Effects of wildlife viewing on the behaviour of grizzly bear (*Ursus arctos*) in the Khutzeymateen (K'tzim-a-deen) Grizzly Bear Sanctuary, British Columbia

by
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Abstract

Some level of human activity is often permitted in protected areas, and concerns arise over the impacts of these activities on the wildlife inhabiting them. Human impacts have traditionally been assessed under the paradigms of conservation biology and wildlife management, which tend to focus on population or community level processes. I argue that public concerns over the impacts of human activity, and especially of non-consumptive recreation, also include a concern for the quality of life of individual animals, and that approaches from the field of animal welfare can address these concerns and thus complement the traditional approaches to the problem.

I measured time budgets of grizzly bears at the Khutzeymateen/ K'tzim-a-deen Grizzly Bear Sanctuary to assess whether human presence appeared to negatively impact the bears. Neither feeding nor travelling behaviours changed significantly in the presence of tourists. Vigilance did increase significantly, but only by modest amounts. Two bears increased their resting by over 18%, leading to an overall significant effect.

These changes indicate that tourist presence does not lead to severe short-term impacts, and suggest that further restrictions are not necessary to protect the quality of life of the bears. Population parameters were not assessed in this study; a long-term monitoring plan would be necessary to rule out possible impacts at this scale.

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Introduction

Background

Eco-tourism and other forms of non-consumptive recreation are rapidly increasing world-wide, and especially in North America (Knight and Gutzwiller K J, 1995; Duffus and Wipond, 1992; Duffus and Dearden, 1990; Boyle and Samson F B, 1985), raising concerns over the proper management of such activities. Much of the scientific work on the effects of eco-tourism addresses, either implicitly or explicitly, concerns over effects at the population level. This likely follows from the tradition of wildlife management, where animals are considered a natural resource, and the aim of management is to utilise the resource in a sustainable manner (Duffus and Wipond, 1992). As population parameters are difficult and time-consuming to measure directly (especially in longer-lived mammals), many researchers have used behavioural indices of disturbance as potential indicators of eventual population-level effects (Miller et al., 2001; Nisbet, 2000; Burson et al., 2000; Gill et al., 1996; Klein et al., 1995; Leslie Jr. and Douglas, 1980). The use of at least one such measure (the departure of animals from a feeding area) has been criticised by Gill et al. (2001) on the basis that whether or not an animal leaves an area to avoid humans depends not only on the fitness costs to the animal of remaining, but also on the availability of alternative habitat. Thus, if an animal does not have access to an alternative feeding area (for instance), it may remain in a disturbed area, incurring high costs without showing any overt avoidance of humans. Likewise, if an animal has easy access to good alternate habitats, they may consistently avoid humans by moving a short distance to an equally good habitat, yet not incur any significant cost. Gill et al. (2001) conclude that if behavioural measures are used to assess the sensitivity of species to disturbance by humans,"there is a risk that valuable resources will be spent and human access restricted in order to protect species for which human presence alters behaviour but has no other impact".

In a discussion of the ethics of medical treatment for sick or injured wildlife, Loftin refers to "the mistaken belief that value lies in the individual wild animals rather than the entire ecosystem" (Loftin, 1985), while in the context of a review of the impacts of petroleum exploration on arctic mammals, Shank (1979) is even more explicit in stating that only population level concerns are important:

> What is commonly forgotten or ignored in these studies is that disruption of normal behaviour is not necessarily bad in itself. Violent behavioural responses to human activities are perfectly acceptable, outside of a moral context, if they fail to lead to population declines. For behavioural disturbance to be of practical

concern, it must be demonstrated that it does, or does not, have demographic consequences.

While population viability and sustainable use of resources are certainly valid goals for management programs, I do not believe they are the *only* valid goals. It is not clear why Shank's 'moral context' is not, in fact, of practical concern to park managers, or why protecting species from behavioural disruption without population consequences would be a waste of valuable resources that should be guarded against. Indeed, Taylor (2000) argues that "it is the good (well-being, welfare) of individual organisms considered as entities having inherent worth, that determines our moral relations with the Earth's wild communities." Further, the very wording of concerns over 'disturbing' or 'harassing' the animals refers to the quality of life of individual animals rather than to population parameters. This suggests that there are two separate concerns that a park's management should address: on the one hand, the population should be protected from any negative effects on its viability, and on the other hand, individuals within that population should be protected from harassment and disturbance, whether or not this leads to eventual population consequences.

The debate over how to define and study the quality of animals' lives has, to a large degree, occurred in the literature on farm animal welfare. Different approaches to the problem include measures from stress physiology (Moberg, 1996), 'naturalness' of behaviours shown in captivity and measurement of abnormal or stereotyped behaviour patterns (Mason, 1991), concerns over the 'fundamental nature' of the animal (Rollin, 1997), and attempts to understand the animal's own perception of its environment and the subjective feelings of the animal (Dawkins, 1990). These different approaches have been reviewed by Fraser (1995) and Stafleu (1996). Some of the concerns that apply to farm animals do not apply to wildlife viewing situations: we are not housing wild animals in ways that may constrain the expression of a natural behavioural repertoire or lead to abnormal, stereotyped behaviours, and we are not using genetic selection or engineering techniques which may violate the fundamental nature of animals. Nevertheless, other concerns may apply. When animals perceive humans as a threat, this may lead to both negative affective states (fear, stress, etc.) and physiological stress responses. Also, if the fundamental nature of wild bears is held to include a fear of humans, then habituation may be considered to affect that nature. These effects are ethical concerns in their own right, whether or not they eventually lead to population consequences.

In addition to managing for the protection of wild animals, both over short and long time scales, management goals often include several factors related to human visitors. The first of these would include managing for a positive visitor experience.

However, this factor falls outside the scope of my study, so I will not discuss it in detail. The second involves managing for the safety of human visitors. This is a particular concern in areas such as the Khutzeymateen, where humans are brought into close proximity of large, powerful, and potentially dangerous animals.

One of the key concerns related to human safety in the context of recreation in grizzly bear habitat is the potential for habituation by the bears. I will follow the terminology suggested by McCullough (1982), who defined habituation to humans as the diminution of responses to humans after several non-negative interactions, and food-conditioning as a learned association between humans and easy food availability after the bear has obtained food (human food or edible garbage) from or near humans. While most authors agree that habituation and food conditioning can be separated, some (Herrero, 1985; McCullough, 1982) hold that habituated bears pose an increased threat to human safety, whether or not their habituation is accompanied by food conditioning. However, evidence from the MacNeil River Game Sanctuary, Alaska (Aumiller and Matt, 1994) suggests that habituation in the absence of food conditioning can occur without any increases in dangerous human-bear encounters.

Objectives

The primary objective of this study was to address concerns over the potential impacts of wildlife viewing on the quality of life of individual bears at the Khutzeymateen Grizzly Bear Sanctuary. Where able, I have also provided information relevant to other ethical concerns.

In general, I have followed the concept set out by Dawkins (1990), which states that assessing the subjective feelings of animals is an important component of welfare assessment, and that while subjective feelings cannot be 'measured' in a purely numerical manner, it is possible to investigate them through scientific means. In particular, I aimed to determine whether the presence of humans in their environment led to changes in the behaviours of the bears that would suggest that the bears perceive human presence as a negative, dangerous or aversive stimulus. While physiological measures of stress might also shed light on this question, the invasiveness of obtaining such measures in wild and free-living animals may be ethically questionable, and the logistical difficulties of obtaining them in bears are considerable. For these reasons, I limited my data collection to behavioural observations. For some behaviours (esp. feeding), it could also be argued plausibly that changes in feeding time might eventually relate to population consequences; a rigorous demonstration of such consequences, however, is outside the scope of this study.

While logistical constraints limited my own data collection to a single field season, a previous review of wildlife activities in the Khutzeymateen (Himmer, 1996) recommended a program of data collection by all bear observers (tour guides, park rangers and volunteer park hosts). This recommendation was implemented, and I had access to a longer term set of data recording some key variables about every bear observation by tourists in the Sanctuary. I examined these records to assess habituation to tourists over time.

Methods

Study area

The Khutzeymateen/ K'tzim-a-deen Grizzly Bear Sanctuary is located 45 km north-east of Prince Rupert, on the British Columbia coast. The park encompasses the 445 km^2 watershed of the Khutzeymateen River, and is situated at the core of a 3850 km^2 no-hunting zone for grizzly bears. Traditional land use of the area included hunting (mountain goat, beaver and seal) and fishing (primarily salmon) by the Gitsiis people, part of the Tsimshian Nation. Extensive commercial logging occurred in the 1950's and

1960's along the shores of the Khutzeymateen inlet, but only a few small stands within the present boundaries of the park were taken. In the 1970's, the United Nations Biological Program identified the Khutzeymateen valley as important grizzly bear habitat, but a proposal for an Ecological Reserve was not approved. In the 1980's, renewed proposals for logging in the valley were put forward, leading eventually to a series of studies, the Khutzeymateen Project. At the same time, the B.C. Ministry of Environment, Lands and Parks established the no-hunting zone for grizzly bears, stretching from the Skeena river in the south to the Work Channel in the south-east and to Pearse Inlet in the north-east, with the Khutzeymateen watershed at its core. Of the options examined by the Khutzeymateen Project, the dominant feeling was that provincial park status would allow the best balance between allowing limited traditional use and protection of grizzly bears and their habitat. The watershed was designated as a class 'A' Provincial Park in August, 1995.

During the land-use conflicts in the late 1980's, public awareness of the area and interest in viewing it grew. Since 1987, two principal wildlife viewing operators have been conducting tours to the Khutzeymateen. These tour operators were allowed to continue operations in the park after its inception, and are still active today. The larger of the two (Ocean Light Tours, operated by Tom Ellis) is based out of Vancouver, and can accommodate up to 9 guests at a time. The smaller (Sun Chaser Tours, operated by Dan Wakeman) is based out of Prince Rupert and accommodates 4-6 guests at a time. For both operations, tours generally last 3-4 days, with guests flown in and out from Prince Rupert by float plane, landing on the inlet outside the estuary. Guests live on the tour boats, at anchor on the inlet, and conduct viewing excursions by inflatable outboard boats (Zodiacs), and occasionally by kayak.

While the Khutzeymateen estuary is the largest and most obvious wildlife viewing area in the vicinity, smaller estuaries exist at Larch Creek, Cedar Creek, Mouse Creek and others along the inlet, outside the park boundaries. Management of the park focuses on viewing bears at the Khutzeymateen estuary. Access to this estuary is limited by tides, as the water depth in the main channels is only sufficient for Zodiacs during an approximately 4-hour window around high tide. While access by kayak or jet-boat may be possible at other times, jet-boats are not allowed by the current management plan, and kayaks are not generally used by the tour operators. Currently, the management of tourism does not permit unguided trips to the estuary nor any access to portions of the park above the estuary. Scenic flight tours are discouraged, with local aircraft companies accepting a voluntary 1000 ft lower altitude limit on flights over the estuary. Further, no shore-based camping or permanent installations are considered; a floating ranger station is towed in from Prince Rupert and anchored in the inlet from May to October, and tour operators accommodate their guests on-board their own vessels. Shore-based viewing is discouraged, although short excursions to two sites rich in bear sign are permitted. These excursions are kept short to reduce the possibility of human scents discouraging bears' use of these features, and no food is allowed on shore, to avoid problems of food conditioning in the bears.

Data Collection

I conducted all behavioural observations from a land-based observation post above the south side of the Khutzeymateen Estuary. This post commanded a view of almost all of the estuary, with the exceptions of zones 21, 20, 37, 8, and parts of 2 and 1 (see Appendix 1--Air photo). My research assistant, Jordan Catherall (JC) and I camped at this spot for about a week at a time to reduce our travel through the lower-elevation areas which are most heavily used by the bears. We established the observation camp on May 6th, at the very beginning of both the tourist season and the bears' seasonal use of the estuary, and continued observations until June 19th, after the last commercial tours of the season.

Grizzly bears have sufficient variation in coat colour and markings to allow individual identification without marking.

For all observations, I used the following behavioural categories:

- Resting: bear lying down, head close to ground, not feeding.
- Travel: bear walking, running or swimming.
- Feeding: bear's mouth close to ground manipulating grasses and sedges.
- Vigilance: further divided into:
    - Head-Up: bear's head higher than shoulders.
    - Scan: bear's head higher than shoulders and sweeping from side to side.
    - Sit-Scan: bear sitting up, head high, sweeping head from side to side or sniffing at air.
    - Stand-Scan: bear rears onto hind legs, either sweeping head or sniffing at air.

Distance to the bears was frequently too large to identify chewing movements, so I was unable to determine if the head-up behaviour precluded feeding. Nevertheless, even if some vigilance behaviours do not decrease feed intake, they still provide insight into the animal’s perception of its environment.

Discrete time-interval sampling generates unbiased estimates of the percentage of time spent in different activities, but the expected variation increases with the rarity of the behaviours or with decreasing duration of behavioural bouts. 1-0 sampling underestimates the true frequency of occurrence of behaviours, but the magnitude of this bias decreases with increasing rarity of the behaviours (Martin and Bateson, 1986). I therefore combined the two methodologies, using the discrete time-interval sampling data to estimate the percentage of the bear's time they spent in each of the four main behavioural categories (Resting, Travel, Feeding and Vigilance) and the 1-0 frequencies for the sub-categories of vigilance (Head-up, Scan, Sit-Scan and Stand-Scan).

I personally observed the bears through a 30x spotting scope and used time-interval scan sampling to collect behavioural data. As the number of bears present at any given time was variable and not known a priori, I chose to keep the interval between successive observations constant at 30sec, allowing the interval between successive observations of a given individual to increase as the number of individuals present increased.

My research assistant collected video-tape footage of most bear visits using a Sony Handicam with 40x zoom power. These tapes were used as aids to identification of individual bears. He also used 12x binoculars and 1-0 sampling with 30 second bins to follow a single bear and to code behavioural data, using the same behavioural categories as above for the time-interval sampling. If several bears were present, he picked one (generally the first one sighted) to follow while others were ignored.

In all, I observed 208 bear visits to the estuary during 240 hours of observation between May 7th and June 19th, 2000. The bear was identified in 162 of these visits; 23 individual bears were identified. Due to problems with low light, fog, condensation, etc., the videotapes were of only limited usefulness. My ability to identify bears on sight improved markedly over the 6-week season; while the bear remained unidentified in 23 of the first 50 bear visits of the season, only 3 of the last 50 bears seen were unidentified. Bears were present approximately half of the time, whether tourists were present (34/63h of observation) or absent (90/177h). Some bear visits were short, or the bear was only partially visible, and I only calculated time budgets for bear visits where I had valid data from at least 10 scan samples. This left 165 observations in the absence of tourists and 35 observations in their presence; for 19 bear visits, tourists were present for only part of the visit. As JC was only able to observe a single bear at a time, I have 1-0 frequency data for only 123 of the visits.

As we defined the presence/ absence of tourists based on their visibility from our observation post, it is possible that the bears perceived the arrival of tourists either earlier or later than we did. It is also likely that changes in behaviour by the bears would not occur instantaneously with the arrival or departure of tourist. However, as the time course of such changes is not known, and my data were insufficient to describe it, I analyse the data based on the assumption that the time course of changes in behaviour and the measurement error in declaring tourist arrival and departure are both short relative to the duration over which average time budgets are calculated.

Following the recommendation of Himmer (1996), records of all bear observations in the sanctuary by the two tour guides, the park rangers (during the high season May-August) and the volunteer hosts (September-November) were available for 1995 to 2000. Each record included the date, location, start and end times of the observation, bear class (lone adult, adult pair, etc.), bear's activity (e.g. feeding or travelling) and reaction to people (e.g. No reaction, walked away, etc.), the behaviour of the humans (e.g. move closer, move away, etc.), closest distance to bear (<50, 50-100, 100-200 and >200 m.), relation to wind and the number of people present. This data set included observations on the estuary at the head of the Khutzeymateen inlet, where my own observations were taken, as well as at other locations further down the inlet. As these observations were taken by the human visitors to the estuary, they do not include any data for bears when there were no humans in close proximity. Also, as the data were collected by several individuals, there may be differences in the observers' coding of behaviours.

Analysis

Time budgets (the percentage of total time the bear was visible that it spent in each of the four behavioural categories) were calculated separately for each bear visit, and where tourists were present for part of the bear visit, separately for the part of the visit before, during and after the tourist's presence. As intervals between successive observations of a given bear were longer when several bears were present on the estuary, these observations were weighted by the observation interval, so that, for instance, a five-minute period with 10 observations (only one bear present) would contribute equally to the overall time budget as a five-minute period with only 5 observations (2 bears present). Initial data exploration suggested that data for parts of a bear visit before tourists arrived, after tourists left, and where no tourists were present during any part of the visit did not differ. For the analysis presented, these three groups were pooled to increase the sample size. One-zero frequencies for vigilance behaviours recorded by JC were also calculated separately for the parts of bear visits with and without tourists. While some variables were not entirely normal in distribution (see Appendix 2), conclusions of statistical tests were not different when non-parametric tests were used, and I present the parametric analyses as they allow calculation of means and confidence intervals for effect sizes.

For those bear visits where tourists arrived (and/ or left) partway through the bear's visit (n=19 visits), I was able to calculate the change in behaviour by a given bear on a single occasion (see Appendix 3). However, as these bear visits included multiple observations of some individual bears, I then calculated an average difference for each bear (n=7 bears) before analysis.

To test for overall differences in average behaviour, I used a one-way ANOVA with different bear visits as the sampling unit, tourist presence (yes/no) as the independent variable and each of the behaviours (either % time or 1-0 frequency) as the dependent variables. While several of these visits were in fact the same individual bear, this test allows for prediction of the behaviour of a bear during the next observed bear visit. Where I had observations of the bear's behaviour both with and without tourist presence during the same visit by the bear, I calculated the differences within each paired observation and used a Student's t-test to test whether these differed from zero, with the individual bears as the sampling unit. As many of the variables did not differ significantly between the two categories of tourist presence, I also calculated and report 95% confidence intervals for the magnitude of the effect.

From the data set collected by the guides over previous 5 years, I examined two variables as potential indicators of habituation: 1) the reactions of the bears and 2) the closest approach distance to the bears. Both of these, of course, are reflections both of the bears' tolerance of human approach, of the tourists' willingness to approach bears, and of potential variation in how given behaviours are recorded, but I felt that these two variables might offer some useful insight. For the bear's reactions, I grouped all modes of retreat (walk, run) and grouped 'unaware' and 'no reaction' to reduce the number of response levels. I then calculated the fraction of bear visits in a given year where each reaction was shown. I also calculated an average approach distance by using the midpoint of each class used by the tour operators, using 300m as an arbitrary 'midpoint' of the '>200m' class.

Results

Overall, bears spent on average 50% of their time feeding, 20% vigilant, 14% travelling and 7% resting (see Table 1). Large variations were observed, both between different bears and between different visits by the same bear.

The resting component of the time budgets increased significantly ($F_{1,198}$=9.09; P=0.029) with tourist presence. The distribution of resting time data (see Appendix 2 for data distributions) suggests that the majority of bears do not rest much, if at all, on the estuary. Resting accounted for less than 5% of the time budget in 11/23 bear visits with tourists present, and 133/165 visits in their absence. In the remaining bear visits, resting accounted for up to 70% of the visit, with a similar range seen both with and without tourist presence. While the increase in resting was only statistically significant in the un-paired tests, it approached significance (n=7; T=2.07; P=0.08) when data were paired within bear-visit (Table 2). Two of the seven bears in the paired analysis rested neither with tourists present or absent, three bears increased resting by 2-5%, and the remaining two increased resting by 18 and 13%, respectively.

While most bears spent, on average, 10-15% of their time in vigilance behaviours, others averaged as high as 40%. During individual visits, variation was higher, with bears typically spending between 10 and 50% of their time in vigilance behaviours. On a few occasions, a bear appeared to be merely passing through the study area, and spent most of its time (up to 90%) travelling, with no vigilance behaviour displayed. On two occasions, over 60% of the bear's visit was spent vigilant; these were both sows with young cubs. Overall average vigilance behaviour did not increase when tourists were present ($F_{1,198}$=0.01; P=0.94), but when paired within bear visit, vigilance did increase in the presence of tourists (n=7; T=7.26; P=0.0003). During some of these visits the bear spent less time vigilant during the part of the visit where tourists were present, but most

(5/7) of the bears in the paired analysis were observed during two or more visits that could be used for this analysis, and on average all 7 spent slightly more time (3-9%) vigilant when tourists were present. The mean effect sizes were relatively small, however, and the 95% confidence intervals did not encompass increases accounting for more that 9% of the bears' time budgets. While six of the seven bears did decrease their feeding to compensate for the increases in vigilance, only three decreased their feeding by more than 10% (range 11 to 34%), and these three also increased their resting time (range 5 to 22%)

Four types of vigilance behaviour were recorded in the 1-0 sampling data set: Head-up, scan, sit-scan and stand-scan. However, as the bias of the sampling method increases with the frequency of the behaviour, I only used data for variables occurring on average in fewer than 10% of the 30sec observation bins, dropping the Scan behaviour which occurred more frequently. I also dropped the Sit-Scan behaviour, partly because it occurred only 5-6 times in my entire data set, and partly because it did not seem to be a distinct behaviour, but rather a sub-set of the Scan behaviour. The head-up behaviour occurred in 5.2% of bins, with no significant difference based on tourist presence ($F_{1,121}$=0.8; P=0.4). The Stand-Scan behaviour also occurred infrequently (0.35% of bins overall), and did not differ based on tourist presence ($F_{1,121}$=0.09; P=0.8).

Travelling did not differ statistically in either of the analyses performed, and 95% confidence intervals are not consistent with any changes accounting for more than 11% of the bears' time budgets.

The effect of tourist presence on feeding behaviour was not statistically significant, but variation in this behaviour was high, such that the observed data were consistent with both the null hypothesis of no effect and with an alternate hypothesis of up to 24% less time spent feeding during tourist presence. However, this large confidence interval was at least partly due to the small sample size in the paired analysis; the confidence interval for the unpaired data is consistent with no more than a 13% decrease in feeding.

Over the five years for which I had data reported by the tour guides and the parks rangers, the bears showed no reaction to the tourists in 53% of observations, retreated in 36% of observations, and approached tourists in 7% of observations ('Other' bear reactions reported in 4% of cases). There were no linear trends with time (year) for the likelihood that bears would show any one of these reactions (see Table 3). There were marked differences in reactions with the distance to which tourists approached, but these appeared to be driven by the fact that those bears that were going to retreat tended to do so when the tourists were still far away; therefore there are relatively few bears running or retreating from tourists at 50 meters or less. If the distance to which tourists approach is taken as a measure of the tolerance of the bear rather than the behaviour of the tourist, this could provide an indication of habituation. The average distance of closest approach between bears and tourists did show a dramatic decline from 210 m in 1995 to 97 m in 1997, but in 1998 and 1999 it was essentially the same as in 1996, at 140-160 m.

In addition to the formal data recording, I often made notes about the bears' behaviour, especially with regard to their reactions to tourists. These impressions were supplemented by my own observations when touring the estuary by zodiac, and discussions with tour guides, rangers and tourists. While the bears most often seemed to show no reaction to tourists, the occasional bear would avoid being approached closely. We occasionally observed these bears moving in and out of cover, rearing, sniffing, and looking at the tourists before deciding to leave the estuary for the cover of the forests. It is quite possible that on other occasions a bear might have been close to the estuary, become aware of tourists and decided not to emerge from the cover of forest, without our being aware of its presence. On one occasion, we were watching a bear feeding on one of the open avalanche slopes. As a tourist zodiac drifted past, the bear went out of sight behind a solitary large bush in the middle of the slope, and resumed feeding immediately after the tourists had passed. On other occasions, though, we were left with the impression that the bears took advantage of the tourists presence (which would mean the absence of other, less tolerant, bears) to rest. This was confirmed by the tour guides, who said that some bears would often face *away* from the tourists to rest, and that when the tourists started the zodiac engine to leave, the bear would get up and walk off into the forest or resume foraging. This would suggest that the bear considered that the tourists as a known, safe quantity, and any threats would come from elsewhere. I observed a similar pattern on one or two occasions, but as these coincided with the rising tide reaching the bear's position, it was not clear whether bear was leaving because of the tide or because of the tourists' departure.

On another occasion, I was watching “Sparky”, one of the younger and more tourist-tolerant bears, shortly after he started appearing independently of his mother. He was travelling and feeding around the centre of the estuary, when he was startled by an otter splashing around in one of the channels right behind him, and ran for several minutes. Following this, he slowly and cautiously returned to the channel to investigate. This observation suggests that the tolerance of bears towards tourists is not necessarily generalised to a tolerance of other stimuli.

Discussion

The large variation in responses by different bears is consistent with previous studies. Gunther (1990) reports that responses by grizzlies to human presence in Pelican Valley, Yellowstone National Park, range from flight in 53% of observed cases to approach toward humans in 14% of cases. McLennan and Shackleton (1989), working in the Flatheads region straddling the border between British Columbia and Montana, also reported that approximately 50% of bears ran from various human stimuli when the stimulus approached within 75 m of the bear. A somewhat counter-intuitive finding in their data was that bears were in fact *more* likely to move away from a person on foot when the person was more than 150 m away, but this can be explained by suggesting that those bears who are intolerant of human approach will have left the area before a pedestrian is able to approach closely. Both of these results show higher rates of retreating from humans than in our present study. On the other hand, Fagen and Fagen (1990) used play behaviour as a sensitive index of disturbance, and found no effects of human presence on the behaviour of grizzly bears at Pack Creek, Alaska. Olson and Gilbert (1994) followed 10 identified females with young over three years at Brooks River, Alaska, and found that half of these females consistently tolerated human presence within 50 m without overt behavioural changes. Those bears that were less tolerant of human proximity preferentially used areas further away from the human camp throughout the summer, and were only seen near camp after human tourist activities ended for the season.

It has been suggested that coastal bears are more tolerant of human presence and less likely to act aggressively towards humans than are bears living further inland. This difference has been attributed to the richness of food sources (especially salmon runs), which attract large numbers of bears and are not easily defensible, thus leading to a tolerance of other bears (Craighead et al., 1995). It is possible that this may be generalised to a tolerance of other species, as well as a reduction of food-defending behaviours, which are a frequent cause of human-directed attacks (Herrero, 1985). However, an additional factor that is likely to affect bear-human interactions is the predictability of the human's presence and behaviours. In many of the coastal bear-viewing areas, humans are largely restricted to relatively few trails (e.g. MacNeil River Falls (Aumiller and Matt, 1994), Brooks River (Olson and Gilbert, 1994) and Pack Creek (Fagen and Fagen, 1994)), or, as in the Khutzeymateen, to inflatable boats on tidal waterways. In interior areas, by contrast, trails may criss-cross the habitat, and off-trail hiking may be common, especially at higher elevations. Working with mountain sheep in south-western Alberta, MacArthur (1982) found that animals showed much higher cardiac and behavioural responses to humans approaching from over a ridge (unexpected direction) than to human approach directly from the road (expected direction).

The increase in resting behaviour that I observed during tourist visits was unexpected. The only previous study where resting was documented (White et al., 1999) reported that resting dropped from 10% to 0% of average time budgets when bears were disturbed by tourists. Like the play behaviour used by Fagen and Fagen (1990), resting would seem to be a sensitive indicator of whether bears are perceiving human presence as aversive or potentially threatening. While resting varied greatly in this study (from 0 to almost 70% of time budgets during individual bear visits both during and without tourist presence), the fact that it was not suppressed (in fact it increased slightly) while tourists were present, suggests that these bears are not highly disturbed by human presence.

The effects on feeding behaviour were not statistically significant, but the variation was high and 95% confidence intervals encompassed potentially adverse effects as well as the null hypothesis of no change. Since my study encompassed the entire tourist season, it would be difficult to increase the sample size in future studies. Potentially, better-quality video footage and/ or a researcher already familiar with the individual bears from a previous field season would allow identification of all bears (my ability to identify the bears increased dramatically as the field season progressed), which might increase the number of paired observations. Experimental tourist approaches could also be used towards the same end, but this would raise several ethical questions of its own. In previous studies, much larger effects have been reported. White (1999) found that foraging by grizzly bears on army cutworm moths in Glacier National Park, Montana dropped from 67% of the undisturbed time budget to 14% when climbers were present, while moving increased from 12% to 62%. Unfortunately, no measures of dispersion around the mean or statistical tests were presented, and it is not clear whether the authors define the 'disturbed' condition by the reaction of the bears, rather than the presence of climbers *per se*. Thus it is not clear if the 18 'undisturbed' bears were measured in the absence of climbers, or in the presence of climbers but when there was no overt reaction by the bears. Nevertheless, at least one third of bears in White's study reacted to human presence by leaving the foraging site, which I rarely observed in the Khutzeymateen.

Vigilance behaviours as a fraction of total time visible on the estuary differed significantly in the paired data analyses, but not in the unpaired analysis, despite a much larger sample size. This is likely due to large differences between individual bears, as well as large variations between different visits by the same bear. All of the bears we observed both with tourists present and absent did increase their levels of vigilance slightly in the presence of tourists. This increase, however, accounted for a relatively small proportion of the overall time budget (less than 10%). The 1-0 sampling was used to measure differences in rare behaviours, such as rearing onto the hind legs to scan (Stand-scan), that would not be likely to be seen in time-budget data. However, neither Stand-Scanning nor Head-Up behaviours changed with tourist presence.

In the analysis of the data collected by the tour guides, no linear trends with year were significant. However, the confidence intervals for the slopes were quite wide, consistent with changes of up to 15% per annum in either direction in the likelihood that a bear would show no reaction to tourists. The regression analyses were performed on data from only 5 years, so continued data collection may be of benefit in increasing the precision of these estimates. It is also likely, however, that habituation curves are not linear, and that the bulk of the change (if any) occurred soon after tourists began frequenting the estuary during the mid-1980's.

The ethical and management implications of habituation can be discussed on at least three levels: human safety, effects on the bear, and effects on the quality of the wildlife viewing experience. As discussed in the introduction, some authors suggest that all habituation in bears leads to an increased risk to humans (Herrero, 1985; McCullough, 1982), while others maintain that if habituation occurs in the absence of food-conditioning, the risk to humans is either unaffected or reduced (Aumiller and Matt, 1994; Jope, 1985).

Habituation also affects the bears themselves. On the positive side, a habituated bear will spend less time and energy reacting to stimuli that do not pose a real risk to it, and this is likely to be accompanied by a reduction in fear or other negative subjective feelings in the animal. If habituated bears are less likely to attack humans, they are also less likely to be removed from the population by management actions, which is a frequent response to attacks by bears on humans, especially if fatal to the human (Herrero, 1985). On the other hand, there is a possibility that habituated bears, because they do not avoid humans, may be at a higher risk from poaching or legal hunting. This, however, assumes that the bears will generalise a learned tolerance towards tourists to encounters with humans in other contexts. It is not currently known what aspect of the human stimulus bears react to or habituate to, nor is it clear to what extent such habituation would be generalised. Herrero (1985) mentions an attempt by park rangers in Great Smoky National Park to teach black bears to avoid roadsides by harassing them with sticks, sounds and other aversive stimuli when they were present near roadways panhandling food from tourists; the bears quickly learned to avoid the road when there were rangers present but continued frequenting roadways and panhandling food from tourists when rangers were absent.

From the point of view of the human tourist experience, again, habituation may be seen as positive, by allowing easier viewing of the animals, or negative, by allowing *too* easy viewing which may reduce the impression of wilderness. Lastly, if human wariness is seen as important components of the grizzly bears' fundamental nature (Rollin, 1997), then habituation may be seen as a violation of that nature.

Overall, it does not appear that tourist visitation at current levels is having a significant negative effect on the bears' quality of life. There are some minor changes in behaviour, and it is possible that the presence of tourists is having some subtle effects on the social structure of the bear population, by discouraging the presence of certain individuals at certain times (< 4 h / day, centred on high tide). However, the data are insufficient to attempt to describe such potential effects. My data also do not address potential consequences at the population level. While negative effects at *either* the population level *or* the individual level should be sufficient reason for adjusting our management practices, a lack of effects at one level or the other is not sufficient to conclude that current practices are acceptable. As it could be possible to have population effects without behavioural changes, or vice-versa, both should be monitored.

Management Implications

There are some effects of tourist presence on the short-term behaviour of the bears. The magnitude of these changes is relatively small, and it is unlikely that they represent a serious impairment to the well-being of the bears, at the current levels of tourist access. Thus it does not appear necessary to restrict tourist activities further to safeguard the bears' quality of life. However, potential population consequences are not directly addressed in this study. Further, several features of the current management (e.g. the predictability of tourist approaches, the small number of tourists present at any given time) may mitigate the impact of human presence. Any relaxation of the current regulations should therefore be done slowly and carefully (if at all), allowing time for any increase in the magnitude of tourists' effects on behaviour or on the number of bears using the estuary to be detected.

Table 1: Behaviour of bears with tourists absent or present, based on data from time-interval sampling, expressed as percent time (±SD). Difference is calculated as the percent time engaged in the behaviour with tourists present minus the percent time when tourists absent. Sample size refers to individual bear visits; only 23 individually recognised bears are represented.

Percent of time	Behaviour			
(Mean ± SD)	Feed	Travel	Vigilant	Rest
Tourists absent (n=165)	57.3±18.3	15.5±16.9	21.6±12.8	4.8±11.6
Tourists present (n=35)	52.3±23.8	13.1±13.3	21.7±9.8	12.6±21.9
Difference (pres. – abs.)	-5.0	-2.4	0.2	7.8
95% C.I. of difference	-12.0, 2.0	-8.4, 3.6	-4.3, 4.7	2.7, 12.9

Table 2: Difference in behaviour between parts of bear visits with tourists present and those parts with tourists absent. Differences are calculated within each of 19 bear visits where tourists were present during part of the visit. These differences were then averaged for each individual bear involved, and the 7 bear averages used to calculate means and confidence intervals.

	Behaviour			
	Feed	Travel	Vigilant	Rest
Difference (pres. – abs.) (n=7)	-10.8	-2.8	6.7	7.3
95% C.I. of difference	-24.8, 3.2	-11.0, 5.5	4.3, 8.4	-1.0, 15.6

Table 3: Percentage of bears in each year showing different classes of reaction to human approach, and closest distance to which tourists approached the bear, with the attained significance level testing against the null hypothesis that the slope is zero, and 95% CI for the slope of the regression line.

Year	Sample size	Retreat (%)	None (%)	Approach (%)	Other (%)	Distance (m)
1995	111	30.6	64.9	2.7	1.8	210
1996	87	52.9	35.6	5.7	5.7	163
1997	75	38.7	44.0	12.0	5.3	97
1998	121	27.3	59.5	10.0	3.3	140
1999	91	35.2	56.0	6.6	2.2	141
P-value		0.7	0.9	0.4	0.8	0.3
95% C. I. of slope		-12.8, 9.5	-13.2, 14.5	-2.4, 4.8	-2.2, 1.9	-53.6, 21.4

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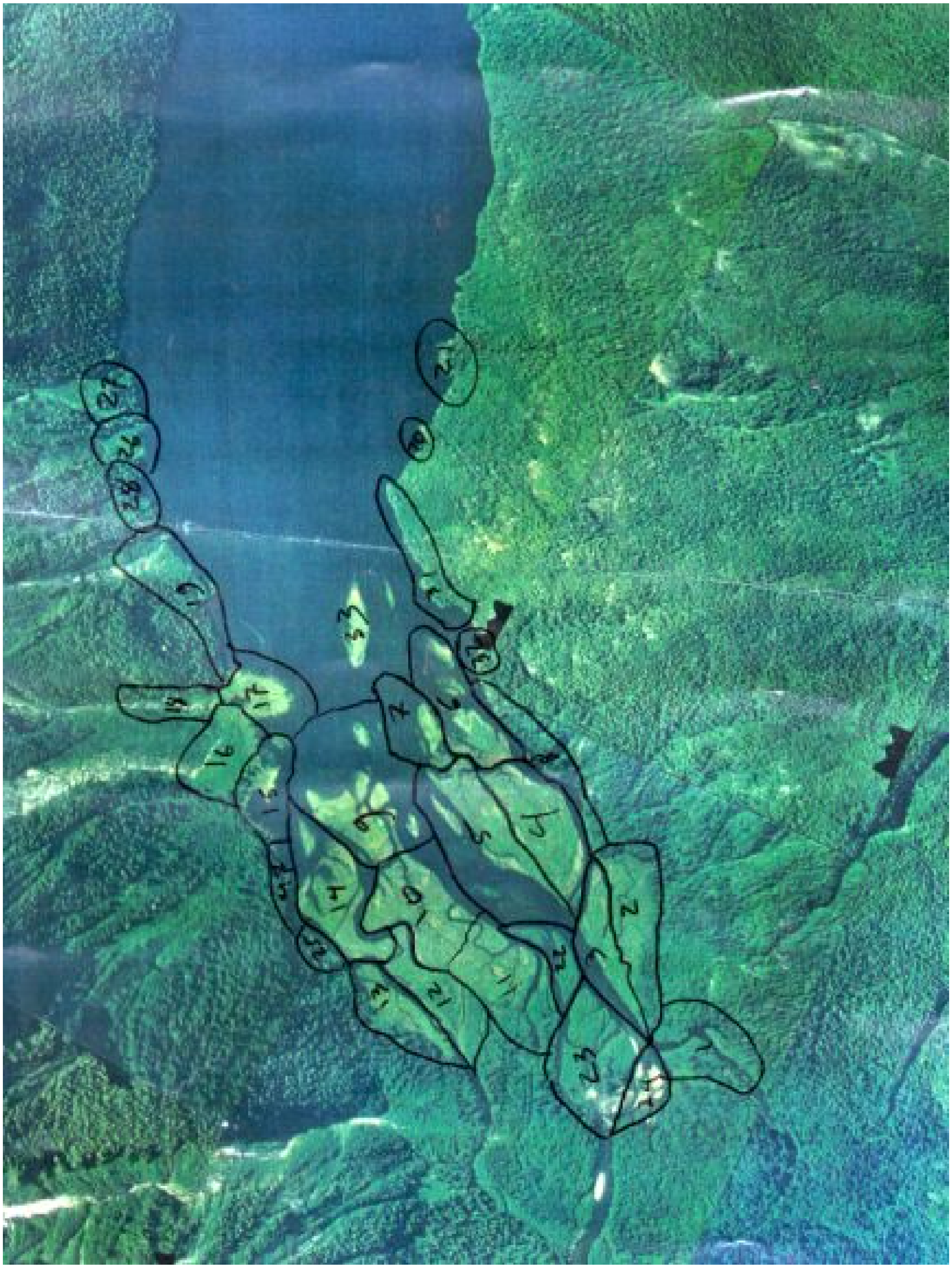
Appendix 1: Air photo of the Khutzeymateen estuary.



Appendix 2: Stem-and-leaf plots or histograms for variables measured.

```
Variable=Feed (Time Int.); Tourist=Yes
Stem Leaf
8 1246

7 00448

6 00145699

5 133568

4 126

3 1

2 459

1 199

0 03

----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

```
Variable=Feed (Time Int.); Tourist=No
Stem Leaf
8 55677
8 0011122234
7 55555566666788899
7 00011111222333444
6 556777788888899
6 0011122233334
5 555556666667788888888999
5 0000123334444444
4 555666688899
4 0001233334
3 566788999
3 011333
2 99
2 03
1 5
1 124
0 5
0 00
----+----+----+----+----
Multiply Stem.Leaf by 10**-1
```

```
Variable=Travel (Time Int.); Tourist=Yes
Stem Leaf
5 0
4 5
4 3
3
3 02
2 7
2 23
1 5566
1 0234
0 5566779
0 000233334444
----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

```
Variable=Travel (Time Int.); Tourist=No
Stem Leaf
9 5
9
8 5
8 4
7 5
7
6 7
6 2
5
5 00024
4
4 33
3 58
3 123334
2 5566777889
2 0000112233444
1 5556667777789
1 0000011111112222222222222333444
0 555555555666666677777777777888888899999
0 00000000111122222223333333344444444444
----+----+----+----+----+----+----+----
Multiply Stem.Leaf by 10**-1
```

Appendix 2: Stem-and-leaf plots or histograms for variables measured.

```
Variable=Vigilant (Time Int.);
 Tourist=Yes
Stem Leaf
6
6
5
5
4
4
3 55668
3 0333
2 667
2 111223344
1 67899
1 001133
0 69
0 0
----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

```
Variable=Vigilant (Time Int.);
 Tourist=No
Stem Leaf
6 5
6 4
5 6
5 224
4 667
4 0022244
3 5677889
3 0011111222333344
2 5666666677788899
2 0000001111222222223333334444
1 5556666666666777777888888888999999
1 0000122222333333333444444
0 5566777777888888899
0 00000033
----+----+----+----+----+----+--
Multiply Stem.Leaf by 10**-1
```

```
Variable=Rest (Time Int.); Tourist=Yes
Stem Leaf
7 1
6 5
6
5 57
5 1
4
4 2
3 8
3
2
2
1 6
1 4
0 667
0 00000000000000000122233
----+----+----+----+---
Multiply Stem.Leaf by 10**-1
```

```
Variable=Rest (Time Int.); Tourist=No
Histogram

0.675+*
     .*
     .
     .
     .
     .*
     .*
     .*
     .*
     .*
     .***
     .**
     .**
0.025+*********************************
----+----+----+----+----+----+----+----
* may represent up to 4 counts
```

Appendix 2: Stem-and-leaf plots or histograms for variables measured.

```
Variable=Head-up (1-0); Tourist=Yes
Stem Leaf
3 3

2


2 4

1


1

0 557


0 000000000000011233

----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

```
Variable=Head-up (1-0); Tourist=No
Histogram
0.33+*
    .
    .*
    .*
    .*
    .*
    .**
    .*
0.17+*
    .*
    .*
    .****
    .***
    .*
    .****
    .*****
0.01+***************************
----+----+----+----+----+--
* may represent up to 2 counts
```

```
Variable=Scan (1-0); Tourist=Yes
Stem Leaf
3 4
2 588
2 1
1 68
1 0113
0 77899
0 000003
----+----+----+----+
Multiply Stem.Leaf by 10**-1
```

```
Variable=Scan (1-0); Tourist=No
Stem Leaf
5 03
4
4 0444
3 55678
3 013444
2 56666778899
2 00001111112222223333344
1 5555667788899
1 00011111111222333444
0 566777889999
0 000004
----+----+----+----+--
Multiply Stem.Leaf by 10**-1
```

Appendix 2: Stem-and-leaf plots or histograms for variables measured.

```
Variable=Sit-Scan (1-0); Tourist=Yes
Stem Leaf



6 7

5

4

3

2 5

1 36

0 000000000000000000
----+----+----+----+
Multiply Stem.Leaf by 10**-2
```

```
Variable=Sit-Scan (1-0); Tourist=No
Histogram
0.031+*
0.025+
0.019+
0.013+*
0.007+*
0.001+************************
----+----+----+----+----+----+----
* may represent up to 4 counts
```

```
Variable=Stand-Scan (1-0); Tourist=Yes
Stem Leaf
8

7 7

6

5

4

3

2

1 8

0 00000000000000000000

----+----+----+----+
Multiply Stem.Leaf by 10**-2
```

```
Variable= Stand-Scan (1-0); Tourist=No
Histogram
0.0875+*
      .
      .
      .
      .
      .
      .
      .
      .*
      .*
      .*
      .*
      .
      .
      .*
      .*
      .*
0.0025+**********************
----+----+----+----+----+----+----
* may represent up to 4 counts
```

Appendix 3: Differences used in paired tests.

Differences (tourist present-tourist absent) in behaviour for each bear visit where applicable:

OBS	NBV	NAME	_NAME_	AP_FEED	AP_TRAV	AP_VIG	AP_OTHER	AP_REST	JC_HU	JC_SC	JC_SITSC	JC_STSC	JC_IA
1	5		DIFF	0.01307	-0.05882	0.04575	0.000000	0.00000	0.00000	0.10526	0.000000	0	0
2	6		DIFF	-0.19473	0.04868	0.14604	0.000000	0.00000	.	.	.	.	.
3	71		DIFF	-0.35313	-0.00230	-0.02556	-0.004219	0.38521	-0.28848	-0.00376	0.015625	0	0
4	146	BADGER	DIFF	0.05352	-0.09417	0.04065	0.000000	0.00000	-0.08696	0.07609	0.000000	0	0
5	206	BADGER	DIFF	-0.15584	0.01299	0.14286	0.000000	0.00000	.	.	.	.	.
6	90	HLF	DIFF	-0.29004	0.11967	0.17038	0.000000	0.00000	0.00263	0.08421	0.000000	0	0
7	107	HLF	DIFF	-0.38812	0.09821	-0.07458	0.000000	0.36450	.	.	.	.	.
8	89	LEFTY	DIFF	-0.34783	0.19074	0.09642	0.000000	0.06066	-0.33333	-0.09885	0.000000	0	0
9	106	LEFTY	DIFF	-0.26060	-0.17270	0.02007	0.017241	0.39599	.	.	.	.	.
10	43	LUCY	DIFF	-0.26137	0.15476	0.08280	0.000000	0.02381	.	.	.	.	.
11	51	LUCY	DIFF	-0.11060	0.02926	0.01103	0.007813	0.06250	0.05125	0.04369	0.000000	0	0
12	53	LUCY	DIFF	0.03533	-0.11923	0.12738	-0.043478	0.00000	0.01266	0.03877	0.025316	0	0
13	108	LUCY	DIFF	0.32387	-0.23209	-0.09179	0.000000	0.00000	.	.	.	.	.
14	201	QUEEN_OF	DIFF	-0.02943	-0.02716	0.05659	0.000000	0.00000	0.00225	-0.02474	0.000000	0	0
15	44	SPARKY	DIFF	-0.21135	0.16049	0.02617	0.000000	0.02469	.	.	.	.	.
16	52	SPARKY	DIFF	-0.43727	0.03417	-0.07166	0.008197	0.46656	-0.03704	-0.11111	0.000000	0	0
17	54	SPARKY	DIFF	0.07568	-0.09580	0.32240	-0.039808	-0.26247	0.00000	0.09211	0.000000	0	0
18	138	SPARKY	DIFF	0.13755	-0.10223	-0.03159	0.020548	-0.02428	.	.	.	.	.
19	91	VICTOR	DIFF	0.07810	-0.20190	0.09714	0.000000	0.02667	.	.	.	.	.

Average difference calculated for each individual bear represented above

OBS	NAME	_FREQ_	AP_FEED	AP_TRAV	AP_VIG	AP_OTHER	AP_REST	JC_HU	JC_SC	JC_SITSC	JC_STSC	JC_IA
1	BADGER	2	-0.05116	-0.04059	0.091754	0.0000000	0.00000	-0.08696	0.076087	0.000000	0	0
2	HLF	2	-0.33908	0.10894	0.047896	0.0000000	0.18225	0.00263	0.084211	0.000000	0	0
3	LEFTY	2	-0.30421	0.00902	0.058246	0.0086207	0.22832	-0.33333	-0.098851	0.000000	0	0
4	LUCY	4	-0.00319	-0.04182	0.032355	-.0089164	0.02158	0.03195	0.041230	0.012658	0	0
5	QUEEN_OF	1	-0.02943	-0.02716	0.056593	0.0000000	0.00000	0.00225	-0.024738	0.000000	0	0
6	SPARKY	4	-0.10885	-0.00084	0.061329	-.0027657	0.05113	-0.01852	-0.009503	0.000000	0	0
7	VICTOR	1	0.07810	-0.20190	0.097143	0.0000000	0.02667	.	.	.	.	.

T-test of null hypothesis that mean difference is zero

Variable	N	Mean	Std Dev	T	Prob>|T|
AP_FEED	7	-0.1082613	0.1564817	-1.8304547	0.1169
AP_TRAV	7	-0.0277665	0.0926043	-0.7933020	0.4578
AP_VIG	7	0.0636165	0.0231788	7.2615275	0.0003
AP_OTHER	7	-0.000437352	0.0051661	-0.2239857	0.8302
AP_REST	7	0.0728487	0.0930839	2.0706002	0.0838
JC_HU	6	-0.0669955	0.1364685	-1.2025104	0.2830
JC_SC	6	0.0114060	0.0696759	0.4009848	0.7050
JC_SITSC	6	0.0021097	0.0051677	1.0000000	0.3632