Monitoring Recreational Impacts in Wilderness of Kamchatka (Example of Kronotsky State Natural Biosphere Preserve)

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Abstract—This paper describes an assessment and monitoring program that was designed and initiated for monitoring recreational impacts in a wilderness in Kamchatka. The framework of the recreational assessment was tested through its application to a case study conducted during the summers of 2008 and 2009 in the Kronotsky State Natural Biosphere Preserve (Kamchatka peninsula, Russia). A detailed assessment of different components of natural complexes of the Preserve and the maps of their ecological conditions showed that some sites had been highly disturbed. Management implications for Caldera of Uzon volcano and other significant geothermal areas that allow any type of recreational activity were explored.

Keywords: recreational impacts, monitoring, protected areas, wilderness, Kamchatka

Introduction to a Problem

Kamchatka peninsula is comparable to the best regions in diversity and wealth of recreation resources. Protected areas (PAs), commonly considered to be wilderness, cover over 14 percent of the surface of the region (fig. 1) and provide a wide range of recreation opportunities—from bathing in hot springs and bear watching to kayaking and scientific tourism. Most of these areas have extremely fragile ecosystems (geothermal, tundra, and alpine ecosystems); therefore, current managers are faced with the problem of recreational impacts manifesting in the loss of vegetation, soil erosion, associated aesthetic degradation, etc.

Different types of protected areas in Russia, particularly in Kamchatka, have peculiarities that influence development of recreation and recreational impacts management on these territories. For instance, Zapovedniks or Preserves (strictly protected federal PAs) have the main goal to conserve natural resources and only educational and scientific ecotourism in small groups is allowed there. These PAs have scientific staff that can develop and implement recreational monitoring programs. On the other hand, regional protected areas—mainly nature parks that were developed specifically to provide different types of nature-based recreation and that receive the most recreational pressure in Kamchatka—often don't have any programs or staff for providing recreational monitoring or information for managing recreational impacts.

In the last few years, the number of tourists traveling to Kamchatka has grown significantly (fig. 2). On one hand, this emphasizes the attractiveness of the region, but on the other hand it reveals very serious problems. The rapid growth of tourism occurs under conditions of absence of effective tools and programs for recreational management at most destinations. In such situations, the development of recreation monitoring programs to provide assessment of the state of conservation resources and the severity of threats and measures of success in management responses (Buckley and others 2008) becomes very relevant to Kamchatka environmental practice.

Short Literature Review

In the Russian traditional works devoted to recreational impacts and the practice of wilderness management, a normative approach is applied for solving the problem of resource conservation when the area is used for different types of recreation. This approach focuses on the search for precise quantitative standards for carrying capacity or the level of use, e.g., the "safety" length of a route, correlated with the total land area, or the number of visitors per day (per month, season, year) that can be received on the route without damage to nature. However, studies by some authors show that there is no direct relationship between the amount of use and level of impact, especially in protected areas with established trail systems (Chizhova 2002). Although the term carrying capacity suggests that the number of users is the main concern, the carrying capacity is also a function of other use conditions, such as type of use, timing and location of encounters between visitors, and visitor behavior (Stankey and

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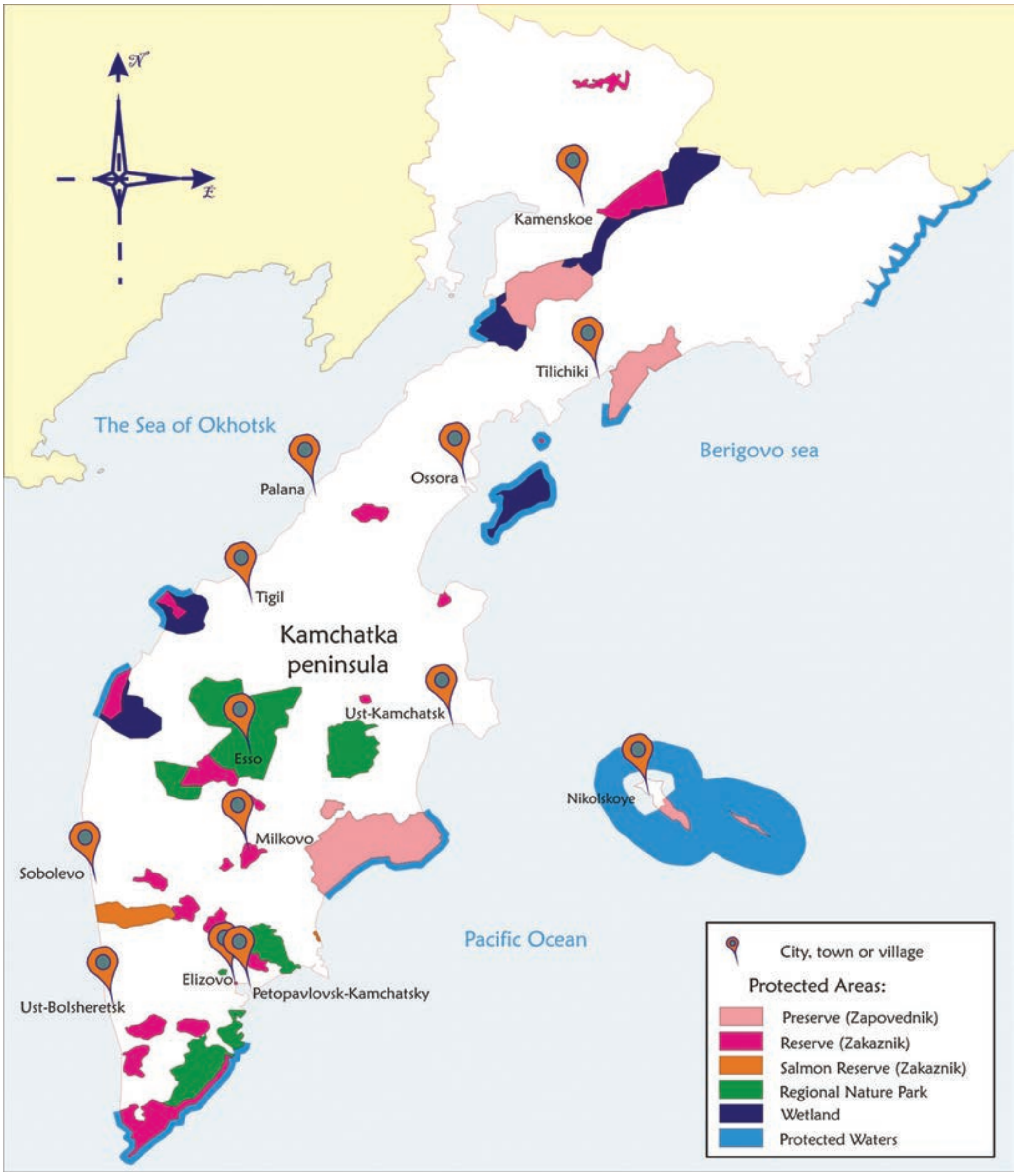

Figure 1—Protected areas of Kamchatka.

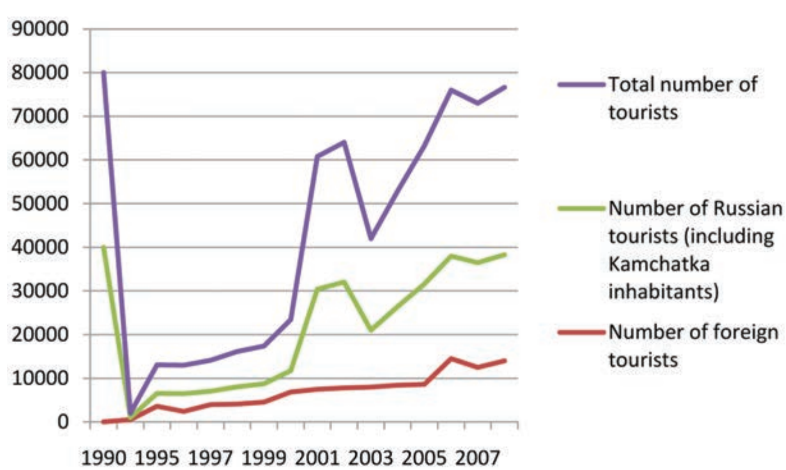

Figure 2—Annual numbers of tourists coming to Kamchatka.

Manning 1986). Therefore, it is necessary to turn to another approach that is based not on the establishment of allowable visitor numbers but on the long-term planning and analysis of a recreation opportunity spectrum, forms and types of recreation activities, and different models for development of recreation (Chizhova 2007). This approach is realized in the LAC (Limits of Acceptable Change) framework (Eagles and others 2002; Lucas 1985; Stankey 1998; Stankey and others 1984; Watson and Cole 1992), which was developed to address the issue of recreation carrying capacity and to manage recreation impacts (Cole and Stankey 1998; Stankey and McCool 1984).

The initial impact assessment and monitoring programs provide an essential element for the LAC recreation resource planning and management framework (Marion 1998). They offer managers the most objective tools for setting objectives for natural conditions and processes, and evaluating the extent of human influence and subsequent results of implemented actions (Cole 1983, 1989; Marion 1991). The capabilities and management utility of such programs are attracting increased international attention due to dramatic expansions of ecotourism worldwide (Marion 1995).

The LAC methodology and associated programs for recreation monitoring have already been applied and effectively used in some Russian natural areas (Chizhova 2007; Ivanov and Labutina 2006; Ivanov and others 2006; Kalikhman and others 1999). This paper describes our attempt to design and implement such a program for Kronotsky State Natural Biosphere Preserve. It discusses one aspect of a recreation monitoring program: the monitoring of resource conditions. The framework for recreational impact assessment and monitoring was tested through its application to a case study, conducted during the summer of 2008 in Uzon-Geyzer region of the Preserve.

The overall objective of this case study was to inventory all camping areas and trails along the route to assess the existing recreation impact and establish a network of key sites for subsequent long-term impact monitoring. This paper discusses the preliminary findings of our assessment work. Future evaluation of these sites will allow us to examine changes in campsite and trail conditions over time and attempt to relate these trends to changes in the amount, type, and distribution of visitor use.

Study Area

Kronotsky Preserve is recognized for its importance in the conservation of the Earth's natural resources. It has Biosphere Reserve status and is in the List of World Heritage sites. The Preserve is located in the eastern part of Kamchatka and is known for various types of volcanic activity: active and extinct volcanoes, geysers, and thermal sources. It contains such unique nature monuments as the Valley of Geysers, the Caldera of Uzon Volcano, the Death Valley, Burlyaschiy (Bubbling) Volcano, Lake Kronotskoye, the Semyachiksky Estuary, glaciers of the Kronotsky Peninsula, and the unique Sakhalin fir grove.

The area in our study lies in the Uzon-Geyzer region of the Preserve and is located along the former all-Union tourist route to the Valley of Geysers through Burlyaschiy Volcano and the Caldera of Uzon Volcano (fig. 3). The region is a volcanic-tectonic depression with heights from 350 m to 1000 m above sea level and has vulnerable types of vegetation coverage: swamps and areas of geothermal communities, lichen, lichen-shrub and shrub tundra, alder elfin wood, and mountain pine.

The development of unplanned and unmanaged recreation in the 1960s and the operation of the all-Union tourist route from 1962-1976 produced a heavy negative impact on different components of natural complexes along the route. The annual visitation of the route was only about 3,000 persons per year; however, given the conditions of the extremely fragile ecosystems of the region and the absence of any recreational planning and visitor management, this has become a threat to the safety of the unique natural features.

The route has been closed and nowadays the tourist activity in the Preserve is concentrated in the Valley of Geysers and in the Caldera of Uzon Volcano, in strict compliance with the requirements for preserving the natural landscape. The fulfillment of these requirements is controlled *only* in the Valley of Geysers by preserve scientists through annual ecological monitoring. Today, the other part of the Preserve, including the former all-Union route, is sometimes visited for the purposes of ecological education and scientific tourism, but the state of its resources has not been assessed or managed.

Methods

In 2007-2008, using the methodologies of different authors (Cole 1989, 1991; Cole and others 2008; Manning and others 2006; Marion 1995; Marion and others 2006), a multiparameter campsite and trail condition assessment system was developed for monitoring resource conditions of the routes in the Kronotsky State Natural Preserve. Procedures and protocols for assessing inventory and resource condition parameters were developed. The resource condition parameters (e.g., campsite size or trail width, exposed soil, etc.) documented the site conditions, while the inventory parameters (site number and name, site location (GPS coordinates), description of landscape, type of vegetation cover, soil type, relief, character of boundaries, distance from river) documented the site location or the resource attributes. The study involved detailed examination of trails and campsites along two parts of a once integrated tourist route, stretching from the famous Valley of Geysers to Burlyaschiy Volcano (fig. 3). The campsites were assessed on 12 resource condition parameters and 9 inventory parameters, and the trails on 5 resource condition parameters and 8 inventory parameters. Measurement accuracy and precision were enhanced through training and supervision of qualified field staff and the use of specially developed protocols.

Campsite Impact Assessment

Along the route, we searched for campsites, which were marked by the evidence of a campfire. Campsite boundaries were defined by pronounced changes in vegetation cover, vegetation height/disturbance, vegetation composition, or, more rarely, topography. In cases when the understory vegetation was sparse and it was difficult to establish an accurate border, the boundary was defined hypothetically.

Figure 3—Location of the study area.

For assessment of the campsite condition and measurement of the campsite areas we employed the radial transect method (Cole 1982; Marion 1991, 1995). A point was established near the center of the disturbed area of the campsite, and distances from this point to the first significant difference in vegetation were measured along 16 cardinal directions. This defined the central disturbed area. Within this area, four 1-m^2 quadrats were located along north, south, east, and west transects, halfway to the edge of the core (Cole and others 2008). These procedures were applied to all selected within campsite areas with different degrees of disturbance (defined by difference in vegetation).

Approximately 18 to 20 1-m^2 quadrats were randomly located along transects in the campsite perimeter. Within each quadrat the following parameters were estimated or counted:

- Percentage cover of vegetation, medium height of plants and the number of sick and oppressed plants of each vascular plant species;
- Number of shrubs rooted in each quadrat;
- Total number of species;
- Total percentage cover of live vascular vegetation;
- Number of ruderal species;
- Organic litter; and
- Various soil parameters (bulk density, penetration resistance, infiltration rate, and moisture).

All these parameters were also estimated for adjacent, environmentally similar but undisturbed control sites that were selected to represent conditions in the absence of the campsite influence.

Within each campsite boundary, we also counted the number of trees with scars clearly caused by humans, number of trees with roots exposed by trampling, and number of social trails that connected the campsite to the trail, other campsites, or water. The extent of the development (for example, seats and fire rings) and the cleanliness of the site were also noted. Finally, we took photos of each site to document impacts and mapped the total site area (total impacted area) and selected areas with defined differences in vegetation, mineral soil exposure, and other visible characteristics.

Trail Impact Assessment

Trail impact assessment included both the assessment of the trail condition and the assessment of components of natural complexes in the zone of trail impacts. As one of the purposes of this study was to inventory trails, we have carefully examined the entire trail condition. Each 50 m we measured the width and depth of the trail and its vegetation cover. We also identified and investigated eroded areas, as well as highly disturbed areas on or near the trail (so-called "windows of trampling" (Chizhova and Sevostianova 2007)), confined mainly to the points of sightseeing and intersections with other trails.

As in the case with assessing the campsites, when the trail lied in clinker and it was difficult to establish its accurate boundary, the width was defined hypothetically. Measurements of soil eroded sites included the following parameters: coordinates of the site, soil texture, slope length and steepness, average width and depth of the main gully, and total area of the eroded site. To assess the influence on "windows of trampling," we used the same methodology as for campsites.

For detailed assessment of different components of natural complexes in the zone of trail impacts and for the subsequent long-term monitoring of their dynamics, several permanent key sites have been established on the trail in every natural complex, using methodology by Chizhova and Sevostianova (2007). Several transects were located on both sides of the trail, running 10 m in length and perpendicular to the trail. Similar to the campsites impact assessment, distances from the middle point of the trail to the first significant difference in vegetation were measured and 1-m^2 quadrats were located along these transects in areas with different degrees of disturbance. The list of estimated parameters and characteristics was the same as that in the evaluation of the campsites impacts (see above).

Data Analysis

As a measure of the level of impact on different components of natural complexes in the zone of the trail and campsite influence we used the level of their disturbance, estimated by comparison of the results of field studies in disturbed areas with those in the control sites. The main indicators of such disturbance were the following: absolute vegetation cover loss, loss in species composition, vegetation depression, total number of sick and oppressed plants, tree damage and root exposure ratings (Monz 1998), mineral soil exposure, depletion of organic litter, number of social trails and fire rings, and changes in soil parameters. These characteristics were used for the campsite and "windows of trampling" impacts assessment, as well as for assessment of the components of natural complexes on the key sites in the zone of trail impacts. For evaluation of trail disturbance we estimated its total length, average and maximum depth, the development of soil erosion (average width and depth of main gully, total area and length of eroded site), total number and area of "windows of trampling" and total vegetation cover.

To get an overall evaluation of the intensity of impacts (level of impact) and the ecological condition of trails and campsites, we developed a rating scale of 5 points, and simultaneously introduced a 0 through 4 condition class scale: (1) light impact—site is barely discernible, but is distinguishable as a campsite or trail; (2) moderate impact—significant change (approximately 20 to 50 percent) of the natural characteristics; (3) heavy impact—high degree (50 to 80 percent) of changes; (4) severe impact—the highest possible impact and changes of the natural characteristics (>80 percent). For areas with no apparent impact we introduced the Class (0).

Results

The campsites and trails along the Valley of Geysers-Burlyaschiy Volcano route were assessed in summers 2008 and 2009. We found a large range of campsite and trail conditions with the median condition class being 1 for campsites, 3 for trails, and 1 for trail's key sites (table 1). This indicates that sites tend to be lightly to highly impacted.

We have assessed 6 separate camping areas in two parts of the route (table 1). Campsites were found mainly in lichen and lichen-shrub tundra. The impacted area of campsites ranged from 181 to 526 m^2 with the median campsite size being 297 m^2, comprised mostly of moderately and lightly impacted areas.

Inventories and condition class assessments were completed for 42 km of trails. While 18.3 km (43.6 percent of the total) were classified as having no impacts or being in a lightly impacted condition and barely distinguishable (Class 0 or 1), 17.8 km (42.4 percent) were assessed as being heavily or severely impacted with highly eroded treads (Class 3 and 4) (figs. 4a and b). We developed 7 key sites for assessment of components of natural complexes in the zone of the trail impacts. The detailed assessment of key areas revealed a surprisingly restricted spread of trail impacts on adjacent areas. In the major number of key sites the impact zone was only 1.5 m wide with mostly lightly impacted areas (1st Class condition). At the same time, the study of "windows of trampling" at the most popular and interesting sights on the route showed perilous results. Over 40 percent of the area of the key site near the mud hole "Sculptor" in the Uzon Caldera was identified as heavily and severely disturbed (fig. 5). The detailed assessment of different components of natural complexes of the Kronotsky State Natural Preserve along the researched route allowed us to compose field maps of the ecological conditions, where we separated areas with different levels of recreational impacts (fig. 6).

Discussion and Conclusions

Discussion

The primary objective of this study was to assess the level of impact on a system of trails and campsites along the Valley of Geysers–Burlyaschiy Volcano route. There was no significant recreational activity on most of the route for more than 30 years, but in spite of this, the general conclusion of our research is that the examined system of trails and campsites in the Kronotsky Preserve is moderately to heavily disturbed. We have revealed some long stretches of highly eroded trails and identified numerous severely disturbed "hot spots." We also identified a significant number of areas at the most popular sights along the route as heavily to severely disturbed.

Table 1—Summary of the campsite and trail impacts in two parts of the route the Valley of Geysers–Burlyaschiy Volcano.

Impact characteristic		Part of the route	
		Valley of Geysers–Caldera Uson	Caldera Uson–Burlyaschiy Volcano
Campsites	Number of sites inventoried	2	4
	Total area of all sites, m^2	363.05	1418.03
	Condition Class	1	1
	Percentage of 4th class areas	1.2 (0.4–2.0)	4.75 (0.0–18.0)
	Percentage of 3rd class areas	9.4 (1.0–17.8)	13.75 (5.0–24.0)
	Percentage of 2nd class areas	22.5 (13.0–32.0)	23.75 (8.0–33.0)
	Percentage of 1st class areas	62.0 (49.8–75.0)	57.25 (53.0–68.0)
Trails	Total length of the trail, km	16	27
	Average width of the trail, cm	32.0	28.6
	Average depth of the trail, cm	18.5	15.3
	Condition Class	3	3
	Percentage of 4th class trails	13.2	12.6
	Percentage of 3rd class trails	26.7	29.6
	Percentage of 2nd class trails	18.4	14.8
	Percentage of 1st class trails	23.0	24.1
	Percentage of 0 class trails	18.7	18.9
Trail's key sites	Number of sites developed	3	4
	Total area of all sites	180.03	243.18
	Condition Class	1	1
	Percentage of 4th class areas	1.1 (0.0–2.1)	3.8 (1.4–4.6)
	Percentage of 3rd class areas	7.5 (2.8 – 14.5)	4.2 (3.6–8.2)
	Percentage of 2nd class areas	25.1 (15.3–34.6)	32.3 (14.5–40.1)
	Percentage of 1st class areas	66.3 (48.5–82.1)	59.7 (52.8–61.4)

Note: Values are medians followed by minimum and maximum values observed in parentheses. The percentage of the different class areas for campsites and trail's key sites is estimated with no account taken of the areas without impact.

The condition of the trails and campsites depends on several factors: their immediate environment, design, maintenance, and the amount, type, and timing of the use they receive. There is abundant evidence that use characteristics are the least important out of these influential factors (Cole 1991; Helgath 1975; Tinsley and Fish 1985). This is vividly illustrated by the results of our research.

The main problems on the route were: absence of any engineering arrangement at some popular sights, widespread wet and muddy areas (geothermal areas, swamps, valleys of streams), high vulnerability of tundra and geothermal communities along the trails and in campsites, and easily washed sandy soils, provoking the development of scour erosion even on small slopes. In most cases, the changes in condition of natural complexes in the Kronotsky Preserve are provoked not by the present amount of use, but by breaking of ecosystem stability during the Soviet period of active use of the route. Today we are witnessing the processes of recovery of natural complexes in some sites, as well as the processes of erosion and gully development in other sites. Consequently, the critical factors that influence trail and campsite conditions are most likely to be related to environment (for example, soil characteristics or slope steepness) rather than use. This suggests that the principal solutions to trail and campsite impact problems involve increasing the ability of these sites to withstand use (through improved design and engineering) or changes in their location to places that are more capable of withstanding use (Cole 1991).

Prospects

Currently, we are working on the development of a GIS-based methodology for estimation of recreational impacts and condition classes of campsites and trails in Kronotsky State Natural Preserve. Using this methodology, the analysis of data for the above mentioned separate impact parameters will allow us to improve knowledge of the boundaries of sites with different degrees of disturbance, selected in the field, to calculate the level of impact and to give a complete integral campsite and trail condition assessment.

Figures 4a and b—More than 40 % of trails were assessed as being heavily and severely impacted with highly eroded treads.

Figure 5—The key site near the mud hole "Sculptor" in the Uzon Caldera.

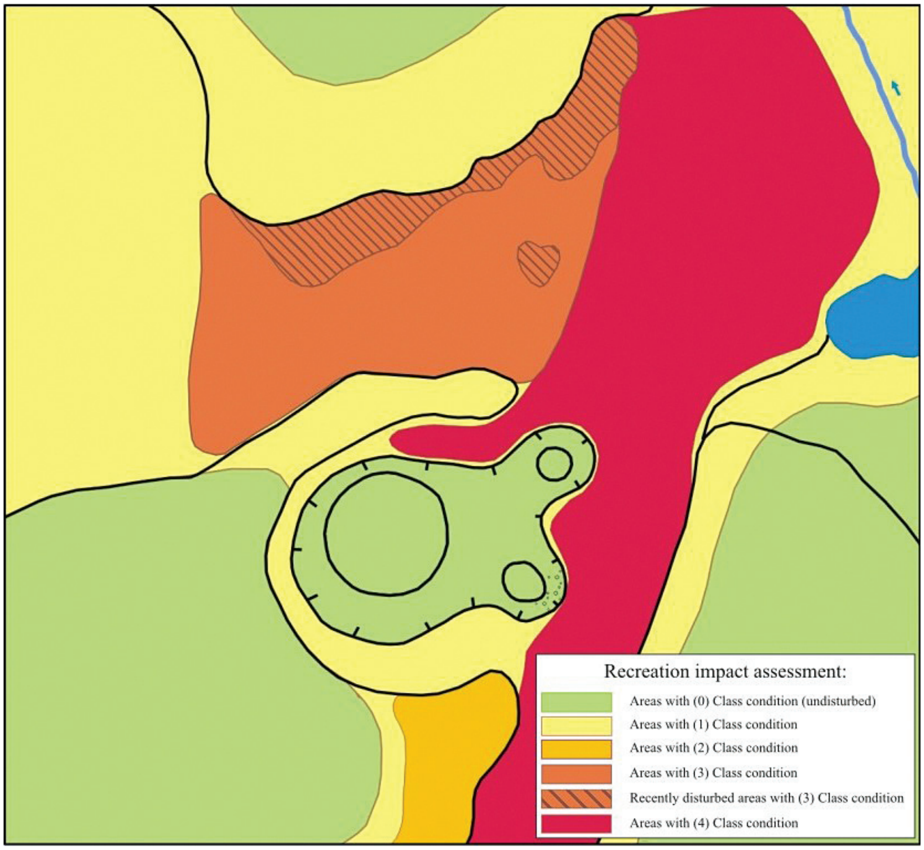

Figure 6—Illustration of ecological condition map depicting level of recreation impact.

Kamchatka's wilderness should provide solitude and silence. Therefore, it's very important to monitor crowding and quality of recreation experience in general. The results of our research will be useful not only for Kronotsky preserve, but also for other wilderness areas—particularly for the new process of protected area planning. Moreover, developed monitoring protocols and systems of indicators seem appropriate, and with some modifications, can be applicable to many ecosystem types at Kamchatka.

Conclusions

While describing the current condition at individual "problem" sites and quantifying the subsequent progression of the impact trends are beyond the scope of this paper, this research is important preliminary work necessary to complete this task in the future. It is one of the first studies on environmental assessment of the recreational areas of Kamchatka, but even the preliminary findings of our initial work corroborate the importance of basing wilderness management programs on knowledge about trail and campsite impacts, and emphasize the necessity of adopting the recreation assessment and monitoring framework to the practice of decision-making.

The situation along the all-Union tourist route to the Valley of Geysers is a revealing example of the consequences of unplanned or poorly planned and implemented tourism and a striking demonstration of the importance of developing campsite and trail monitoring programs to preserve resource conditions while simultaneously allowing for visitation. Properly implemented, recreation impact monitoring programs provide a standard approach for collecting and analyzing resource conditions data over time. Analysis of the data from periodic reassessments enables managers to detect and evaluate changes in resource conditions. Deteriorating conditions can be revealed before severe or irreversible damage occurs, giving time for implementing corrective actions. Analysis of recreation impact monitoring data can also describe relationships between resource conditions and the influential use-related and environmental factors. Finally, a recreation impact monitoring program is indispensable to the new protected area planning and management frameworks, including the limits of acceptable change (LAC) (Stankey and others 1984).

In conclusion, the values of Kamchatka protected areas are inextricably linked to their naturalness. Trampled vegetation and the proliferation of trails, campsites, and fire rings have potential to impair ecosystem function and quality of visitor experiences. Recreational impact monitoring programs offer managers a tool for assessing such changes and provide an essential basis for making resource protection decisions (Marion 1995).

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