreation, and Wilderness Study Area prescriptions; the study

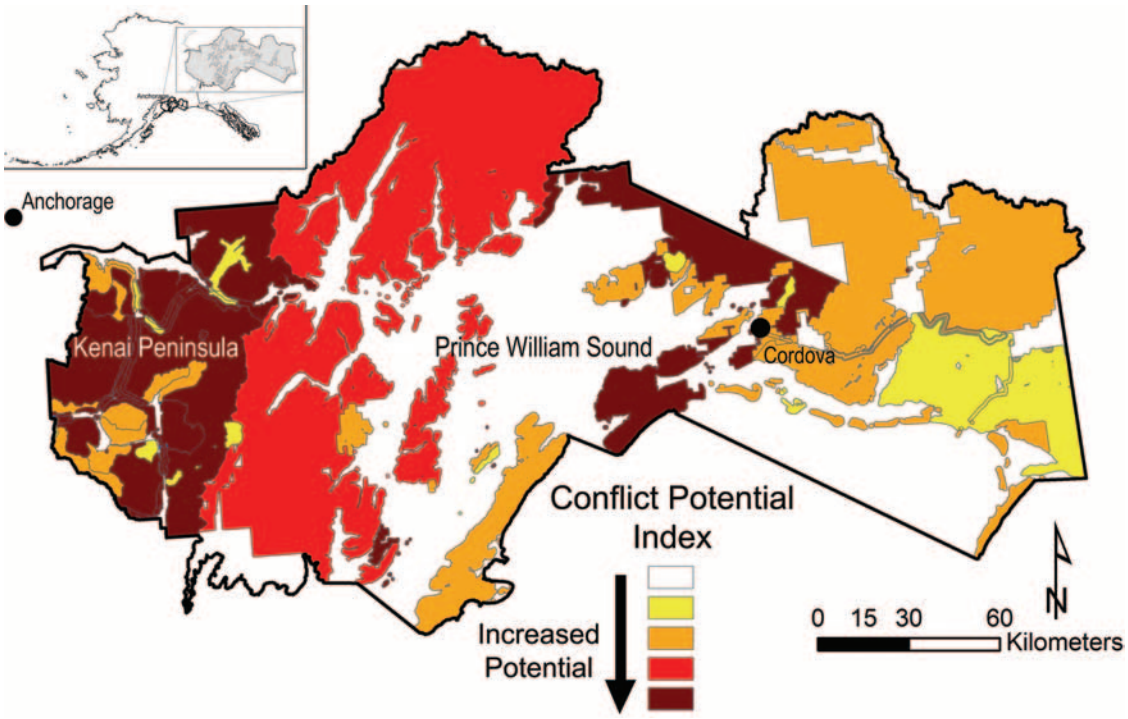


**Figure 1. Map of conflict potential indices for Chugach National Forest Plan (2002) prescriptions. Conflict potential is a combination of public forest use preferences weighted by the intensity of public values within the prescriptions. The index was calculated by summing the acceptable/unacceptable use ratios within each prescription area and multiplying by the number of values mapped in the area.**

participants expressed greater net ambivalence over use of these areas. Prescriptions that appear least controversial based on at least 30 observations include the Wild River, Scenic River, and ANILCA 501(b)-1 prescriptions.

The conflict potential for the CNF is displayed visually in Figure 1 for each forest management prescription. Geographically, the greatest potential conflict exists on the Kenai Peninsula (western reach of the CNF) and in eastern Prince William Sound near the community of Cordova. The examination of potential conflict by prescription, however, can mask important areas of consensus or disagreement for specific forest uses in specific locations. Figure 2 displays maps for nine forest uses that indicate areas of acceptable or unacceptable use by 2K grid cells that may be more useful for future forest plan allocations. Although commercial timber management is generally not acceptable forestwide, there are corridors on the Kenai Peninsula where this use may not conflict with place-specific public preferences. Motorized recreation appears as a mosaic of apparent low and high conflict areas, suggesting the need for even larger scale (more place-specific) planning analysis of acceptable areas for motorized use. The potential for conflict in commercial tourism activity is quite high in the central Kenai Peninsula (western reach of the CNF) and may reflect competition over national forest use between Alaska "locals" and commercial tourism operators that are perceived to represent non-Alaskans.

The list of prospective forest uses across the CNF with relatively low potential for conflict include forest gathering, vegetation management, recreation facilities, and the designation of Wild River or Scenic River and Wilderness Study Area. The low conflict potential with vegetation management but opposition to commercial timber management is consistent with public survey results from national forests in Colorado and Wyoming (Clement and Cheng 2011). Subsistence use of the CNF also appears to have relatively low conflict potential with two noteworthy exceptions: areas of the forest located nearest the city of Anchorage in the west and the area near the community of Cordova in the east. These spatial results reflect the historical conflict over subsistence resources between urban Alaskans seeking sporting opportunities and rural communities and Alaska Native populations that receive subsistence preference for fish and wildlife under federal laws. These areas of the CNF are mixing zones between urban and rural resident lifestyles and forest use.

## Discussion

The results from participatory mapping of CNF values and preferences in 2012 indicate general consistency between public spatial preferences and forest management direction identified as forest prescriptions by the IDT in the 2002 CNF plan. However, a review of administrative appeals for the 2002 CNF plan indicates discontent with the participatory process in developing the forest plan; concerns included the plan's potential impact on wildlife, soil, and air quality, recommendations for Wild River and Scenic River and Wilderness Study Area, and access and travel management involving motorized use (USDA Forest Service 2012e). Some of these citizen appeals are related to the spatial delineation of forest plan prescriptions for which PPGIS may be useful in adjusting these areas in the future. Our analysis of the 2012 PPGIS data indicates that forest prescription areas may be so large that they mask potential conflict in more place-specific forest locations.

This 2012 PPGIS study, although more limited in response than the 1998

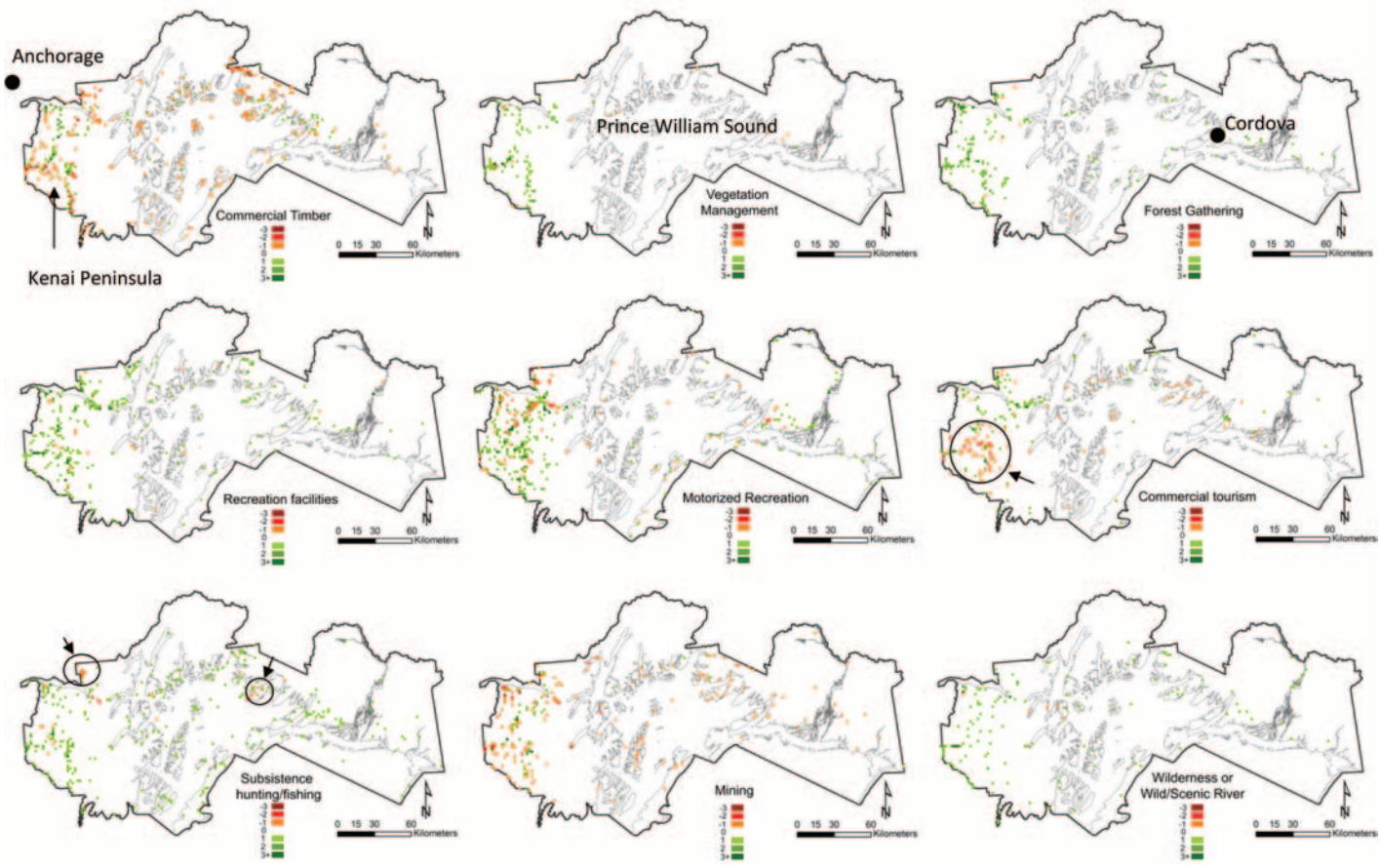


**Figure 2. Preferred public forest uses determined by net point counts within 2K grid cells. Green colors indicate acceptable uses (i.e., acceptable points exceed unacceptable points within each cell) and red colors indicate unacceptable uses (unacceptable points exceed acceptable points). The net differences in point counts are normalized and color-coded on a scale ranging from +3 (acceptable) to −3 (unacceptable).**

study, suggests the potential utility of PPGIS to assist forest planners under the new planning rule in identifying areas suitable for various forest uses. Suitability analysis, as described in the new planning rule, is intended to ensure that future forest uses are compatible with the desired condition of the land. Suitability analysis also allows consideration of social criteria wherein "suitability identifications may be made after consideration of historic uses and of issues that have arisen in the planning process" [36 CFR §219.7(e)(1)(v)]. The use of PPGIS can provide a more systematic approach to identifying the social suitability of various forest uses to augment traditional biophysical suitability analyses. PPGIS provides the opportunity to spatially overlay biophysical suitability results, obtained by experts, with social/cultural suitability data provided through a PPGIS process. Spatially explicit social/cultural suitability mapping has been historically lacking in national forest planning.

This study was necessarily limited in its sampling effort because of budgetary constraints as well as the lack of Office of Management and Budget approval, which precluded official Forest Service involvement. Therefore, the study could not follow the PPGIS protocol described by Brown and Reed (2009) for national forest planning, which provides options for nondigital mapping by participants, sampling of diverse stakeholder groups, and voluntary national participation through notice in the *Federal Register*. The purpose of this study was to replicate the 1998 Chugach study to monitor changes in forest values over time (Brown and Donovan 2013) and to perform a trial of the mapping of forest use preferences as a new component of PPGIS data collection. The exclusive Internet-based PPGIS method used in 2012 was probably the most important reason that participation rates significantly lagged behind the 1998 paper-based PPGIS response rate. Although the digital divide is closing, a gap still exists. Furthermore, PPGIS studies of the general public, as reported in the literature, have been biased toward older, male participants with more formal education, with underrepresentation of minority groups. Brown et al. (2013) provided a more detailed account of PPGIS participant characteristics, and Brown and Reed (2009) analyzed potential demographic effects on PPGIS responses. As a longitudinal monitoring study, the response reported herein was not optimal but sufficient for analysis. If PPGIS is to be used in earnest for future forest planning, the expanded PPGIS protocol described by Brown and Reed (2009) should be followed.

The use of PPGIS in a national forest plan revision process will not resolve inherent social conflict over the purposes for national forests. However, PPGIS can address an important requirement that is likely to manifest in virtually any national forest planning process: the allocation of specific areas of the national forest to broad classes of acceptable and nonacceptable uses. The identification of spatially explicit acceptable/nonacceptable uses in PPGIS should not be used as a public referendum on forest plan allocation but rather to identify areas with high potential for conflict.

What are the implications of using PPGIS in future forest planning, given the

new forest planning rule? Under the new planning rule, the term "prescription" is no longer used, but the idea of spatial allocation of forest lands for particular purposes remains intact. The Forest Service is required to include management areas or geographic areas [36 CFR §219.7(d)] and provide for the identification of new designated areas defined as "an area or feature identified and managed to maintain its unique special character or purpose" (36 CFR §219.19). The new planning rule also requires that specific lands within the forest plan be identified as suitable or not suitable for multiple uses or activities based on the desired conditions applicable to those lands, although suitability need not be identified for every use or activity [36 CFR §219.7(e)(1)(v)]. The suitability analysis of national forest lands is where PPGIS can assist the agency in determining whether particular activities or uses are consistent with desired conditions. Desired conditions explicitly allow for the "description of specific social, economic, and/or ecological characteristics of the plan area, or a portion of the plan area…" [36 CFR §219.7(e)(1)(i)].

In the new planning rule, participation is defined as "…a wide range of public involvement tools and processes, such as collaboration, public meetings, open houses, workshops, and comment periods" (36 CFR §219.19). This discretionary, ad hoc approach to public participation arguably contradicts the planning rule requirement to "…use the best available scientific information to inform the planning process…" (36 CFR §219.3). There is evidence that voluntary public participation in forest planning, in contrast with scientific public sampling, will be different and potentially biased (Brown et al. 2013). If the best available science is to be applied in forest planning, this principle should also extend to the participation process wherein scientifically representative samples of the "public" are collected to determine the extent of voluntary participation bias.

The failure of the new planning rule to advocate best practice in public participation, whether such participation includes PPGIS or not, represents the status quo and leaves the Forest Service vulnerable to challenge about the adequacy of public involvement. The vagueness of the participation standard that relies on public notice and voluntary comments will not provide the agency with defensible information about public values and preferences. The continued participation focus on nonspatial, nonrepresentative comments in the forest planning process will not help the agency escape the forest planning quagmire. The use of PPGIS methods in national forest planning would represent a step forward in collecting more useful information for forest planners. And yet, we harbor no illusions about the ability of participatory spatial planning methods such as PPGIS to fundamentally alter the historical challenges of national forest planning. In a review of reasons why PPGIS has failed to breach the walls of academia to find a place in agency planning practices, Brown (2012) cited the following agency barriers to adoption: (1) lack of specific directives or incentives for agencies to engage the public; (2) fear of the general public, which can and does express doubt about agency capacity and leadership; (3) lack of experience implementing effective public participation methods; (4) expert/lay divide in knowledge systems that manifest in the participation process; and (5) regulatory barriers such as OMB approval. For PPGIS to improve the forest planning process, the Forest Service must meaningfully encourage and involve the public in forest planning irrespective of the GIS component. Layering geospatial technology on top of a participatory process that lacks genuine agency commitment to public engagement will not alter the status quo in national forest planning. In short, the most critical element to future forest planning effectiveness is the PP, not the GIS.

## Endnotes

1. The PPGIS application interface may be viewed at www.landscapemap2.org/chugach (use access code 101-0101).
2. ANILCA is the acronym for the Alaska Native Claims Settlement Act, a law passed by Congress in 1980 that designated over 100 million acres (400,000 $km^2$) of public lands in Alaska. ANILCA 501(b)-2 refers to the clause in the Act specifying that lands in the Copper River Delta be managed for fish and wildlife conservation as the primary goal.

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