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Recreational rates and future land-use preferences for four Department of Energy sites: consistency despite demographic and geographical differences

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Abstract

The management of ecosystems has been improved by both a public understanding of ecosystem structure and function and by managers' understanding of public perceptions and attitudes. This is especially true for contaminated lands where there are a variety of remediation, restoration, and future land-use decisions to be made. This paper synthesizes several surveys from four US Department of Energy (DOE) sites in the states of South Carolina, Idaho, Nevada, and New York. Although ethnic composition varied among the sites, age and gender did not. The percentage of the study population engaged in hunting ranged from 30% to 41% and that in fishing ranged from 55% to 74%. Average hunting rates ranged from 9 (New York) to 15 (South Carolina) days/year; average fishing rates ranged from 12 (New Mexico) to 38 (New York) days a year. Despite the demographic and recreational rate differences, there was remarkable agreement about future land uses. Maintaining these DOE sites as National Environmental Research Parks and using them for nonconsumptive recreation rated the highest. The lowest rated future land uses were current and additional nuclear waste storage and the building of homes and factories. People who participated in a recreational activity rated those future land uses higher than nonusers. While these data on recreational rates can be used to assess the potential risk to people using contaminated sites and to aid in setting clean-up standards based on potential risk, the information on land-use preferences can be used by managers to determine future use and to plan for such use. This information is particularly relevant to the Department of Energy's "Risk-based End State Vision."

Keywords: Risk perception; Future land use; Recreation rates; NERP; Hunting; Fishing; Ethnicity; Department of Energy

1. Introduction

A critical component of successful land management, including the conservation of critical habitats, is an understanding of public attitudes and perceptions. The importance of the involvement of stakeholders in decisions about future uses of sites has been recognized by a number of committees (Commission on Risk Assessment and Risk Management, 1997; NRC, 1994). These committees were established partly because of the response of the public to management decisions. Public perceptions and concerns about future uses of public lands are always critical for decisions (Slocombe, 1993), particularly where multiple land uses are being considered (Yin and Pierce, 1993). The Management of human activities that impact ecosystem structure and function is clearly a social process (Norgaard, 1992; Meffe and Viederman, 1995), and nowhere is this more important than the contaminated lands where not only is future use an issue but also public and occupational safety are important.

Often public attitudes have been solicited on the siting of chemical plants and nuclear facilities and the storage and hazardous wastes (Kunreuther et al., 1990; Slovic et al., 1991; Mitchell, 1992; Mitchell et al., 1997; Kivimaki and Kalimo, 1993; Flynn et al., 1994). When people are asked at the beginning of the process to make decisions about whether they want a hazardous facility close to them, they answer "No". Much less attention has been given to public attitudes about future uses for sites that are already contaminated and are facing

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possible remediation. Yet these views are extremely important to decisions about the level of clean-up, levels of future risk, and future management of the site. People do not seem to worry about the risk from contaminated sites within urban and suburban areas which are in the process of being converted to other productive uses (Powers et al., 2000; US Conference of Mayors, 2000). Where land managers are required to make decisions about restoration, remediation, and future land use, understanding attitudes and future land-use preferences is essential (Lowrie and Greenberg, 1997).

In this paper the recreational rates and future land-use preferences were compared for people living around four US Department of Energy (DOE) sites in four states, including the Brookhaven National Laboratory (BNL, New York), the Idaho National Engineering and Environmental Laboratory (INEEL, Idaho), the Los Alamos National Laboratory (LANL, New Mexico), and the Savannah River Site (SRS, South Carolina). The four sites range from urban (BNL) to rural (INEEL); from the east (BNL) and south (SRS) to the west (LANL, INEEL). Recreational rates and land-use preferences were predicted to vary among sites because of the differences in the sizes of the sites, ethnicities, and population density (urban vs. rural). Land in urban regions, such as near BNL, is under more pressure from development than land in rural areas. Further, other studies have shown that there are ethnic differences in environmental attitudes and perceptions (Taylor, 1989; Bullard and Wright, 1986; Flynn et al., 1994; Arp and Kenny, 1996), suggesting that future land-use preferences might differ.

In their Future Use Report, which involved stakeholders in the evaluation of possible future uses, the DOE assumed that the average recreational user might be on their sites for a maximum of 14 days a year (DOE, 1996), an assumption that was to be tested in this research. This research is part of a larger effort by the Consortium for Risk Evaluation with Stakeholder Participation to understand exposure, risk, and public understanding of the risks on Department of Energy lands (Goldstein et al., 2000).

The DOE's nuclear weapons complex has about 5000 facilities located at 16 major sites and at more than 100 smaller sites (Crowley and Ahearne, 2002). Some 113 of the DOE sites around the country contain chemical and radiological wastes generated by the production of nuclear weapons (DOE, 2000). The potential clean-up costs for DOE facilities are enormous. Estimates run as high as $350 billion over the next 75 years, making it increasingly clear that decisions about the levels of clean-up will be made with an eye to reduce overall costs (Grumbly, 1996).

The DOE's enormous environmental management task averaged about $6 billion a year in the 1990s and represents 20% of the world's environmental remediation market (Sink and Frank, 1996), nearly equaling the budget of the US Environmental Protection Agency. Information on stakeholder views about future land uses and potential recreational uses are important to decisions about clean-up, since these uses will drive the levels of clean-up required. This information is relevant to the newly articulated "Risk-based Endstates Vision" of the Department of Energy (DOE, 2003), which will guide future cleanup that uses risk as one of the main drivers.

2. Methods

The objective of this study was to interview people with different relationships to four DOE sites: the Brookhaven National Laboratory, the Idaho National Engineering and Environmental Laboratory, the Los Alamos National Laboratory, and the Savannah River Site (Fig. 1). The four sites were chosen because they represent both rural and urban sites, range in size from relatively small to some of the largest DOE sites (INEEL, SRS), and contain different types of habitats. The larger sites have a wide range of habitats and environments, making it important to assess perceptions of appropriate future land use there.

We interviewed people at local and regional events, which included people who actually used the sites for hunting, people living directly adjacent to the sites, and members of the general public who might use these sites if the lands were opened to the public for more of the year. The populations were chosen to represent people with different degrees of familiarity with the sites. All of the facilities were involved in nuclear weapons production and energy research and are now in various stages of remediation (NRC, 1995). All are intended to be maintained by the DOE after clean-up is completed (NRC, 2000).

At BNL, subjects were interviewed at an Earth Day festival at Islip ($N = 154$) and at a sports/home show at the Nassau colosseum ($N = 352$). Further information can be found in Burger (submitted for publication) and Burger et al. (in press).

At INEEL, subjects were interviewed at a St. Anthony's pancake breakfast ($N = 263$), the Idaho Falls street fair (closest large city, $N = 262$), the Shoshone–Bannock powwow (represented American Indians, $N = 324$), in Boise (the urban capital, $N = 494$), which is 250 km away, and the Lewiston roundup (regional, rural, $N = 351$). More in-depth data from these surveys can be found in Burger (1999a, b, 2003b) and Burger et al. (1999b, 2000a, b).

At LANL, subjects were interviewed at the Sante Fe air show (nearest city, $N = 350$) and in Albuquerque (nearest large city, $N = 356$). More in-depth data can be

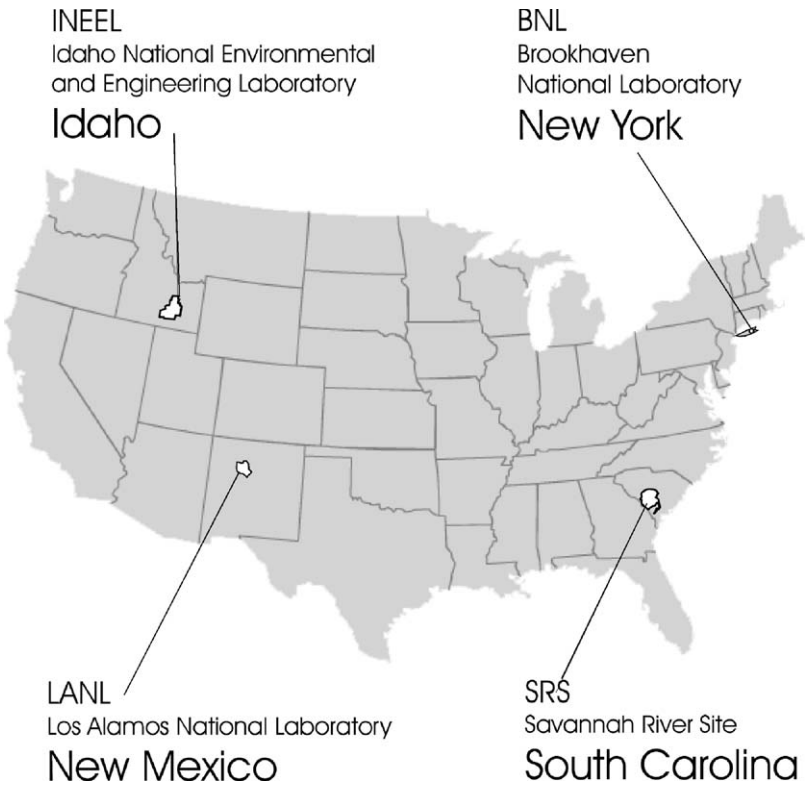

Fig. 1. Map of the United States showing the locations of the four Department of Energy sites.

found in Burger (2000a, 2003a) and Burger et al. (2003a, b).

At SRS, subjects were interviewed in person at three events: (1) the Palmetto Sportsmen's Show in Columbia SC ($N = 285$) (hunters and anglers, Burger et al., 1997); (2) the Aiken Trials horse show ($N = 286$, the local public, Burger, 2000b; Burger et al., 1999a); and (3) the Mayfest in Columbia ($N = 399$, the general public, Burger, 1998). Subjects were also interviewed by phone (hunters, $N = 71$, Sanchez and Burger, 1998; Burger and Sanchez, 1999). Each of the three events was attended by 10,000 people or more. Aiken is 20 km from SRS and Columbia is about 100 km away. The papers listed above give more details on each of the surveys. In this paper, information on recreational rates, environmental perceptions, and future land-use preferences was compared among the four populations. Demographics of respondents and sample sizes are shown in Table 1.

Our overall protocol was to use the same questionnaire at all sites, administered by the same interviewers, using the same techniques. People at all events were interviewed while they waited for activities to begin. Subjects were willing to talk to us, and many continued to discuss the various issues with us long after the interview was completed. We randomly selected a person waiting in line or standing about and then moved 2–3 m in a transect to select the next person. All interviewers were trained and conducted the surveys at all of the places. Each interviewer used the same process, selecting the next person regardless of his or her identity. Samples were not selected according to a table of random numbers, but there is no reason to believe that they were not representative of those attending the events. Nearly everyone (over 95%) we approached agreed to answer the questions; the exceptions were mostly people who were engaged in other discussions. Although there were differences in the demographics of the subjects interviewed, they are representative of the people attending these events (see the papers mentioned above). It should be noted, however, that the results represent people who attended these events and not the general population.

The questionnaire was divided into parts dealing with demography, recreational activities, and future land use at the DOE site in question. Recreational questions dealt with days spent in each activity (i.e., hunting, fishing, hiking, camping, bird-watching, photographing). Respondents were asked to rate the desirability of future land uses for the DOE site on a scale of 1 (never desirable) to 5 (most desirable). Land use options included recreational, residential, commercial, nuclear, and preservation or research activities.

We used a one-way analysis of variance (AVOVA) (SAS Proc NPAR1WAY) to distinguish significant differences among groups (SAS, 1995), with a Duncan post hoc test to determine which of the response scores

Table 1
Demographics of people interviewed living around the Savannah River Site (South Carolina), the Idaho National Engineering and Environmental Laboratory (Idaho), the Los Alamos National Laboratory (New Mexico), and the Brookhaven National Laboratory (New York), USA

	SRS	INEEL	LANL	BNL
Sample size	986	1694	724	507
% Men	61	48	66	63
% Black	13	[a]	2	4
% White	84	71	66	86
% Hispanic	[a]	2	22	7
% American, Indian	3	27	4	3
Age, means ± SE (range)	37.3 ± 0.42 (11–82)	39.08 ± 0.38 (11–87)	39.7 ± 0.57 (10–88)	40.4 ± 0.64 (12–90)
Education				
% Less than high school Graduate	6	13	15	14
% Graduated high school + Some college	46	37	32	30
% Graduated college	48	50	53	56
Income				
Less than $20 K	—	—	63	42
20–40 K	—	—	9	16
41–60 K	—	—	5	19
Greater than 60 K	—	—	23	23

—, data not taken.
[a] Less than 0.5%.

differed. We used Kruskal–Wallis χ^2 tests to test for differences among our sample populations because of the differences in sample sizes.

Linear regression procedures were used to determine whether interactions between ethnicity, income (log transformed), gender, age, or education contributed to an explanation of the variations in ratings for future land uses (PROC GLM; SAS, 1995). The procedure adds the variable that contributes the most to the R^2, then adds the next variable that increases the R^2 the most, continuing until all significant variables are added. Thus, variables that vary colinearly are entered only if they add independently to explaining the variation. However, there were no significant interactions between any of the variables.

3. Results

3.1. Recreational rates

At all sites, a higher percentage of people engaged in fishing than in hunting (Table 2). The percentage of people engaged in nonconsumptive activities, such as hiking and camping, varied by region. There were also significant differences in the number of days/year subjects engaged in recreational activities at the different sites. The highest hunting rates (average number of days/year) were at SRS, and the highest fishing rates were at BNL. The lowest fishing rates were at LANL (a dry regional habitat with few fishing opportunities). This suggests that people were leaving their immediate vicinity to fish.

3.2. Future land use

There were significant differences for every site in the ratings of preferred future land use (Fig. 2, ANOVA, $P<0.001$ for each site). At all sites maintaining the DOE site as a National Environmental Research Park (NERP; DOE, 1994) or using it for hiking (and sometimes camping and bird-watching) were ranked the highest. Similarly, using the nearby DOE site for current or future nuclear waste storage and for building homes and factories were rated the lowest (Fig. 2). Subjects living around LANL rated current future land use higher than did people from elsewhere. Where it was relevant, returning the land to American Indians was generally not rated very high as a potential future land use (except at the Idaho pow-wow).

GLM (SAS) models indicated that the particular site was generally the factor that contributed the most to differences in relative ratings of future land uses. For example, the model ($F = 33.9$, $r^2 = 0.13$, $P<0.001$) for NERP (the highest rated future land use) included site ($F = 88.3$) ethnicity ($F = 12.7$), and age ($F = 6.7$). The model for hiking (the next highest rated land use) included site ($F = 42.1$), ethnicity ($F = 4.9$), and rates of hiking ($F = 8.0$) and hunting ($F = 4.4$). Hunting rates were entered for hiking because many subjects said they hiked whenever they hunted.

Table 2
Recreational rates for people interviewed

	SRS	INEEL	LANL	BNL	Kruskal–Wallis χ^2 (P)
Sample size	986	1694	724	507	
% Engaging in activity					
Hunting	30	39	41	32	
Fishing	58	61	55	74	
Hiking	35	63	71	53	
Camping	38	75	69	50	
Bird-watching	—	—	29	49	
Photography	50	71	49	31	
Recreational rates[a]					
Hunting	15.2±1.29	11.5±0.94	7.71±0.77	8.79±1.20	7.77 (0.05)
Fishing	23.8±0.71	17.4±0.96	12.0±0.98	38.2±2.66	96.6 (0.0001)
Hiking	5.77±1.04	20.2±1.42	21.8±1.88	16.6±2.11	263 (0.0001)
Camping	4.91±0.61	14.5±0.70	14.2±1.31	8.71±1.51	377 (0.0001)
Bird-watching	9.74±0.71	—	33.2±3.56	30.2±3.43	161 (0.0001)
Photography	22.0±2.18	39.7±1.75	25.3±2.52	31.3±4.00	7.29 (0.007)

—, activities not asked about.
[a] Recreational rates (number of days/year) are computed for those who engage in each activity.

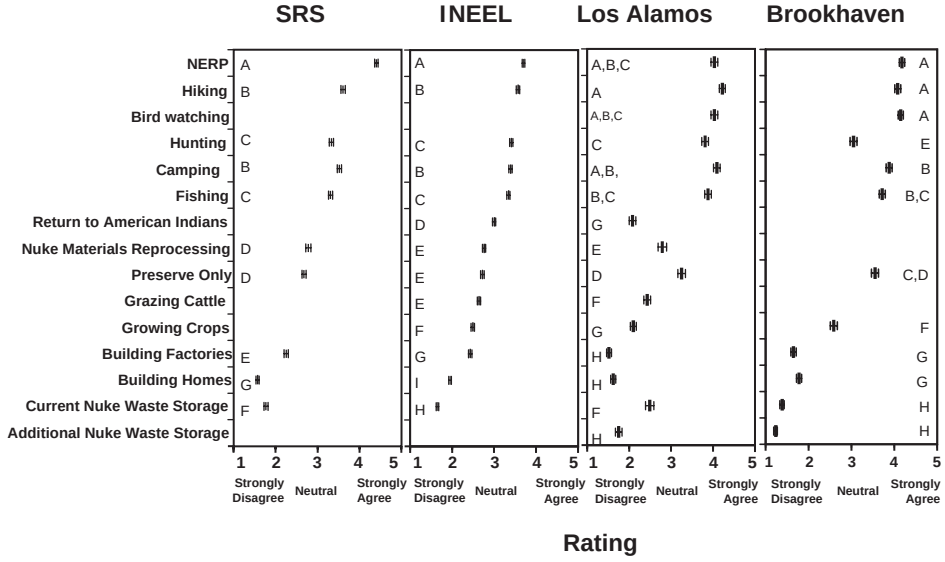

Fig. 2. Relative ratings of future land uses for the four Department of Energy sites examined. Given are means±standard errors. Letters that differ indicate significantly different ratings among uses within sites. NERP, National Environmental Research Park, Nuke, nuclear.

3.3. Recreational rates and future land use

For some activities (such as hiking), there was no significant relationship between the mean number of days devoted to the activity and the rating of that activity for future land use. However, for others, there was a significant correlation, but it was not high; for example, for camping, $r^2 = 0.05$ ($P < 0.005$, $N = 2038$); for fishing, $r^2 = -0.11$ ($P < 0.0001$) and for hunting, $r^2 = 0.14$ ($P < 0.0001$).

However, there were significant differences between the overall rating of preferred land use and whether subjects engaged in that activity (regardless of the number of days in which they engaged in that activity). The differences were greatest for consumptive activities (such as hunting and fishing) and least for nonconsumptive activities (Table 3).

4. Discussion

4.1. Methodological issues

There is a potential for biases whenever the population is not truly drawn randomly from the entire regional population. The overall study population near

Table 3
Ratings for recreation for people interviewed at INEEL, SRS, LANL, and BNL

	Does participate	Does not participate	Kruskal–Wallis χ^2
	$N = 1274$	$N = 2268$	
Hunting	3.97 ± 0.05	3.06 ± 0.03	287(0.0001)
	$N = 2087$	$N = 1453$	
Fishing	3.67 ± 0.03	3.20 ± 0.04	88.3 (0.0001)
	$N = 2038$	$N = 1524$	
Camping	3.68 ± 0.03	3.55 ± 0.04	3.41 (0.06)
	$N = 1887$	$N = 1679$	
Hiking	3.91 ± 0.03	3.63 ± 0.04	30.5 (0.0001)

The comparison of those who participate in each activity versus those who did not. Given are means $\pm$SE and Kruskall–Wallis χ^2.

each of the four DOE sites may have had some biases: (1) people were not included because they did not attend the event; (2) the old or injured may have been underrepresented because they did not attend such events; (3) some groups were not targeted (public officials, DOE employees, regulators); and (4) people living far away from the study sites were not included (e.g., others not living in the targeted states). The surveys, however, were designed to obtain a wide range of views from people living in different regions around each site. Further, the survey obtained the views of current residents and did not take into account future generations.

Survey methods that depend on interviews have the potential for bias in the selection of interview subjects. This was partly minimized by the protocol that involved the walking of transects through the venue and the 3-m inter subject distance. Nonetheless, some biases may have occurred in subject selection.

4.2. Recreational rates

Recreational rates were of interest for several reasons: (1) they are indicative of the potential maximum use of local recreational opportunities, (2) they provide comparative data among different recreational activities, and (3) they provide information about potential exposure if DOE sites are open for uncontrolled recreation. The data indicated that the activities most subjects engaged in varied by location, with fishing being highest at SRS and BNL, camping at INEEL and LANL, and hiking at LANL.

One of the objectives of this study was to determine whether the recreational exposure of 14 days/year assumed by DOE (1996) was reasonable. This objective was met, within a framework that recognized the limitations of the data set. At all sites, the most popular activity averaged over 20 days/year, indicating that the 14-days/year assumption of the DOE may be low given that some people may engage in a majority of their activities on DOE lands, that people engage in more than one activity, and that people often camp (which usually involves more than an 8-h day). Further, some DOE sites (INEEL and LANL in this study) are close to lands held by American Indians, who generally have higher hunting and fishing rates than other populations (Burger, 1999a) and who would use these lands for religious, herbal, medicinal, or other cultural reasons. The variations in both the percentage of people engaged in particular activities and the relative rates of participation indicated that site-specific information on recreational patterns is important for exposure scenarios.

One difficulty with these surveys was that we did not ask about total recreational days. That is, were the days engaged in different recreational activities additive, or were they the same days. While some people mentioned that they hunted and fished on the same days, most people stated that either they went hunting or they went fishing, suggesting that some proportions were additive. Even so, the average number of days engaged in the most popular activity was above 20 days for each site, indicating a relatively high recreational rate.

4.3. Future land use

Future land-use preferences across the four sites were remarkably similar (refer to Fig. 2): (1) NERP, hiking, bird-watching, and camping were rated the highest; (2) the building of homes and factories was rated low; and (3) nuclear storage was rated the lowest. Each of these will be discussed below.

The reasons for the generally high rating of NERP may be to due a desire to maintain the status quo (all sites except BNL are already NERPs), to ensure a continuing mission, and to provide habitat for wildlife. Three of the sites are currently NERPs, and this is indicated on signs that the public regularly sees; BNL has a designated wild and protected area. Thus, interest in maintaining these sites as NERPs preserves the status quo (money and jobs for the local region), provides wildlife habitat, and sounds like "apple pie and motherhood" in terms of American values.

The high ratings for hiking, bird-watching, and camping (and hunting and fishing in some places) were not surprising, given the high recreational rates. Further, it was consistent with wanting to preserve the lands for NERPs, which also have a research component. These ratings may have reflected current use (albeit illegal in some cases) and the need for more recreational opportunities within local regions.

The uniformly low rating for additional nuclear storage (and current storage in all cases except LANL) was also not surprising. The public is generally distrustful of information sources surrounding toxic

and hazardous waste sites (Slovic, 1987, 1993; Pillisuk and Acredolo, 1988; Mitchell, 1992; Barke and Jenkins-Smith, 1993). DOE sites are even more problematic because they combine many of the worst fears about such sites, with an added concern about radiation. However, while the general public may be overly concerned about hazardous waste sites, people living nearby are often less concerned about health and safety risks because of economic dependence on these sites (Rogers, 1984, 1997). This is not only a matter of economic dependence, but also of a perception of safety borne of experience. The relatively low frequency of risky events (spills, accidents, or other injuries) may be interpreted by local people within a context of daily activities with no risk (Rogers, 1997). In contrast, people who live farther from a nuclear waste site hear only about major risk events. They have no direct personal experience with these hazardous facilities, but they remember information about unwanted risk events, often from facilities far from their homes (even as far away as Chernobyl, Ukraine). Environmental concerns have consistently been associated with the expectation of harmful consequences (Stern et al., 1995). Thus, people with little firsthand experience of the safety of nuclear operations may be alarmed about potential effects. Further, attitudes toward nuclear reprocessing vary generally, with people living close by rating it much higher than those living farther away (Freeman, 1993; Hanink, 1995).

4.4. Management implications

These data have management implications for both current and future use. Although all of the sites were not open to on-site recreation, there were some instances in which people were on site. For example, there is limited and controlled hunting on SRS and INEEL, some people walk on-site along the edges, and some people actually enter the site to hike or ride horses, providing potential risk to off-site receptors (Burger, 1999a; Burger et al., 2000a, b). Further, the data indicated that the 14-days/year assumption of the DOE (1996) for potential exposure on DOE sites is an underestimate because of the high average recreational rates at all of the DOE sites. At the least, the data indicated that exposure scenarios should be adjusted for local recreational rates. The data, however, can also be used to make remediation decisions with potential exposure in mind. That is, where sites (or portions of sites) are to be opened for recreation, remediation must take into account potential exposures higher than the 14 days/year.

The data on future use preferences will be helpful in remediation decisions and in determining the potential future uses of DOE lands. The overwhelming support for NERPs and recreational activities suggests that the DOE should consider using parts of decommissioned lands for these purposes. The uniformity in NERP receiving the highest rating suggests some concern for protecting lands for conservation and wildlife and for maintaining the status quo.

Similarly, the uniformly low rating for nuclear storage, both current and future, indicates that the DOE has a massive risk communications issue that must be addressed. Both the real risks and the perceived risks need attention. The real risks to the public from current (or future) storage, as well as to on-site recreational users, needs further discussion among the DOE, the regulators, and the public. Perceived risks of hazardous waste sites generally vary among risk assessors and the general public (Slovic, 1987, 1993). This finding has been interpreted to mean that the general public is wrong, but it should be noted that risk assessors also have "perceived" ratings which are subject to their own biases.

The data were meant to begin a process of understanding of a range of stakeholder views that could inform management and policy decisions and to do so for a number of DOE sites, as envisioned in the recently initiated Risk-based End State Visions (DOE, 2003). In most studies, only one location or facility is examined, while in this study, data were collected from subjects living at several locations around each of four facilities. This provides a more general picture of recreational rates, land-use preferences, and the relationships among sites.

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