



Determining bear activity levels in the lower Brooks River, an area of high visitor use in Katmai National Park, Alaska





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Front Cover: Brown bears feed on salmon on the bridge at Brooks Camp in Katmai National Preserve, Alaska. Photo by NPS (taken by remote camera for study).

DETERMINING BEAR ACTIVITY LEVELS IN THE LOWER BROOKS RIVER, AN AREA OF HIGH VISITOR USE IN KATMAI NATIONAL PARK, ALASKA

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ABSTRACT

Brooks River, a salmon (*Oncorhynchus* spp.) migratory route and spawning stream in Katmai National Park, is an important feeding area for brown bears (*Ursus arctos*), as well as a focal point for visitor use in the park. Currently, a floating bridge provides access between Brooks Camp facilities on the North side of the lower Brooks River and bear viewing platforms and other facilities on the south side of the river. Access to the bridge from the north side of the river is via a trail that parallels a section of the lower river that has been documented as a productive bear feeding area. It has been suggested that repositioning the bridge downriver of its current location could reduce the number of human-bear interactions and bear-related human-traffic delays, in part because the downriver location would allow more direct access to the bridge without the need to walk along the river bank. To evaluate whether bear activity was lower downstream of the current bridge location, we used time-interval photography to record bears present within 50 m of the current and the proposed bridge locations during July and September 2004. We found that during September all measures of bear activity were higher within 50 m of the current bridge location than within 50 m of the proposed downriver site. We suggest that repositioning the bridge to the proposed downriver site could provide more direct access to the bridge on the north side of the river and could reduce bear-caused human traffic delays because 1) people would no longer have to travel parallel to the river adjacent to a known productive bear feeding area, and 2) the bridge would be relocated to a site with relatively less bear activity. We recommend that the effects of any change in the location or nature of the bridge be assessed through documentation and comparison of bear use patterns using methods similar to those employed for this study.

INTRODUCTION

During summer and fall, brown bear (*Ursus arctos*) feeding activity is concentrated along salmon (*Oncorhynchus* spp.) spawning streams throughout southwest Alaska. The brown bear population on the Alaska Peninsula was generally depressed during the 1970s due to high bear harvest, poor salmon escapements, and severe winters. Reduced bear harvests during the late 1970s have allowed the population to recover and for bear densities to increase, although this increase has leveled off in recent years (Butler 2005). Katmai National Park, located on the northern portion of the Alaska Peninsula (Fig. 1), is the

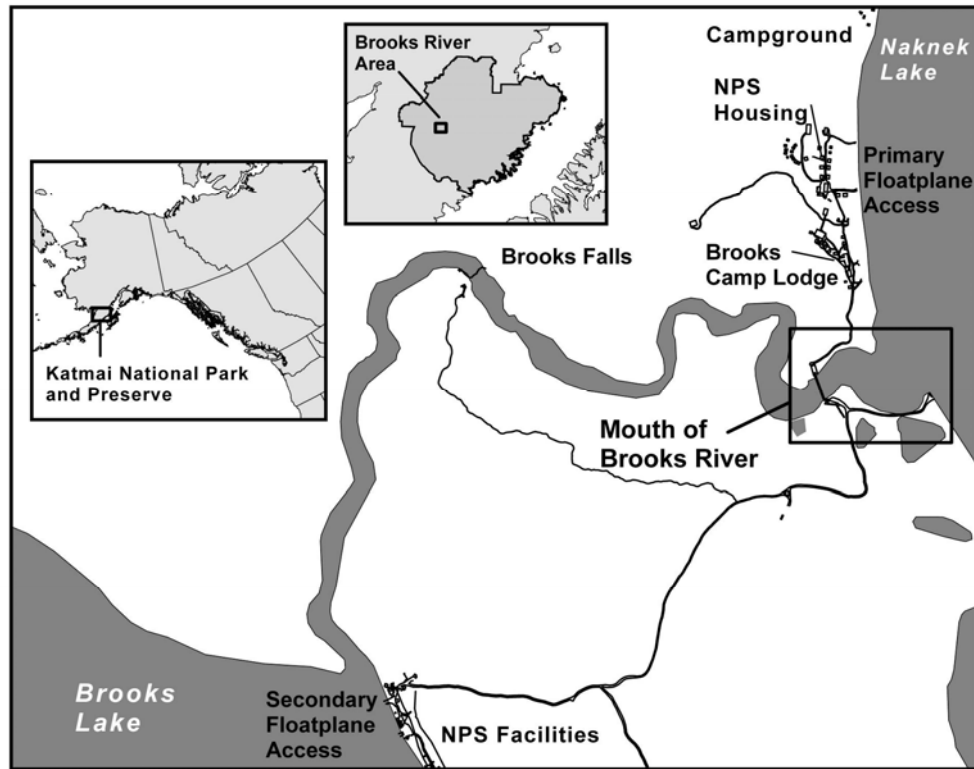


Figure 1. Study area map showing location of Brooks River within Katmai National Park, Alaska. Facilities and access sites are delineated.

largest land area closed to bear hunting in southwest Alaska and supports one of the highest-density protected populations of brown bears in the North America (Miller et al. 1997, Olson and Putera 2007).

Interest in bear viewing at bear feeding concentration sites has grown steadily since establishment of the world-renowned McNeil River State Game Sanctuary bear viewing program in the 1970s. Visitation to other bear concentration sites on the west side of Cook Inlet has increased markedly over the past 20 years, as have commercial services available to access them (Matz 2000). Unlike McNeil Falls, where access is limited to groups of 10 through a lottery permit system, other bear concentration sites, including Brooks River, do not currently limit visitation.

Brooks River is a focal point of visitor use within Katmai National Park. During summer 2004, >10,000 visitor days were documented there (National Park Service [NPS], unpublished data). Visitor activity at Brooks River historically focused on sport fishing, but over the last 20 years bear viewing has become the dominant visitor activity during July and September. Bear viewing at Brooks River has grown in part due to trends in the bear population there. Over the past 25 years, the number of independent bears estimated to regularly feed on salmon at Brooks River has more than doubled, and an increasing trend in bear numbers has been evident even within the past few years (T. Olson, NPS, unpublished data).

Brooks Camp is only accessible by float plane or boat. Bear viewing platforms, Lake Brooks NPS facilities, and the alternate float plane beach access site are located on the south side of Brooks River, while the primary float plane beach access site, nearly all Brooks Camp visitor facilities, and Brooks Camp NPS facilities are located on the north side of the river (Fig. 1). The primary focal point for float plane traffic is the beach in front of Brooks Camp. To facilitate movement of people across the river, NPS has annually installed a floating bridge across the lower river from May through camp closing in September since 1981 (Figs. 1, 2). The location of this floating bridge has been 100 m upstream of where the established trail on the north side of the river to Brooks Camp meets the lower river bank. Consequently, to access the bridge on the north side of the river, people must walk along the north bank of the river for about 100 m. The Lower River Viewing Platform is located within 10 m of the bridge on the south side of the river.

Humans and bears coexist in relatively close proximity at Brooks Camp, but the NPS strives to maintain a minimum distance of 50 m between humans and bears to help 1) encourage safe interactions, 2) minimize impacts to bears, 3) manage the level of human habituation, and 4) minimize the chances of a bear obtaining a fish from an angler (NPS 2006). Maintaining this minimum distance sometimes results in >30-minute delays in human traffic flow across the floating bridge due to bear activity and bear proximity to the bridge and/or trail along the river, particularly after the first week of September (Proffitt 2002, Olson et al. 2002, Bentley et al. 2007). People waiting to cross the bridge often wait on the Lower River Platform and in the vicinity of where the trail from camp intersects the river (Figs. 1, 2; the area is often referred to as the "corner").

The NPS has evaluated a number of alternatives for managing visitation at Brooks Camp since 1980. Most recently, a Brooks Camp development concept plan environmental impact statement (EIS) was finalized in 1996 (NPS 1996). The proposed action identified in the EIS was relocation of all services and facilities to the south side of the river (thus eliminating the need for a bridge) combined with human use limits. However, this proposed action has not yet been implemented. Bear numbers, bear activity levels, and visitation levels have all increased substantially since the EIS was finalized. To reduce human-bear interactions and human traffic delays in the vicinity of the floating bridge, in recent years it has also been proposed that the floating bridge be repositioned downstream of its current location to eliminate the need to walk along the north river bank to access the bridge.

To evaluate whether repositioning the floating bridge might alleviate some human traffic delays due to bears, this project was designed to determine bear river-use patterns via time-lapse photography during daylight hours within 1) 50 m of the current bridge location, and 2) within 50 m of a possible alternative downstream bridge site (Fig. 2).

STUDY AREA

Brooks River, a 2.5-km salmon migratory route and spawning stream, is located in the interior of Katmai National Park, approximately 467 km southwest of Anchorage (Fig. 1). Brooks River is part of the Naknek drainage, which is one of most productive salmon spawning drainages in the region. Sockeye salmon migrate up Brooks River during late June through July; they spawn and die between late August and October (Merrell 1964). A small silver salmon run also occurs in Brooks River during late August and September.

During July >20 bears sometimes congregate at Brooks River Falls to catch salmon as they school below the falls and attempt to leap over the falls on their upstream spawning migration, making the site a key visitor attraction. During September and into October, salmon spawn in Brooks River, and many bears concentrate their use toward the river below Brooks Falls to feed in particular on spawned-out salmon carcasses that tend to accumulate in backwaters and eddies, and eventually also along the lakeshore in front of Brooks Camp (Braaten 1988, Olson 1993). In recent years as many as 71 independent bears have been identified regularly using Brooks River during July, and as many as 49 independent bears have been identified regularly using the river during the fall (T. Olson, NPS, unpublished data).

Brooks Camp, located immediately north of the mouth of Brooks River along the Naknek Lake shoreline, includes a 60-person lodge, a 60-person campground, a visitor center and auditorium, and NPS and lodge housing and support facilities. Most Brooks Camp visitation is focused during the lodge operating period of 1 June through 18 September, with peak visitation during July and September.

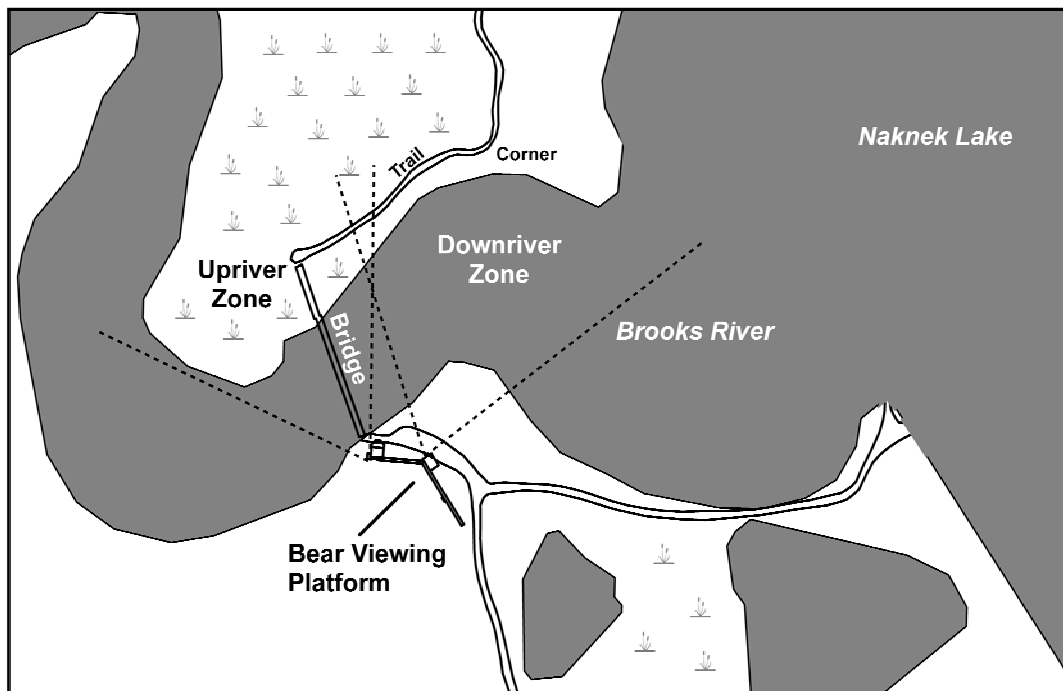


Figure 2. Study area map of the Brooks River, Katmai National Park, Alaska. Cameras mounted on viewing platform provided angles of view that are indicated as the upriver and downriver zones of the study area.

METHODS

We subdivided the lower river study area into 2 zones for data collection. These 2 zones corresponded to areas visible from the Lower River Platform (Fig. 2) that were within 50 m of the current bridge location (Upriver Zone) and within 50 m of an alternative downstream bridge location (Downriver Zone; Fig. 2). We used 2 digital cameras (Nikon Coolpix 4300) outfitted with aftermarket intervalometers (Digisnap 2800) and powered by large 12-volt batteries to document bear and human activity at 10-minute intervals 24 hours/day within the 2 zones and within the broader areas visible from where the 2 cameras were mounted on the Lower River Platform. We installed 1 camera on the upstream end of the platform to capture use of the Upriver Zone, and the other camera on the downstream end of the structure to capture use of the Downriver Zone (Fig. 2). Both cameras were attached to viewing platform support beams at a height of about 4 m. Data were collected between 12–29 July and 3–28 September 2004.

We initially reviewed the photographs recorded to exclude those that: 1) contained no discernable images due to low light during overnight hours, 2) contained blurry images due to rain and condensation on the weatherproof housing lens, or 3) contained partial images due to vehicles parked in front of the camera (Downstream Zone only). We then compared the times and dates of remaining photographs between the 2 cameras to identify time periods in which usable photographs were recorded by both cameras, and we then included in statistical analysis only photographs that were recorded simultaneously by both cameras during similar times (Fig. 3). During July, photos from 13 different days were included in analysis, and during September 26 days were included.

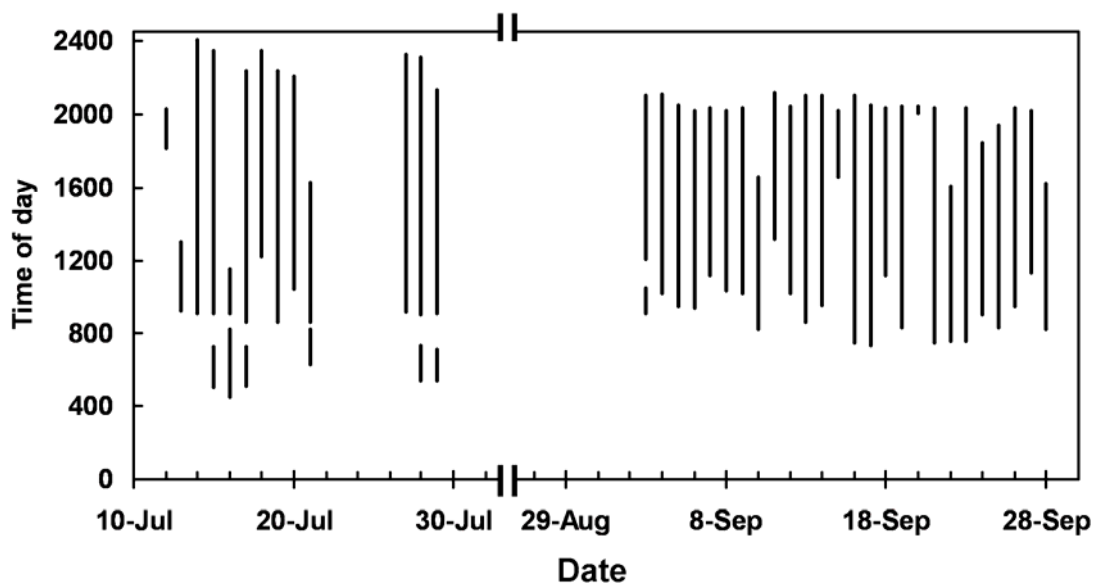


Figure 3. Periods of time between 12–29 July and 3–28 September 2004 when both the upriver and downriver cameras provided usable photographs, Brooks River, Katmai National Park, Alaska. Daily beginning and ending times were constrained by darkness, but other factors that affected whether photographs could be used included rain or fog on the camera housings and obstruction of the camera view by vehicles parked in front of the downriver camera.

Data coded for each photograph within the 2 zones illustrated in Figure 2 included zone; date; time; number of independent bears present (no dependent offspring apparent in photograph); number of family groups present (a female bear with at least 1 dependent offspring; a dependent offspring without an accompanying adult female in a photograph was also coded as a family group); activities for the bears that were present (resting or non-resting); bear location (in water, on land or on the trail); number of consecutive previous photographs from the same location in which bears were present; presence/absence of people on the bridge; presence/absence of people at the corner; and number of consecutive previous photographs where people were gathered at the corner (while presumably waiting to cross the river). Analyses reported here did not examine bear location within zones, but that data is available for future comparisons. Prior to analysis, we created an additional variable by adding the number of independent bears to the number of family groups to obtain total bear groups.

Because previous research indicated that bear activity in the lower Brooks River was higher during the fall than during July (Olson 1993), we analyzed data separately for the July and September sampling periods. Also, because previous research indicated differences in bear use patterns prior to and following lodge closure (lodge closed 18 Sept 2004; Olson et al. 1997), we subdivided some of our fall analyses between these 2 periods.

Data Analysis

We compared activity in the two zones by four different approaches.

First, we calculated the average number of bear groups observed per picture per day in each zone. We then used Wilcoxon paired-sample tests (Zar 1984) to determine whether these activity summaries differed for the two zones during July, early September, and late September. To examine the distribution of differences, we performed Wilcoxon tests on the individual photo pairs for each day. These tests were intended to represent post-hoc examinations of the differences within time periods, so reported probabilities were adjusted by Bonferroni adjustments where the critical P-value is changed from α to α/n to account for multiple tests within each time period (Zar 1984). We set $\alpha = 0.05$ for all analyses. To visually examine the cumulative spatial use patterns of bears within the area monitored, for each photograph with a clear image we digitally marked the locations of all independent bears (including those visible outside of the 2 river zones) on 2 photographs depicting the upriver and downriver camera views.

Second, we compared the daily maximum number of consecutive photographs containing bears between the upriver and downriver zones using Wilcoxon tests. The daily maximum number of people standing on the corner between July and September was calculated and plotted along with the average bear activity and the consecutive bear activity analyses.

Third, because prolonged human traffic delays at the bridge have sometimes been due to resting bears in the vicinity, we also calculated the daily proportion of observed bear

groups, both independent bears and family groups, that were classified as resting and compared these proportions between zones and bear group types with Wilcoxon paired sample tests.

Fourth, we examined bear diurnal activity patterns for the two zones for each of the three time periods. Diurnal use curves were fitted to the per-photograph counts of bear groups using Systat's (Version 10.0; Systat Software, Inc., San Jose, California) distance weighted least squares procedure (tension = 3.0). Linear regression analyses were conducted to determine whether apparent changes in activity as a function of time of day were significant.

We performed one follow-up analysis to determine, by linear regression, the strength of the relationship between the daily maximum number of consecutive photographs with bears present in a zone and the daily maximum number of consecutive photographs with people gathered at the corner. This analysis was only performed for the times when the lodge was open in July and early September.

RESULTS

A total of 2,431 pairs of photographs were included in analysis from 413 hours of camera operation in July and September 2004. During July, the earliest time in the day when a usable photograph was recorded was 0448 hours (Alaska Daylight Savings Time), and capture of usable photographs at 10-minute intervals continued until as late as 0005 hours the following day. During September daylight hours were reduced; consequently, the earliest usable photograph was recorded at 0734 hours and the latest usable photograph was recorded at 2114 hours (Fig. 3).

Activity Patterns by Zone and Season

Substantially more bear activity was recorded within the 2 river zones during September than during July (Fig. 4). Bear activity increased steadily throughout most of September in the Upriver Zone, while activity in the Downriver Zone also increased but showed a more marked increase after the lodge closed in mid-September. The distribution of bear use within each zone appeared to reflect salmon carcass deposition sites mapped by Braaten (1988; Fig. 5).

Our comparisons of bear numbers between zones reflected these seasonal patterns. The number of bears present per photograph was greater in the Upriver Zone than in the Downriver Zone throughout September, but there was no difference in July (Table 1). Bear activity was greater in the Upriver Zone on 88% ($n = 26$; 6 significantly different in post-hoc comparisons) of the days compared during September, in contrast to 23% ($n = 13$; none significantly different) of the days compared during July (Table 2, Fig. 4). Significantly more bears were documented in the Downriver Zone on only 1 day (3 Sep).

Bear presence in the Downriver Zone appeared to be for shorter periods of time and was more sporadic than in the upriver zone throughout the season (Fig. 7). The daily

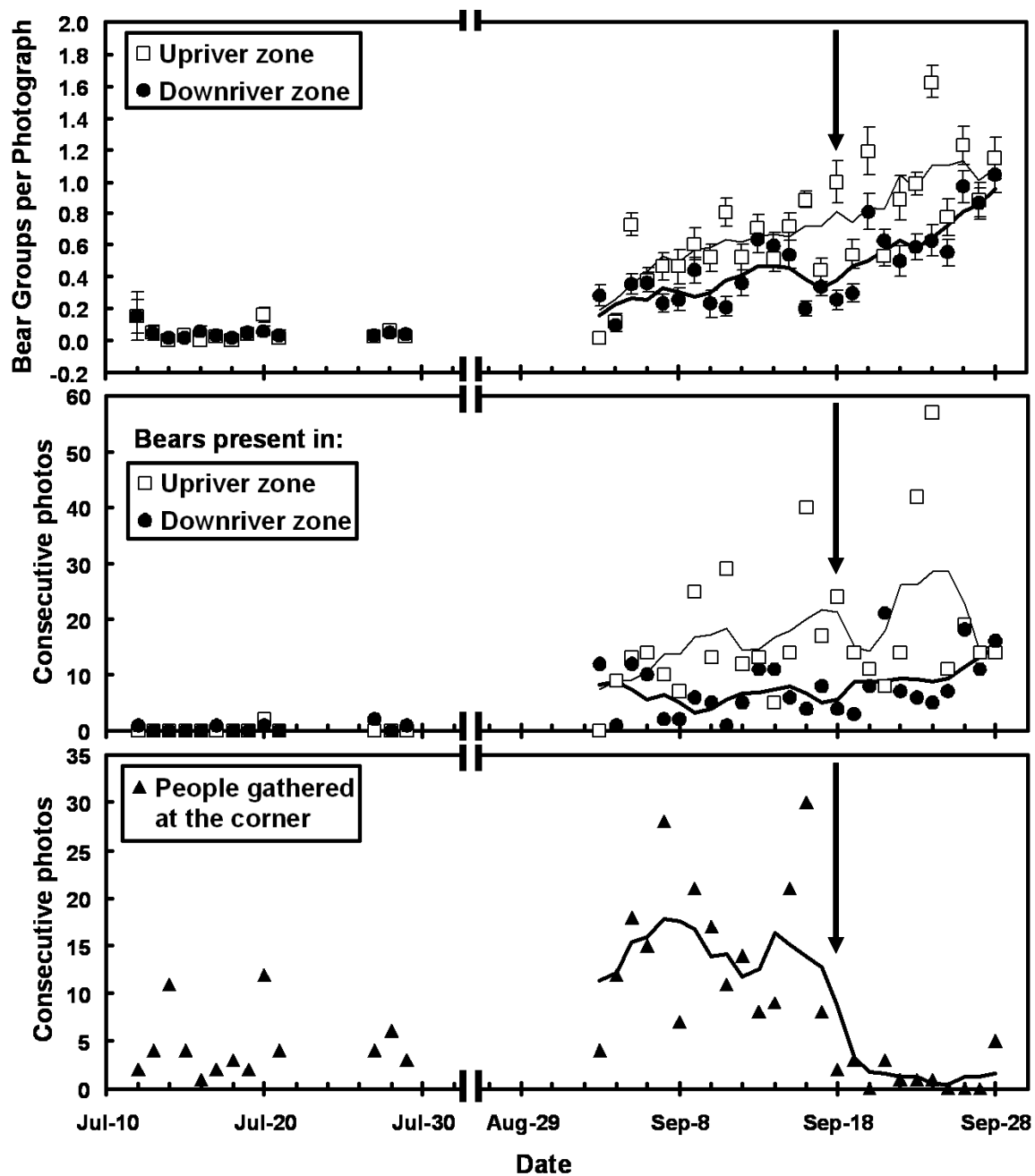


Figure 4. Changes in bear and human activity in the study area during summer 2004. The upper panel displays the average number of bear groups per photo for each day in the upriver and downriver zones of the study area. Standard error bars are displayed for each data point. The central panel displays the greatest number of consecutive photos in which a bear was within the upriver and downriver zones for each day. The lower panel shows the greatest number of consecutive photographs each day in which people were gathered at the corner. The vertical arrow marks September 18, when lodge facilities closed for the season.



Figure 5. Bear spatial use patterns upstream and downstream of the present bridge location during July, and pre- and post-lodge-closure during September, Brooks River, Katmai National Park, Alaska, 2004. Each dot is 60% transparent and represents one bear; locations where more than four bear sightings overlap are completely white. September activity corresponds to carcass availability per Braaten (1988).

maximum number of consecutive photographs with bears present was greater in the Upriver Zone than in the Downriver Zone during September but not during July (Table 3). In addition, the maximum number of consecutive photographs with people gathered at the corner was lower during July than during September (Table 3, Fig. 4).

Table 1. Paired Sample Wilcoxon tests on daily averages of the number of bear groups per photo taken at 10-minute intervals in the upriver zone (current bridge location) and downriver zone (potential bridge location) by major time period with data summarized by day.

Time Period	N(days)	Mean total bear groups/picture				Difference	P
		Upriver	Std Dev	Downriver	Std Dev		
July	13	0.045	0.054	0.047	0.035	(0.002)	0.100
Early September	15	0.527	0.237	0.343	0.154	0.185	0.011
Late September	11	0.983	0.317	0.648	0.254	0.335	0.006

In both zones, family groups were more often resting than were other bears, but there was no difference between zones in the proportion of family groups or independent bears resting (Table 4).

The relationship between the daily maximum number of consecutive photos with bears present in the Upriver Zone and the daily maximum number of consecutive photos with people gathered at the corner was poor for July; however, a correlation was evident in September ($n = 15$, $R^2 = 0.32$, $P = 0.028$).

Bear Diurnal Use Patterns

During July there was no relationship found between time of day and bear use in either zone (Table 5, Fig. 6). During September bear activity in the Upriver Zone generally declined throughout the day prior to lodge closing, then the activity pattern changed to increasing use throughout the day following lodge closure (Table 5, Fig. 6). In contrast, in September in the Downriver Zone, bear use increased throughout the day during both the pre- and post-lodge-closing periods (Table 5, Fig. 6).

DISCUSSION

Bear activity in the study zones appeared higher in September than July, consistent with the nature of resource availability in the area and results of previous studies (e.g., Braaten 1988, Olson 1993). Salmon carcasses and injured fish are sometimes available to bears during July within the study zones; however, because salmon are vigorous and migrating during July, they are relatively difficult for bears to catch. Also, any salmon carcasses that drift downstream during July are likely to be picked up by bears versus forming carcass deposits (Olson 1993). Although some bears forage for salmon in the lower river during July, the focal point of fishing activity for many bears during that month is Brooks Falls. In contrast, in September when salmon are spawning in Brooks River, many more dead and dying spawned-out salmon are available to bears in the lower river and along the Naknek Lake shoreline (Braaten 1988, Olson 1993). Bear numbers and levels of use in the lower river tend to increase throughout the fall, to some degree corresponding with

the spatiotemporal pattern of salmon availability (Olson 1993, Olson and Gilbert 1994, Olson et al. 1997).

Table 2. Wilcoxon tests to determine post-hoc differences that contribute to results in Table 1. Data are the average number of bear groups present in photographs taken at 10-minute intervals upriver (current bridge location) and downriver (potential bridge relocation) by day. Significant differences were determined by Bonferroni corrections.

Date	N	Mean bear groups/picture				Difference	P
		Upriver	Std Dev	Downriver	Std Dev		
Jul-12	13	0.154	0.555	0.154	0.376	0.000	ns
Jul-13	21	0.048	0.218	0.048	0.218	0.000	ns
Jul-14	59	0.000	0.000	0.017	0.130	(0.017)	ns
Jul-15	100	0.030	0.171	0.020	0.200	0.010	ns
Jul-16	37	0.000	0.000	0.054	0.229	(0.054)	ns
Jul-17	92	0.022	0.022	0.033	0.179	(0.011)	ns
Jul-18	69	0.000	0.000	0.014	0.120	(0.014)	ns
Jul-19	81	0.037	0.190	0.049	0.269	(0.012)	ns
Jul-20	68	0.162	0.371	0.059	0.237	0.103	ns
Jul-21	55	0.018	0.135	0.036	0.189	(0.018)	ns
Jul-27	83	0.024	0.154	0.036	0.188	(0.012)	ns
Jul-28	96	0.063	0.243	0.052	0.223	0.010	ns
Jul-29	79	0.025	0.158	0.038	0.192	(0.013)	ns
Sep-3	64	0.016	0.125	0.281	0.519	(0.266)	***
Sep-4	64	0.125	0.333	0.094	0.294	0.031	ns
Sep-5	64	0.734	0.570	0.354	0.513	0.381	*
Sep-6	63	0.381	0.607	0.365	0.485	0.016	ns
Sep-7	56	0.464	0.631	0.232	0.426	0.232	ns
Sep-8	58	0.466	0.821	0.259	0.548	0.207	ns
Sep-9	61	0.607	0.759	0.443	0.620	0.164	ns
Sep-10	52	0.519	0.610	0.231	0.614	0.288	ns
Sep-11	47	0.809	0.647	0.213	0.414	0.596	***
Sep-12	61	0.525	0.622	0.361	0.633	0.164	ns
Sep-13	72	0.708	0.740	0.639	0.793	0.069	ns
Sep-14	66	0.515	0.662	0.591	0.656	(0.076)	ns
Sep-15	56	0.714	0.653	0.536	0.660	0.179	ns
Sep-16	79	0.886	0.453	0.203	0.435	0.684	***
Sep-17	79	0.443	0.615	0.342	0.552	0.101	ns
Sep-18	53	1.000	0.981	0.255	0.440	0.745	***
Sep-19	74	0.541	0.797	0.297	0.460	0.243	ns
Sep-20	21	1.190	0.680	0.810	0.512	0.381	ns
Sep-21	77	0.532	0.598	0.623	0.650	(0.091)	ns
Sep-22	48	0.896	0.973	0.500	0.652	0.396	ns
Sep-23	75	0.987	0.626	0.587	0.718	0.400	**
Sep-24	56	1.625	0.752	0.625	0.728	1.000	***
Sep-25	67	0.776	0.966	0.552	0.681	0.224	ns
Sep-26	65	1.231	0.965	0.969	0.829	0.262	ns
Sep-27	52	0.885	0.784	0.865	0.715	0.019	ns
Sep-28	47	1.149	0.859	1.042	0.743	0.107	ns

Bonferroni Probabilities, ns = $P > 0.05$, * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$

Table 3. Wilcoxon tests comparing the daily number of consecutive photographs with bear activity in the Upriver Zone (current bridge location) and Downriver Zone (potential alternative bridge location). The number of consecutive photographs with people waiting at the corner is included for reference. Note that the lodge is closed during late September, when people are rarely observed.

Time period	N	People on Corner		Upriver zone		Downriver zone		P
		Mean	SD	Mean	SD	Mean	SD	
July	13	4.462	3.382	0.154	0.555	0.462	0.660	0.157
Early Sept	15	14.867	7.671	14.733	9.989	6.400	4.032	0.014
Late Sept	11	1.455	1.635	20.727	15.212	9.636	6.071	0.041

Table 4. Likelihood of resting for individual bears versus family groups in upriver and downriver locations. P-values reported are from Wilcoxon tests comparing paired observations across bear groups within zones, and within groups across zones.

Time Period	Group	Upriver zone				Downriver zone				Across Zones P
		N	Mean	SD	P	N	Mean	SD	P	
July	IB	10	0.060	0.158	} 0.317	12	0	0	} -----	0.180
	FG	3	0	0		3	0	0		-----
Early Sept	IB	15	0.132	0.242	} 0.028	15	0.039	0.119	} 0.013	0.208
	FG	13	0.463	0.208		14	0.369	0.311		0.249
Late Sept	IB	11	0.095	0.141	} 0.021	11	0.142	0.199	} 0.047	0.237
	FG	11	0.303	0.278		11	0.362	0.194		0.722

During September, every measure of bear activity was higher in the Upriver Zone, where the bridge was located, than in the Downriver Zone (proposed bridge relocation site). In the Downriver Zone bear activity appeared to be more sporadic and there were fewer overall bears. The primary question posed by this study was whether repositioning the bridge downstream of its present location could reduce bear-human interactions and lengthy human traffic delays due to bear activity. It is apparent that to access the floating bridge, people had to walk along a section of the river where salmon carcasses tended to accumulate, particularly during the fall. Overall bear spatial use patterns within the 2 river zones monitored appeared to reflect salmon carcass accumulation areas. Consequently the layout of the bridge and access trail resulted in human traffic being funneled through a productive bear feeding area. Often traffic flow was affected if bears were near the trail paralleling the river, and/or when the time it took to walk to the bridge delayed crossing because in the interim bears had moved too close to the bridge to allow passage.

Table 5. Results of linear regression analyses of bear activity as a function of time of day. Probabilities are reported for logistic regression results also because the bear group variable is categorical in nature, with only a few values ranging from 0 to 4. Compare these results to figure 6 for an unbiased estimate of the relationship between time of day and bear activity.

Time period	Location	N	r ²	coefficient	S.E.	t	P	Logistic P
July	Upriver	859	0.0001	0.000049	0.000014	0.346	0.729	0.631
	Downriver	895	0.0000	0.000000	0.000014	-0.012	0.990	0.623
Early Sept.	Upriver	956	0.0141	-0.000224	0.000061	-3.688	0.000	0.000
	Downriver	955	0.0142	0.000201	0.000054	3.711	0.000	0.003
Late Sept.	Upriver	642	0.0115	0.000277	0.000101	2.729	0.007	0.059
	Downriver	645	0.0098	0.000204	0.000081	2.524	0.012	0.000

If the bridge was relocated to the proposed site downriver (bridge would extend from the corner on the north bank to in front of the Lower Platform on the south bank), no travel along the river bank would be required to access the bridge. Management of human traffic would likely be simplified because human traffic flow would be more direct and would avoid paralleling the river. This could result in fewer traffic delays, fewer close-range interactions with bears, and less disruption of bear feeding activity. However, other issues related to the location of the bridge including bridge and trail maintenance, river bank erosion (effects of the bridge itself, as well as effects of trail maintenance), and how the bridge affects bear movements (bears are unable to pass under the bridge in parts of the river that are too shallow) would also require evaluation. We also recommend that the effects of any change in the location or nature of the bridge be assessed through documentation and comparison of bear use patterns using methods similar to those employed for this study.

A number of studies in various locations have assessed the effects of human activity on brown bear spatial and temporal use patterns at bear feeding concentration sites including Brooks River. For example, brown bears at Kulik River, a salmon stream in Katmai National Park, left the river at higher rates when people were present nearby than when people were >200 m away (Smith and Johnson 2004). Similarly, at the Douglas River and adjacent salt marshes within Katmai National Park, experimental introduction of visitors altered temporal and/or spatial use patterns, although fall body weight and composition were unaffected (Rode et al. 2006, Rode et al. 2007). Also, at Brooks River, a delay in increased use by bears classified as more wary of people was observed when fall lodge operations were extended (Olson et al. 1997).

Age and/or sex class differences in the effects of human activity on brown bears at feeding concentration sites have also often been reported. Although a number of studies have documented displacement effects of people on some family groups at Brooks River (Braaten 1988, Olson and Gilbert 1994, Olson et al. 1997), studies conducted at Pack Creek, Wolverine Creek, Thumb River, Douglas River, and Kulik River in Alaska and at Glendale Cove in British Columbia have reported that in general, females with dependent

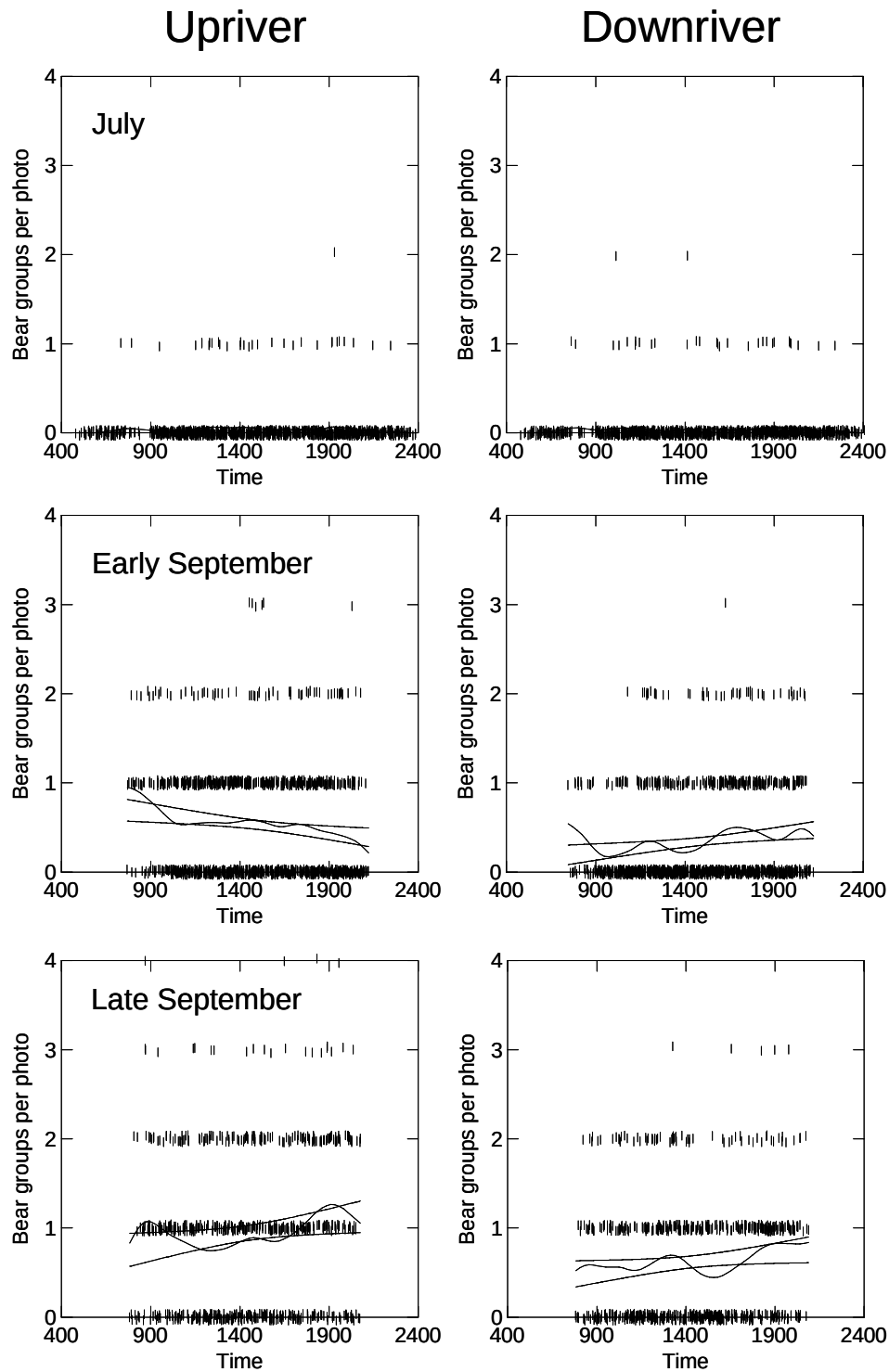


Figure 6. Relationship between the number of bears and time of day by zone, Brooks River, Katmai National Park, Alaska, 2004. Wavy lines indicate non-parametric fits. Where the linear regression was significant, 95% error bars are indicated.

offspring and subadults were less spatially and/or temporally displaced by human activity than were adult males (Warner 1987, Wilker et al. 1997, Smith 2002, Nevin and Gilbert 2005b, Rode et al. 2006, Rode et al. 2007, Tollefson et al. 2005).

During September, activity of family groups was substantially different from that of independent bears as reflected in the proportion of observations in which the bears were resting. However, there were no differences in resting behavior between the two zones, so the role of human activity in this difference is unclear.

Diurnal bear activity patterns documented at brown bear concentration sites vary across studies, and relationships with human activity were sometimes unclear. Crepuscular activity patterns have been documented at several study sites with human activity (e.g., Warner 1987, Olson 1993, Olson et al. 1998, Nevin and Gilbert 2005a); however, similar patterns have also been documented at some sites without human use (e.g., Warner 1987, Olson et al. 1990). In contrast, relatively similar activity levels throughout the day were observed at another study site with human use (Barnes and Wilker 1997), and Olson et al. (1997) reported similar levels of bear use throughout the day at a site with no human activity.

During September, bear diurnal use patterns in our 2 study zones showed changes following lodge closure that may reflect differences in human activity. Prior to lodge closure, the bear diurnal use pattern in the upriver zone showed peak activity early in the day and declining activity thereafter. This occurred somewhat coincident with high human use time periods. In contrast, following lodge closure, the diurnal use pattern in the upriver zone showed a general increasing pattern throughout the day. However, it should be noted that bear use patterns documented in our study zones largely represent activity by some of the more human-tolerant bears that use Brooks River. Less tolerant bears likely focused their use further upstream (Olson 1993, Olson and Gilbert 1994, Olson et al. 1997).

Data Limitations

1. Opportunities to allow human traffic to cross the floating bridge were often brief and likely sometimes occurred in between consecutive photographs that appeared to show continuous bear activity. Hence, the analysis of consecutive photographs with bears present may have somewhat exaggerated the degree to which bear presence affected human traffic. Conversely, bear activity near the base of the Lower River Platform and immediately upstream of the platform went unrecorded because those areas were not visible to the cameras, and such undocumented bear activity would have impeded human traffic flow.
2. Previous research indicated that bear use of the lower river was largely by a relatively small subset of the more human-tolerant bears that frequent Brooks River (Olson 1993, Olson and Gilbert 1994, Olson et al. 1997, Olson et al. 1998). Therefore, it is likely that our data represent the use patterns of a limited subset of the bears that used the area. For example, an estimated half of all bear minutes recorded during observational monitoring of the river below the bridge prior to

- lodge closing in 2004 were by only 4 of the 51 bears identified regularly using Brooks River that fall (T. Olson, NPS, unpublished data). Also all 4 of these bears were adult females, a class of bears that sometimes markedly alter their river use patterns depending upon maternal status (Olson and Gilbert 1994).
3. Bears in vegetative cover were difficult to detect in photographs. Therefore, the data reflect bear use primarily for open areas within the 2 river zones.
 4. Counts of people gathered at the corner only provided a measure of the number of people visible that were waiting to cross from the camp side to the south side of the river. Also, we assumed that people gathered at the corner were waiting to cross the bridge, which may at times have not been the case.
 5. Because the cameras only monitored the river zones, human traffic congestion located away from the corner toward camp was not documented. For example, when bears occasionally bedded near the corner, people were held back toward camp.
 6. Our suggestion that relocating the bridge downstream could reduce human traffic delays was based on our examination of bear use patterns relative to the current bridge location. It should be noted that if the bridge was moved, it is possible that bear use patterns could change to some degree in response.

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