

**MCNEIL RIVER STATE GAME SANCTUARY AND REFUGE  
OPERATIONAL MANAGEMENT PLAN**

**Division of Wildlife Conservation  
Alaska Department of Fish and Game  
Anchorage, Alaska**

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## INTRODUCTION

### History of the Sanctuary and Refuge

The McNeil River State Game Sanctuary was created by the Alaska Legislature in 1967 to provide permanent protection for a unique concentration of brown bears. Its original boundaries encompassed most of the McNeil River and Mikfik Creek drainages. During the last decade the sanctuary has experienced a number of significant changes. The public bear viewing program has grown in popularity. Increased popularity has resulted in changes to the viewing program. More bears are visiting the sanctuary and more individual bears are exhibiting a high degree of tolerance to humans. Sport fishing guides are bringing more clients to the Kamishak River. Large mining claims have been filed in the Paint River drainage. A fish ladder has been constructed in nearby Paint River and the river has been stocked with sockeye salmon. The controversy surrounding construction of the Paint River fish ladder, in particular, has resulted in a great deal of attention being focused on the sanctuary and refuge and how they may be affected by human activities.

In 1991 the Legislature expanded the sanctuary boundaries to include the lower Paint and Kamishak rivers and also created the McNeil River State Game Refuge north of the sanctuary. The refuge includes the entire Paint River drainage, except the portion in the sanctuary, and the Chenik Creek drainage. The revised sanctuary and refuge statutes went into effect on January 1, 1993.

A management plan was last written for the sanctuary by the Division of Wildlife Conservation in 1981. Because of the many changes in circumstances and management, that plan requires revision.

**The sanctuary and refuge, despite having the same name (McNeil River), are completely different entities. This should be kept in mind as you read the goals, objectives, and guidelines of this plan.**

### Management Plan

This management plan provides detailed guidelines in accordance with the statutes of the McNeil River State Game Sanctuary and Refuge, the Commissioner's Title 16 permitting and other authorities, the authorities of the Boards of Fisheries and Game, sanctuary access regulations, and state hunting and fishing regulations.

**Authorities of Boards and Commissioner.** The Board of Fisheries and Board of Game (Boards) and the Commissioner of Fish and Game (Commissioner) have separate authorities over land use activities in sanctuaries and refuges. In the **sanctuary**, AS 16.20.170(e) authorizes the Boards to adopt regulations governing access, entry, development, construction, fishing and

other uses and activities affecting the natural habitat, fish and wildlife, and public use. In the **refuge**, the Commissioner has this authority, except that the Board of Game promulgates hunting and trapping regulations, the Board of Fisheries promulgates fishing regulations, and the Commissioner of Natural Resources may open or close land within the refuge to new mineral entry (AS 16.20.041(d)). The Commissioner of Fish and Game also has the authority to issue various sanctuary access permits and, in both the sanctuary and refuge, to issue fish habitat, special areas, and fish transport permits.

**Implementing This Plan.** Because of the diverse authorities of the Boards and Commissioner, this management plan will be implemented in several ways.

- 1) Guidelines that require Board of Game approval (primarily sanctuary access, hunting regulations, and use of off-road vehicles for hunting) will be submitted as proposals by the Commissioner, after a coordinated review by the appropriate resource management divisions.
- 2) Guidelines that require Board of Fisheries approval (e.g., inriver escapement goal modifications, fishing regulations) will be submitted as proposals by the Commissioner, after a coordinated review by the appropriate resource management divisions.
- 3) Guidelines that require regulations adopted under the Commissioner's authority (primarily refuge regulations and permits) will be adopted by the Commissioner after fulfilling the public notice requirements of the Administrative Procedure Act.
- 4) Guidelines that are within the authority of the Commissioner (e.g., wildlife research and management activities, fish stocking permits, some salmon escapement goals) will be implemented according to this management plan after the management plan is reviewed by the Boards and adopted by the Commissioner.

**Strategic Management Plan.** The ADF&G's Habitat and Restoration Division is developing a strategic management plan for the McNeil River sanctuary and refuge. The strategic plan deals with land use activities requiring state special area and fish habitat permits (AS 16.05.870-895 and 5 AAC 95) and should be completed in 1996.

**McNeil River Advisory Group.** In fall 1991 the Board of Game directed the ADF&G to create a citizen's advisory group that would make recommendations on sanctuary and refuge management. The advisory group was comprised of 10 members appointed by the Commissioner from a wide range of user groups:

<b>Group Member</b>	<b>Primary Affiliation</b>
Rod Arno	Alaska Professional Hunters Association
Ken Castner	Cook Inlet Seiners Association
Nancy Hillstrand	Homer resident
Leo Keeler	Friends of McNeil River

Mike McBride	Chenik Wilderness Lodge
Doug Miller (deceased)	National Wildlife Federation
Sonny Petersen	Katmailand, Inc.
Randy Smith	Alaska Outdoor Council
Peter Thurston	American Copper & Nickel Co., Inc.
Tom Walker	Cook Inlet Aquaculture Association

The group met six times for a total of eight days in 1992. They discussed a variety of issues. Their discussions were not restricted to certain topics; however, it was understood that some of their recommendations might exceed the existing statutory or regulatory authorities of the ADF&G and Boards and that the ADF&G would decide which recommendations would be adopted.

The recommendations of the group (Appendix A) are the result of achieving consensus. All members of the group agreed on the wording of each recommendation. If all members were not satisfied, then a recommendation was not made. These consensus agreements were given a great deal of weight in formulating the provisions of both the operational and strategic management plans; however, not all of the recommendations were adopted.

## GOALS

Many of the management objectives and guidelines in this plan refer to the goals or purposes for which the sanctuary and refuge were established. These goals or purposes are defined in statute (AS 16.20.170 and 16.20.041) as follows:

The McNeil River State Game **Sanctuary** is established to

- (1) provide permanent protection for brown bear and other fish and wildlife and their habitats, so that these resources may be preserved for scientific, aesthetic, and educational purposes;
- (2) manage human use and activities in a way that is compatible with (1) of this subsection and to maintain and enhance the unique bear viewing opportunities within the sanctuary; and
- (3) provide opportunities that are compatible with (1) of this subsection for wildlife viewing, fisheries enhancement, and fishing, for temporary safe anchorage, and for other activities.

The McNeil River State Game **Refuge** is established to

- (1) provide permanent protection for brown bear and other fish and wildlife populations and their habitats, so that these resources may be preserved for scientific, aesthetic, and educational purposes;
- (2) manage human use and activities in a way that is compatible with (1) of this subsection and to maintain and enhance the unique bear viewing opportunities in the McNeil River State Game Sanctuary established under AS 16.20.160;
- (3) provide opportunities that are compatible with (1) of this subsection for wildlife viewing, fisheries enhancement, fishing, hunting, and trapping, for temporary safe anchorage, and for other activities.

The Department of Fish and Game interprets these goals to mean that, in **both the sanctuary and refuge**, permanent protection of fish and wildlife populations and habitat has the highest priority. All human uses must be compatible with this goal. The brown bear population and its habitat is given special emphasis. Second priority is maintaining and enhancing the unique bear viewing opportunities in the **sanctuary**. Note that the **refuge** goals are also intended to protect viewing opportunities in the **sanctuary**. Third priority is to provide opportunities for other human activities, including those listed, that are compatible with protecting fish and wildlife. Thus, bear viewing opportunities in the **refuge** are no higher or lower in priority than any other activity that is

compatible with protecting brown bears and other fish and wildlife populations and their habitats for scientific, aesthetic, and educational purposes. This does not necessarily mean that all allowable uses will be permitted everywhere. Where two activities are not compatible with one another, they may be separated in time or space after a thorough review of alternatives. The statutory purposes and this plan's objectives and guidelines will help determine a suitable solution. The term "unique bear viewing opportunities" is defined in this management plan.

## OBJECTIVES AND GUIDELINES

The following sections identify the major management concerns in the sanctuary and refuge. Recommended management objectives and guidelines are presented. Some of the guidelines are based on the enabling legislation, existing regulations, and recommendations of the McNeil River Advisory Group.

The advisory group's final recommendations are included in Appendix A. Many of the advisory group's recommendations were used to develop the goals, objectives, and guidelines of this plan and the Paint River Salmon Enhancement Operational Plan. However, not all of their recommendations were adopted. In some cases, there were constitutional limits that can only be determined by the Department of Law. Other recommendations were beyond the scope of this plan. All of the recommendations that relate to land uses were also considered during the development of the strategic management plan.

**Objectives and policies for all land uses that require a Title 16 special area permit are being developed during the strategic planning process. These land uses include uses such as commercial recreation sites, mineral exploration and development, leases, and means of access. Until the strategic plan is completed, permits for these uses will be evaluated on a case-by-case basis.**



## BEAR THRESHOLD CRITERIA

Human activities that could significantly affect bears which visit the sanctuary may occur in areas or at times when the bears are either not closely monitored by sanctuary staff or not monitored at all. Under these circumstances, a method is needed to indicate when bear populations are affected. A **bear threshold criterion** is a pre-determined level of change in a bear population that triggers an assessment of potential factors which may have adversely affected the population or the sanctuary's viewing program. A threshold criterion may be based on a population characteristic (e.g., number of bears, sex ratio) or some measure of bear behavior or bear viewing opportunity. **It must be an objective statistic that measures a meaningful characteristic of a bear population, bear behavior, or the bear viewing program and can be reliably and consistently measured.**

Human activities along the lower Paint and Kamishak rivers, in McNeil refuge, or other areas within the range of "McNeil bears" will be allowed, except when they are likely to significantly affect the bears or the sanctuary's bear viewing program. If a human activity that has been allowed is subsequently determined to have a significant adverse impact on fish and wildlife populations or habitats in the sanctuary or refuge, actions must be taken to minimize or curtail its effect.

Proving that a human activity has had an adverse effect on a bear population is a three-step process. First, a significant change in the bear population or bear behavior has to be detected in the sanctuary, compared with data collected prior to the disturbance. Second, the likelihood that the difference might be due to natural events has to be evaluated. Finally, a specific human use or activity must be isolated as a probable cause. Using a bear threshold criterion accomplishes the first step, allowing the ADF&G and others to determine an acceptable level of change beyond which an assessment must be undertaken. The Legislature determined that permanent protection of brown bears and other fish and wildlife and their habitats is the highest priority in the sanctuary and refuge. If a threshold has been exceeded and the bears are in jeopardy, activities likely to have caused the change may be modified or temporarily suspended. This will allow the cause to be identified before further impacts accrue. Modifying or temporarily suspending an activity could also provide the evidence needed to determine whether the activity was or was not a cause of the disturbance. If an activity is demonstrated to jeopardize any purpose for which the sanctuary and refuge were established, then it will be permanently modified or suspended.

Various measures of bear numbers and behavior have been collected for many years at McNeil Falls and Mikfik Creek viewing areas and other areas around McNeil Lagoon. Estimates of bear numbers are meaningful for management purposes and are probably the least subjective criteria for which data has been collected. Following are some examples of data which have been and will be collected.

**Daily count.** Sanctuary staff identify all known individual bears and their offspring. Bears that have not been previously identified are noted and described in writing. At the end of each day, the list of all individuals is tallied for the daily count. This technique depends on the staff's

ability to identify most of the bears in the McNeil Lagoon area with a high degree of certainty. The current staff has this ability; however, new staff will not without a period of training.

**Annual count.** The daily counts are combined into a list of all individual bears observed by sanctuary staff throughout the summer. This list is much more comprehensive (and less variable) than the daily list, because some bears leave the sanctuary early or arrive late in the season, and it is less affected by viewing periods, weather, and other environmental factors. However, this technique has many of the same difficulties as a daily count. Despite their shortcomings, daily and annual counts provide valuable information on bear population dynamics that could not otherwise be obtained without tagging most of the bears in the sanctuary.

**Maximum number in sight.** Beginning in 1983, sanctuary staff have noted the daily maximum number of bears of all ages in sight at any one time from the viewing pad at McNeil Falls. This data is more objective than counts based on identifying individual bears. This criterion may not be as accurate as a systematic daily count (see below). However, this is the only estimate of bear numbers which currently meets the definition for a bear threshold criterion.

**Systematic daily count.** An example of a systematic daily count is an average of hourly counts of all bears in sight from a standardized location. This technique would provide an objective, meaningful, and easily learned method of monitoring changes in bear numbers at McNeil Falls; however, these data are only available for 1986 and 1987. Systematic counts were reinitiated in 1993 so that a baseline figure can be established.

**Bear mortality.** An unusually large number of bears killed in one year or a sustained increase in number of bears killed over several years could indicate that the population is being adversely affected by human activities. One bear that visited the sanctuary was subsequently shot in defense of life or property outside the sanctuary and refuge; however, these mortalities are not dependably reported. Accidental bear mortalities that can be attributed to human activities have also been rare and would probably be underreported. Therefore, human-related mortalities are not a meaningful, objective criterion at this time.

**Bear behavior.** A unique feature of the sanctuary is the extreme tolerance that some individual, wild bears exhibit when approached or observed closely by humans. The tolerance is due, in part, to the highly concentrated food source (salmon), the high number of bears, and the very predictable behavior of humans in the sanctuary. Without these factors, bears would tend to avoid humans just as they do in other parts of Alaska. Because of the importance of bear behavior to the viewing program, one or more threshold criteria should be developed to monitor potential changes. This has proven to be a difficult task. To some extent, the number of bears using McNeil Falls is a measure of bear tolerance of humans, and this will have to suffice until an additional criterion for bear behavior is developed.

**Assumptions and Statistical Analysis.** Determining the most objective threshold criterion depends on several assumptions and statistical methods. Assumptions that were used to narrow the choice to the **maximum number in sight** have already been discussed. After choosing this criterion, additional assumptions were made to objectively collect and analyze the data.

The first step was data collection. The data that will be examined each year to determine if bears or the bear viewing program has been affected will continue to be gathered as follows. Every day that McNeil Falls is visited, sanctuary staff will count the maximum number of bears in sight at one

time from the viewing pad. This criterion is a good index of both bear numbers and viewing opportunity. An "instantaneous" count of individual bears is an unbiased figure that does not rely on the ability of existing staff to identify individual bears throughout the day or season. Because there will only be one maximum count from one point each day, no bears will be counted more than once. The highest seven daily counts from each year will be averaged to determine the median annual maximum count. Attempting to incorporate more than seven daily counts into the median annual maximum count increased the variability, which reduces predictability. Selecting the highest seven daily counts, rather than the daily counts from a predetermined "peak" period, will minimize the unpredictable effects of environmental conditions (e.g., early or late salmon runs, or periods of high water that temporarily reduce bear numbers). The median value of the highest seven daily counts was used instead of the mean value, because medians are less sensitive to potentially misleading extreme data points.

Second, statistical methods were used to determine the "normal" annual fluctuations in bear numbers caused by environmental factors, such as food availability, from 1983-1992. Maximum daily counts were collected consistently from 1983-1992. The average of the 10 median annual maximum counts during this period was 48.6 bears (Appendix B). This is the value that will be used as a benchmark for maintaining bear numbers and viewing opportunity.

The average of the 10 median annual maximum counts during the 10-year baseline period is obviously influenced by low counts in 1983 and 1984 (Appendix B). The low counts may have been due to the large number of bears shot in 1983-84 in the subunit north of the new refuge (GMU 9A-0200 = 36 bears) and south of the sanctuary (GMU 9A-0500 = 5 bears). Also, the brown bear hunting season has been closed in the Kamishak River-Cape Douglas area since fall 1985. While bear numbers have increased in the sanctuary since 1976, the rate of increase declined the summer following hunting seasons, which were open during fall and the following spring every other year. Despite the fact that the median annual maximum counts in 1983 and 1984 are low compared with those after 1984, they were included to gain the longest possible base period for estimating natural variability and because, during a discussion of bear threshold criteria, the McNeil River Advisory Group informally recommended using counts from the last 10 years. Deleting 1983 and 1984 counts from the analysis would increase the average by about five bears to 53.5 and the "lower limit" to 45.392 bears, but may give an artificially high average estimate of bear numbers over the long-term. A higher threshold level is not advantageous if it is frequently triggered by natural events.

Third, the median annual maximum count for each year after 1992 will be compared with the lower limit in Appendix B to determine whether the number of bears is within the range of normal fluctuations. The necessary statistical test is based on a proven statistical technique, a combined Shewhart-CUSUM quality control test outlined by J. M. Lucas in the Journal of Quality Technology (14:51-59) in 1982. A detailed description of the method is provided in two Division of Wildlife Conservation memoranda by E. Becker (Appendix C). The test will detect both large, short-term declines and gradual, long-term drift in the average number of bears.

The median annual maximum count will be compared to the "lower limit" in Appendix B. If the median annual maximum count drops below 41 bears, then the number of bears is below the threshold level and this will trigger an investigation of probable causes. The statistical test also compares each median annual maximum count with previous years to determine whether a cumulative decline in bear numbers has exceeded a predetermined rate (the reference value (k) is set at 47.294 and the cumulative sum limit (h) is -7.839), even before the "lower limit" is reached. For example, on average, the method will detect a decline and trigger an investigation with a long-term loss of just two bears over a six-year period or four bears in less than four years.

Statistical tests must guard against two opposing types of error. The chosen method is a good compromise. The likelihood of concluding that a decline has not occurred when it really has been minimized by selecting a "lower limit" of only three "standard errors," or about eight bears below the mean value. The potential for this type of error has been minimized because the sanctuary's statute clearly establishes bear protection and bear viewing as the highest priority uses for this area. The likelihood of concluding that a decline in bear numbers has occurred when it really has not is only about 1 in 100. This type of error is minimized because other uses should not be unnecessarily restricted if they are compatible with bears and bear viewing.

The 1981 McNeil River management plan was based on maintaining 45 individual bears in the sanctuary, but not necessarily all visible at the falls on any given day. The new threshold is not directly comparable, because it is based on high counts from the viewing pad which do not include other bears seen from the viewing pad during the day, nor bears seen that day in other parts of the sanctuary. Thus, the new threshold is considerably higher than the 1981 objective. This higher threshold is warranted by the increase in bear numbers in the sanctuary during the last decade.

The baseline period was established in early 1993, during the planning process. Since then, the median annual maximum count has been calculated for three years (Appendix B). Although it appears that the lower threshold and the cumulative sum was broken in 1995, there is a methodological explanation for low counts in 1993-1995.

The daily maximum number in sight was not noted consistently from 1993-95. On some days, only the highest daily count among the systematic daily counts (counted once each hour) was available. Typically, a count of the maximum number in sight is slightly higher than the highest of the systematic daily counts (because the systematic count is conducted on the hour, whereas the maximum count can be conducted at any time). Therefore, the median annual maximum count is artificially low for the last three years. The median annual maximum counts for 1994 and 1995, in particular, would have been several bears higher if the maximum daily counts had been conducted every day.

## **Management Objective**

Maintain high numbers of bears that tolerate human presence without regarding humans as a source of food, and other desirable characteristics of the brown bear population and sanctuary bear viewing program, by minimizing human disturbances in the sanctuary and refuge.

## Management Guidelines

### 1. Bear Population Size and Viewing Opportunity

a. **Measurements.** The following indices will be used to monitor changes in the size of the sanctuary's visible brown bear population:

(1) **Systematic daily counts**--The 10-day mean of the median (or another more appropriate measure of central tendency) of an hourly count of the number of bears (excluding offspring in family groups) visible from McNeil Falls each day during the normal peak period of bear use.

(2) **Maximum number in sight**--The median (or another more appropriate measure of central tendency) of the maximum number of bears visible at one time from McNeil Falls each day during the seven highest daily counts during the year.

(3) **Daily count**--The median number of individual adult bears observed each day at McNeil Falls during the period of peak bear use.

(4) **Annual count**--The total number of individual adult bears observed at McNeil Falls during the entire season.

b. The primary criterion will be **systematic daily counts** when an adequate baseline is established. Until then, the **maximum number in sight** will be used as the primary criterion, then it will be a secondary criterion to help assess the validity of the primary criterion. **Daily** and **annual counts** will also be secondary criteria.

c. The baseline period for (2), (3), and (4) is the 10-year period from 1983 to 1992. The baseline period for (1) will be established when sufficient data has been collected to establish a threshold.

d. **Threshold Levels.** An assessment of potential adverse impacts will occur when the annual count of **maximum number in sight** drops below 40.761 bears or the cumulative sum limit exceeds the parameters  $k=47.294$  and  $h=-7.839$  as determined from the combined Shewhart-CUSUM control charts (Lucas 1982) and calculations in Becker's August 23, 1993, memorandum (Appendix C). When secondary criteria also indicate a significant decrease in bear numbers, this will be considered in determining what action to take.

2. Any human use or activity that is likely to have triggered a threshold criterion will be modified or temporarily suspended until it can be determined that the activity is not adversely

affecting bears or the sanctuary's bear viewing program. The burden of proof is on the user, not the State. A use or activity in the sanctuary or refuge that is determined to have caused a threshold criterion to be exceeded shall be modified to avoid or minimize its affect or, if necessary, discontinued.

3. If any bears are killed accidentally or in defense of life and property in the sanctuary or refuge as a result of noncompliance with a permit, the permit may be revoked.

4. Threshold levels will be reviewed annually and may be adjusted when the management plan is updated.

5. New threshold criteria may be developed to replace or supplement the existing criteria.

6. Establishing threshold criteria in this plan does not preclude the use of best professional judgment in issuing, denying, or determining mitigative measures for permits.

## WILDLIFE RESEARCH AND MANAGEMENT

Brown bears have been studied at McNeil Falls and nearby areas since 1954. Much of the limited information available on movements and mortality of McNeil bears was determined by marking 60 bears at McNeil Falls from 1963 to 1973. Additionally, data on numbers of individual bears; bear days of use; feeding, mating, learning, and other behaviors; feeding rates; and salmon escapements have been collected by ADF&G staff and other biologists for many years at McNeil Falls and Mikfik Creek. Aerial surveys of bears in the McNeil and Paint River drainages were conducted in 1991 in anticipation of changes in bear distribution resulting from establishment of a large salmon run in the Paint River.

Also in anticipation of changes caused by the Paint River fish ladder, the ADF&G began assessing the need to resume marking bears that use the sanctuary. In 1973, marking was discontinued primarily because bear viewers objected to visible markers and study objectives had been met. Marking is the most effective way to document shifts in bear distribution. This knowledge may be critical in protecting the sanctuary's bears and bear viewing program from human uses in adjacent areas. Surgically implanting transmitters, so that they are not visible, is feasible; however, it is the most expensive method; battery duration is limited, which would necessitate frequent recapture and handling; range is limited; and it requires minor surgery in the field. Radio-collars are the most effective way to monitor bear movements at this time. Marking would ideally occur before salmon enter the Paint River system in large enough numbers to alter bear distribution. Radio-collars or other visible marks would degrade the viewing experience for some bear viewers and photographers over the short term. However, care could be taken to minimize the effects. For example, only the minimum number of bears needed to get meaningful results could be marked; capturing and handling could occur many miles from viewing areas, probably in spring; collars could be designed to be as inconspicuous as possible; and they could be removed as soon as the study was completed.

While few argue the need to protect the existing viewing program and bears in the sanctuary, there are conflicting ideas on how humans should be allowed to interact with bears in the refuge. Bears in the McNeil Lagoon area are treated at all times to regard humans as a neutral element (except in camp or on the small viewing pads where bears are repelled). This policy has repercussions in areas outside the sanctuary when these tolerant bears approach humans who are unfamiliar with or unwilling to tolerate this behavior. The ADF&G has a great deal of control over bear-human interactions in the sanctuary, through permit stipulations and staff presence. There is little control at present over bear-human encounters in the refuge. Because demand for McNeil bear viewing permits exceeds supply, many potential visitors would like to create additional bear viewing areas in the refuge. Others, such as bear hunters and commercial fishermen, have had to accommodate a growing number of restrictions on their activities in and adjacent to the sanctuary due to bear viewing. These groups oppose the development of additional bear viewing areas like those in McNeil sanctuary because they anticipate it may lead to restrictions on their activities in the refuge, or even beyond.

### Management Objectives

Allow wildlife research that meets the purposes for which the sanctuary and refuge were established, with the highest priority placed on baseline and subsequent studies designed to monitor changes in bear population parameters (e.g., population size, distribution, migration corridors, denning areas, age or sex ratios) or individual behavior.

### **Management Guidelines**

1. Continue collecting long-term data at McNeil Lagoon bear viewing areas (e.g., numbers of individual bears; bear days of use; ancestry; feeding, mating, and other behaviors; feeding rates; numbers of returning salmon). Begin collecting other data (e.g., systematic daily counts) that are most likely to detect a significant change in bear populations, individual bear behavior, or the bear viewing experience.
2. Conduct aerial surveys of the McNeil and Paint River drainages designed to detect major changes in bear numbers and distribution.
3. Conduct onsite surveys in the Paint River drainage, with particular emphasis in areas where bears are concentrated, to identify movement patterns and behavior of individual bears that also use McNeil sanctuary; how bears use the area; what influences bear movements, distribution, and behavior; and bear-human interactions.
4. A limited number of bears that visit McNeil sanctuary may be tagged with visible markers, but only if tagging is critical to protecting the bear population or viewing program. Invisible markers (such as internal transmitters) may be considered if capturing and handling methods are not likely to affect bears, their subsequent behavior, or visitor safety. Intensive spring aerial counts, inconspicuous tattoos, or other alternatives will be used instead of visible markers or radio collars if they can provide adequate information.
5. An isolated bear attack or accidental injury inflicted on a human is possible due to the inherent nature of bears and is not in itself grounds for the ADF&G to subsequently revise either the viewing program or other human uses. If such an event occurs, it will be analyzed and, if a direct cause can be established for the individual bear's behavior, steps will be taken to minimize the possibility of a repeat occurrence.
6. Conduct surveys of hunters, bear viewers, resident Alaskans, and visitors to better understand knowledge, attitudes, behaviors, and expectations of various user groups.



## **BEAR VIEWING AND EDUCATION**

Bear viewing has been a high priority in this area since 1955, when the McNeil River drainage was closed to brown bear hunting. The sanctuary was created in 1967 by the Legislature. Since statehood, the Board of Game and ADF&G have managed the area to protect brown bears and to establish and maintain a world-class bear viewing program.

Over the years, the number of visitors increased steadily. In 1973 the Board of Game adopted regulations which limited the number of visitors to the Falls to 10 per day during the peak visiting period in July and August. Currently, four-day access permits are selected by lottery. Visitors often need four days to accommodate weather conditions (poor weather affects both flying schedules and photography). Beginning in 1993, the Board added most of June to the lottery period. In recent years, approximately 250-300 visitors have been escorted to bear viewing areas each summer.

The number of bears observed at viewing areas has also increased. Because human activity in the sanctuary is predictable and benign, many bears have become tolerant of humans to some degree. The offspring of tolerant females tend to also exhibit a high degree of tolerance.

The success of the viewing program has resulted in greater expectations among visitors. Today's visitors expect to see many more bears than one or two decades ago and they expect to see some bears at very close range. A survey was conducted in 1990 to determine visitor characteristics, attitudes, behaviors, and willingness to pay for the McNeil experience.

### **Management Objectives**

Maintain and enhance the unique bear viewing opportunities in the sanctuary.

Preserve the natural setting and wilderness character of the sanctuary.

Use the refuge as a buffer to protect the sanctuary's bear population and bear viewing program from human uses in adjacent areas and to minimize any adverse effects of tolerant bears on human uses outside the sanctuary and refuge.

### **Management Guidelines**

1. Maintain or increase the proportion of Alaskans obtaining bear viewing permits.
2. Minimize the use of special sanctuary access permits (e.g., scientific/educational, commercial, auction or raffle) to maximize the number of bear viewing permits available for the public drawing.
3. Issue scientific/educational permits before the public drawing to allow unissued sci/ed permit periods to be available for use by the public.

4. Limit the structures associated with the bear viewing program at McNeil Lagoon to the public cook shack, sauna, and outhouses and staff accommodations.
5. The decision to establish a bear viewing program in other parts of the sanctuary or refuge will be considered on a case-by-case basis after a public review to determine (1) how it will be managed and (2) potential affects on bears and other human uses in the sanctuary, refuge, and adjacent areas.
6. Refuge users will be given bear safety information that includes the special characteristics of McNeil bears (e.g., tolerance toward humans), and visitors not accompanied by bear biologists or ADF&G staff will be encouraged to maintain a distance of 100 yards from single bears and 200 yards from bears with cubs.
7. Bear viewers visiting the sanctuary will be provided information regarding the unique characteristics of the McNeil River experience compared with other viewing areas; the compatibility of commercial and sport fishing with bear conservation and viewing, as practiced in the sanctuary; and the compatibility of hunting with conservation of bear populations, including a map depicting areas in Alaska where brown bear hunting is and is not allowed.

## HUNTING

Brown bear hunting has been prohibited in the McNeil River drainage since 1955. Hunting opportunities have declined in other Kamishak Bay drainages with additional brown bear hunting closures on state land south and east of the sanctuary and in the expanded Katmai National Park.

A small, but growing, number of hunters hunt brown bears in the refuge and Amakdedori Creek drainage. Three guide-outfitters currently bring bear hunters to the area. Harvests in this area averaged 3.6 bears per year from 1980 to 1990, but by the end of this period (1988-1990) harvests had increased to an average of 5.0 bears per year. Over half of the bears harvested in this area from 1980-1991 were taken in the Chenik area, about one-third in the Amakdedori area, and the remainder in the Paint River drainage.

Currently, the management objective for bear harvests on the Alaska Peninsula is 5% of the population. The estimated 5% harvest rate for the refuge and Amakdedori drainage is three bears per year.

In 1991 the Board created a registration permit hunt in this area, with a goal of limiting the harvest to three bears per year. When five bears were harvested in this area in fall 1991, the spring 1992 hunt was closed by emergency order. The fall 1993 season was also closed by emergency order until the Board of Game determined whether bear hunting would continue. In 1993 the Board elected to continue a three-bear harvest, but changed it to a drawing permit hunt to minimize the possibility of exceeding the three-bear quota. The first drawing, held in May 1995, attracted a substantial number of applicants that had no intention of hunting bears. In fact, at least six of the eight permittees said they would not hunt bears in the refuge. The Board will readdress bear hunting in the refuge in October 1995.

Bear hunting in the refuge is the most controversial issue in this plan. Environmental groups and many individuals, in Alaska and other states and countries, generally oppose bear hunting in the refuge on the grounds that the loss of tolerant bears will affect (and has probably already affected) the sanctuary's bear viewing program and that hunting tolerant bears from the sanctuary violates the principle of fair chase. Hunting organizations argue that limited bear hunting in the refuge has no effect on bear populations and little or no effect on the bear viewing program. They believe that giving up hunting in the refuge will ultimately lead to closures in other areas.

### Management Objectives

Allow hunting activities that are compatible with the purposes for which the sanctuary and refuge were established.

### Management Guidelines

1. The Board of Game will determine if brown bear hunting should be prohibited in the refuge and adjacent areas. Hunting and trapping other wildlife is compatible with the purposes for which the refuge was established.
2. The bear population in the refuge and Kamishak Bay drainages north to Contact Point can support a harvest of up to three bears per year. Harvest includes any human-related mortality, including legal and illegal hunting, shooting in defense of life or property, or accidental deaths attributable to human uses.
3. If the Board of Game allows bear hunting to continue in the refuge and the harvest exceeds three bears per year, the next scheduled open season for the refuge and Amakdedori drainage will be closed by emergency order until the average number killed over the duration is no greater than three bears per year.
4. Hunting and trapping are prohibited in the sanctuary.

## **SPORT FISHING AND OTHER RECREATIONAL ACTIVITIES**

The primary recreational activities in the sanctuary prior to its expansion were bear watching and bear photography. With the lower Kamishak and Paint rivers now included in the sanctuary, sport anglers outnumber bear watchers. Guides bring more than 550 anglers to the Kamishak River each year, and this use is increasing. A camping area has been established on the lower Kamishak for guides to remain in the sanctuary while anglers are brought in on day trips. Although sport fishing is virtually nonexistent in the Paint River now, introducing salmon could potentially create a new sport fishery.

Visitors often engage in viewing wildlife other than bears, beachcombing, and other recreational activities; however, few people visit the sanctuary or refuge primarily for these reasons. There is some potential for rafting or kayaking in the Paint or Kamishak rivers.

Unsupervised sanctuary and refuge users could affect bears and the sanctuary's bear viewing program. McNeil bears are not food-conditioned; in other words, they do not associate humans with a source of food. However, they could easily become food-conditioned if allowed to sample a visitor's food, fish, or garbage. Food-conditioned bears can be dangerous, and even one of these bears could place the bear viewing program in jeopardy. Unsupervised visitors could also shoot or chase away a tolerant bear, either of which could detract from the viewing program. The sport fishing guide camp on the Kamishak River and other sanctuary visitors that are not closely supervised by department staff must comply with permit conditions intended to prevent food-conditioning and other adverse affects. Because **refuge** visitors do not need access permits, education and voluntary compliance with guidelines will be tried first.

### **Management Objectives**

Allow recreational activities that are compatible with the purposes for which the sanctuary and refuge were established.

### **Management Guidelines**

1. Refuge users will be given bear safety information that includes the special characteristics of McNeil bears (e.g., tolerance towards humans), and visitors not accompanied by bear biologists or ADF&G staff will be encouraged to maintain a distance of 100 yards from single bears and 200 yards from bears with cubs.
2. An isolated bear attack or accidental injury inflicted on a human is possible due to the inherent nature of bears and is not in itself grounds for the ADF&G to subsequently revise either the viewing program or other human uses. If such an event occurs, it will be analyzed and, if a direct cause can be established for the individual bear's behavior, steps will be taken to minimize the possibility of a repeat occurrence.

3. Sport fishing restrictions for Mikfik Creek, McNeil River, and McNeil Lagoon are in 5 AAC 92.065.
4. Sanctuary access permits will not be issued for sport fishing on Mikfik Lake.

## **FISHERIES ENHANCEMENT**

Fisheries enhancement occurred in Kamishak Bay long before the sanctuary was created. In 1932 federal biologists used explosives to modify a falls in "McNeil Creek" (presumably nearby Mikfik Creek) to allow more sockeye salmon upstream. The mouth of Chenik Creek, which had been partially blocked by the 1964 earthquake, was modified in 1981-82 and 1986; hatchery-raised sockeye fry have been and continue to be transplanted annually; and Chenik Lake has been fertilized to increase sockeye numbers. Mikfik and Chenik creeks are historically two of the largest sockeye-producing systems in lower Cook Inlet. Sockeye salmon in Chenik Creek have been decimated in recent years by IHV.

The Paint River drainage was the largest in lower Cook Inlet inaccessible to spawning salmon. Constructing the Paint River fish ladder was the first step in creating a new source of salmon in the region. Additional enhancement activities in the sanctuary and refuge have been considered, including stocking at least three species of salmon in the Paint River, fertilizing the Paint River lakes, and constructing another fish pass at the outlet of the lower Paint River Lake. A proposal to stock sockeye salmon in the McNeil River drainage and fertilize McNeil Lake was considered and rejected by the ADF&G in the 1980s.

A major concern raised during the Corps of Engineers' reevaluation of the Paint River fish ladder permit was protection of natural fish stocks such as McNeil chum salmon and Mikfik sockeyes. The Department of Fish and Game Genetics Policy gives priority to protecting "natural" stocks over transplanted stocks, even after the transplanted stocks begin reproducing naturally in the new environment.

### **Management Objectives**

Allow fisheries enhancement activities in the sanctuary and refuge that are consistent with the purposes for which these areas were established.

### **Management Guidelines**

1. Fisheries enhancement decisions, including the selection and management of brood stocks and facility management plans, will be made in consultation with the other resource management divisions to minimize adverse impacts on the bear population of the sanctuary and refuge and the sanctuary's bear viewing program.
2. If necessary, the fish ladder or other means may be used to eliminate an unacceptable stock from the Paint River.
3. No access is allowed above the mean high tide line in Akjemguiga Cove without a sanctuary access permit.

## COMMERCIAL FISHERIES MANAGEMENT

Commercial fishing has long occurred in Kamishak Bay. Fishermen have used McNeil Lagoon, Chenik Lagoon, and the mouth of the Kamishak River as fishing and anchoring sites since before the sanctuary was established. Until recently, Chenik Creek produced the largest sockeye salmon run in lower Cook Inlet, and in some years Mikfik Creek also contributes a substantial number of sockeyes. McNeil River is generally among the top three chum salmon-producing streams in lower Cook Inlet. According to initial predictions, the Paint River would produce more sockeye and chum salmon than any other system in Kamishak Bay; however, the ultimate number of returning sockeye and chum salmon is now undetermined. Escapement goals have been established for salmon stocks in several streams, as follows: Mikfik Creek (5,000-7,000 sockeyes), McNeil River (20,000-40,000 chums), Chenik Creek (10,000 sockeyes).

Some commercial fishing activities have a negative impact on the sanctuary's bears and viewing program. By working cooperatively, the fishermen and fisheries and wildlife managers have resolved most concerns. Commercial fishing is compatible with the purposes for which the sanctuary and refuge were established, but only with continued cooperation and consultation.

The best example of this cooperation was the development of the Mikfik Creek - McNeil Lagoon Salmon Fishery Management Plan in 1988. The divisions of Commercial Fisheries and Wildlife Conservation and seiners came to a mutual agreement that allowed seiners to harvest sockeyes in a manner compatible with bears and the bear viewing program.

There has been a relatively high level of cooperation in considering bears and the bear viewing program in fisheries management decisions in this part of Kamishak Bay. Commercial Fisheries Division has drafted a Paint River Salmon Enhancement Project Operational Plan that addresses many of the concerns raised by the Division of Wildlife Conservation and McNeil River Advisory Group. When the enhancement plan is completed, it will guide decision-making. Ultimately, the authority to integrate fisheries and wildlife management decisions rests with the Commissioner--who signs sanctuary and refuge management plans, enhancement plans, and fish transport permits--and the Boards.

Decisions involving fish stocking (e.g., where, what species, run timing), salmon escapement goals, and stock separation) are among the most significant factors affecting bears in the sanctuary and refuge. These decisions are currently made by the fisheries divisions and the Board of Fisheries. The Board of Fisheries allocates fish between user groups. Bear viewers at McNeil are a user group that is significantly affected by fisheries-related decisions. The best way to consider all user groups is for fisheries allocation issues to be decided by both the Board of Fisheries and Board of Game in joint session.

### Management Objectives

Allow commercial fishing activities that are consistent with the purposes for which the sanctuary and refuge were established.



Establish salmon escapement levels sufficient to support a high population of brown bears in the sanctuary and maintain a viable salmon population.

### **Management Guidelines**

1. In accordance with statutory mandates, the optimal escapement goal for McNeil and Paint rivers and Mikfik Creek will be determined by the Board of Fisheries and Board of Game in joint session.
2. The Division of Commercial Fisheries will establish or modify biological escapement goals for stocks in sanctuary and refuge streams, in accordance with the Salmon Escapement Goal Policy, in consultation with other resource management divisions.
3. **Mikfik Creek - McNeil Lagoon Salmon Fishery Management Plan.** Management of the sockeye salmon return to Mikfik Creek will be carried out to allow adequate escapement and to provide fish for bear consumption throughout the course of the run in accordance with the provisions of the Mikfik Creek - McNeil Lagoon Salmon Fishery Management Plan.
4. Similar commercial fishery management plans will be developed, when appropriate, for Akjemguiga Cove and Chenik Lagoon by the Commercial Fisheries Division in consultation with seiners and other resource management divisions.
5. The following guidelines are voluntary for seiners in Chenik Lagoon unless it is determined that they are ineffective, at which time they will be reassessed.
  - a. Avoid going dry in Chenik Lagoon while fishing. If not possible, remove all fish from nets. Whenever possible, the ADF&G will attempt to schedule fishery openings following long closures on flood tides.
  - b. Do not leave unattended vessels in the Chenik Lagoon. If this is absolutely necessary, clean your vessel completely, disinfecting the hold and removing all fish from nets.
  - c. Minimize spotter plane activity over the lagoon and the lodge in consideration of Chenik lodge guests. Consideration of guests' viewing experience is also requested.
  - d. Minimize negative impact to bears in creek mouth. This is the viewing area utilized by Chenik lodge guests. Consideration of guests' viewing experience is requested.
  - e. Stay out of fresh water while commercial fishing. Plunge [chase away from shore with poles] fish only below the level of tide (i.e., in saltwater).
  - f. Recreational hiking around the creek mouth and stream is not advised due to possible negative bear-human interactions.

## **FUNDING**

For many years, bear research and management of the bear viewing program have been the sanctuary's primary costs. Fees derived from sanctuary access permits have not covered the cost of managing the sanctuary. When the sanctuary was expanded and the refuge created, the ADF&G acquired additional responsibility to monitor existing and anticipated human uses and to ensure their compatibility with sanctuary and refuge purposes. These uses include sport fishing guide camps on the Kamishak River and potentially in the Paint River drainage, the Paint River fish ladder and associated fisheries enhancement activities, possible mineral exploration and development in the refuge, and commercial fishing activities in the sanctuary and refuge.

Bear viewing fees are not the only means of funding management of the sanctuary and refuge. Other sources of funding include the state's general fund; application and user fees for other activities in the sanctuary; donations to the Alaska Watchable Wildlife Conservation Trust; the sale of videos, posters, calendars, and other McNeil mementos; and commercial user fees. Potential sources of funding include an auction or raffle of several bear viewing permits or a percentage of concessionaire revenues.

Currently, Alaskan resident fees for a bear viewing permit are \$100 for regular and \$50 for standby. Nonresident fees are \$250 regular and \$125 standby. All applicants pay a \$20 application fee, which is used to cover the cost of administering the drawing.

### **Management Objectives**

Users and supporters should share the cost of managing the sanctuary and refuge.

Management costs should not be borne by one user group at the expense of another.

### **Management Guidelines**

1. Refer to the section on Visitor Permits and Fees.
2. Implement innovative ways to increase voluntary revenues from bear viewers and other users that will help keep fees as low as possible (e.g., media permits, permit auctions or raffles, optional purchases of mementos, and donations).
3. Videos, posters, patches, pins, decals, hats, t-shirts or other mementos will be offered as optional purchases. An attractive brochure will be produced that includes an order form to let visitors order mementos. The same brochure will be mailed and passed out to tourists and Alaskan residents.
4. Seek legislative approval to hold an annual auction or raffle, or both, with the proceeds to go into a fund dedicated for sanctuary and refuge management and research.

5. The Division of Wildlife Conservation should employ an independent marketing group to implement these ideas, if it is more cost-effective.

## VISITOR PERMITS AND FEES

In 1973 the Board of Game adopted regulations which required all visitors to the sanctuary to obtain a permit and limited the number of visitors to McNeil Falls to 10 per day during the peak period of bear use in July and August. This system was modified several times during the 1970s and 1980s to accommodate a growing demand while protecting bears and the viewing opportunity. Beginning in 1983, an application fee of \$5 was required to participate in the permit drawing. In 1987 the application fee was raised to \$10 and a user fee of \$40 was required of all permit holders. In 1993 both the application and user fee was raised; the application fee is \$20, user fees for Alaskan residents are \$100 for regular and \$50 for standby permits, and user fees for nonresidents are \$250 for regular and \$125 for standby permits.

A survey was conducted in 1992 to determine how much bear watchers would be willing to pay for a wildlife conservation tag and McNeil related products, such as pins, calendars, and t-shirts. Bills to establish a wildlife conservation tag, which would help fund state wildlife watching programs such as McNeil, failed in the 1992 and 1993 legislative sessions. A book, video, calendar, and poster featuring McNeil bears were produced in 1993 and a percentage of the proceeds will help fund McNeil sanctuary and refuge management.

In 1992 and 1993 the Board of Game substantially revised sanctuary access regulations. These regulations were implemented in 1993 and 1994.

Up to 15 special access permits may be issued by the Commissioner each year. These permits are reserved from the 10-person limit at bear viewing sites. Applications for 10 scientific/educational permits are reviewed by a committee of ADF&G staff and recommendations based on technical merits are forwarded to the Commissioner. The primary selection criteria for these permits are benefits to the sanctuary, the bear population, or the bear viewing program. In recent years, applications for scientific/educational permits have increased. A more detailed list of criteria and formal review procedures has been developed to limit permits issued for scientific and educational purposes to only applicants that clearly satisfy those criteria, with the remaining slots being issued to the public through the permit lottery. The other five special permits are reserved for the Commissioner to issue at his or her discretion.

A standby system is used to ensure that as many visitors as possible get to the bear viewing areas. Until 1990 there was an informal method for issuing standby permits. The sanctuary manager was contacted by radio or by visiting the sanctuary and, if any vacancies were available, standby permits were issued on a first-come-first-served basis. The demand for these permits, particularly during the peak viewing period, eventually outgrew this simple system. In 1991 and 1992 standby permits were issued on a first-come-first-served basis to people who telephoned in at a scheduled time. Managing this was very labor-intensive and therefore costly, and it tended to favor Homer residents (because local calls have an advantage over long-distance) and a few others that had learned how to use the system (e.g., employ a phone bank). However, this method was very efficient at keeping the number bear viewers near the maximum of 10 per day. A new procedure for issuing standby permits went into effect in 1993. Standby permits were

issued by lottery at the same time as regular bear viewing permits. This is a much less costly method, and it appears to be equally effective in filling empty slots.

### **Management Objectives**

Maximize the number of bear viewers each year, with the following constraints: issue lottery permits only for the period when bears are likely to be seen, for no more than 10 visitors per day escorted to bear viewing areas, and for a duration of four days.

Maximize the number of first-time visitors, while providing some opportunity for repeat visits after a waiting period.

Establish application fees that cover the entire cost of administering application procedures; however, strive to keep user fees lower than the maximum amount visitors are willing to pay to maintain this bear viewing opportunity for a broad cross-section of the public.

### **Management Guidelines**

1. Sanctuary access permit regulations and fees are specified in 5 AAC 92.065 and 5 AAC 93.030.
2. Support legislative action to establish a wildlife conservation tag that will be required of all people who enter the sanctuary, including sport anglers and commercial fishermen. The tag should cost \$10, which would be in addition to application and permit fees.
3. Introduce and support legislative action to establish a commercial media permit such as that recommended by the McNeil River Advisory Group, if the Department of Law determines this is legal.
4. Reevaluate the effectiveness of the existing standby system based on the 1993-1995 visitor seasons.

## **STAFFING**

Although the sanctuary was created in 1967, the ADF&G did not assign seasonal staff to the sanctuary to monitor bear-human interactions until 1973. By then, unlimited visitation and unregulated human activities had decreased the number of bears at the Falls from an average of 25-30 to as few as 12. As the bear viewing program evolved under the close supervision of sanctuary staff, the number of bears and their tolerance of humans increased. In 1991 a student intern position was added to the sanctuary staff to help with increased demands on their time.

Up until the summer of 1993 the focus has been on the visitor program in McNeil Lagoon. By adding the Kamishak River and lower Paint River areas to the sanctuary and creating a large refuge as a buffer, the Legislature substantially increased the area of responsibility and the variety of human uses to be monitored and managed.

### **Management Objectives**

Assign an adequate number of staff to accomplish the goals, management objectives, and management guidelines of the sanctuary and refuge.

### **Management Guidelines**

1. Continue funding two fish and wildlife technicians and one additional fish and wildlife technician or student intern as sanctuary staff. Where necessary or desirable, use other division employees or volunteers to augment McNeil staff or monitor bears or human activities in the sanctuary and refuge.
2. Coordinate and share monitoring and research activities in the sanctuary and refuge with other state and federal resource agencies whenever feasible.

## REPORTS, EVALUATION, AND REVISIONS

Plans, management objectives, and guidelines must evolve as circumstances, experience, and management philosophies change. Reports provide a record of observations that can be assessed by managers and others. Sanctuary staff write an annual report. Recently, three other annual reports have been required by law. Sanctuary and refuge statutes require the Commissioner to report to the Legislature, sanctuary regulations require commercial users to report to the ADF&G, and the permit for the Paint River fish ladder requires Cook Inlet Aquaculture and state and federal agencies to report to the Corps of Engineers. These reports will help the ADF&G monitor fish and wildlife populations, habitats, and human uses in the area. The management plan and regulations can be evaluated periodically to reaffirm existing goals and objectives or, if necessary, establish new goals and objectives.

### Management Objectives

Monitor effectiveness of sanctuary and refuge management plan and regulations to determine whether changes are needed.

### Management Guidelines

1. An annual report will be written by sanctuary staff describing visitor and bear use of the sanctuary and refuge during the field season, comparing it with previous years, and including any other fish or wildlife observations, recommendations and requirements for the next field season, and any other points of interest.
2. Commercial use permittees will prepare and submit an annual report to the ADF&G within 30 days of the expiration of the permit. The report shall include the following: (a) pictures of the site taken before and after cleanup, (b) a map showing the location of all permit activities which were not shown in the permit plan, or any modifications of the permit plan, (c) a detailed statement of cleanup and restoration work at the site, (d) total number of clients brought to the site and angler-days, (e) total numbers of fish caught and fish kept (by species), (f) first and last dates at the site, and (g) a daily log of bear sightings and bear-human interactions.
3. An annual report will be prepared by the Division of Wildlife Conservation, in consultation with the other divisions, for the Commissioner to submit to the Legislature by January 30 on the status of brown bears and other fish and wildlife resources within the sanctuary and refuge and the effects of fishing, fisheries enhancement, hunting, trapping, and mineral resource development on brown bears and other fish and wildlife resources in the sanctuary and refuge.
4. Cook Inlet Aquaculture Association will meet with representatives of the Alaska Department of Fish and Game, Alaska Department of Natural Resources, U.S. Fish and Wildlife Service, and the National Park Service annually in February, beginning in 1993. Additional meetings will be held as required by the U.S. Army Corps of Engineers. The purpose of the meeting(s) will be to review available reports and pertinent scientific information, including the

Commissioner's annual report to the Legislature on the status of resources in the McNeil River State Game Sanctuary and Refuge; and any similar data on resources in Katmai National Park and Preserve. The primary agenda for each meeting will be to consider variations, if any, in bear concentrations or behavior at either McNeil or Katmai which could reasonably be attributed to the introduction of salmon into the Paint River via the fish ladder authorized by the Corps permit, and to recommend any appropriate remedial measures. A written report, including a minority report if there is disagreement among the parties will be submitted to the District Engineer, U. S. Army Corps of Engineers, (within 30 days of the date of any meeting) for review to determine if future modification, suspension, or revocation of the permit is warranted.

5. The management plan and regulations will be evaluated at least once every three years to reaffirm existing goals, objectives, or guidelines or, if necessary, to establish new ones.



## DEFINITIONS

**Bear threshold criterion** - A pre-determined level of change in a bear population that triggers an assessment of potential factors which may have adversely affected the population or the sanctuary's viewing program. It must (1) be based on an objective unit of measure, (2) measure a meaningful characteristic of a bear population, bear behavior, or the bear viewing program, and (3) be reliably and consistently measured.

**Commercial recreational user** - Lodge operators, fishing guides, guide-outfitters, other guides and assistant guides, and air taxi operators serving recreational users.

**Optimal escapement goal** - A specific management objective for the escapement that considers biological and allocative factors (refer to Salmon Escapement Goal Policy).

**Unique bear viewing opportunities** - Areas within the sanctuary during periods when brown bears are visible in unusually high numbers or where individual bears show an unusual tolerance to human presence relative to other areas in the sanctuary. Unique bear viewing opportunities include, at a minimum, McNeil Falls, McNeil Lagoon, Mikfik Creek, and McNeil Spit from June through August.

## APPENDIX A

### COMPLETE LIST OF MCNEIL RIVER ADVISORY GROUP CONSENSUS AGREEMENTS

#### GOALS

1. Maintaining and enhancing the "unique bear viewing opportunities" at McNeil Falls has a higher priority than other allowable uses.

#### VISITOR PERMITS AND FEES

1. Collect the sanctuary user fee only after the drawing winners have been selected.
2. Establish three types of sanctuary visitor permits: resident, nonresident, and nonresident alien.
3. Continue issuing standby permits.
4. Establish a maximum of three 3-person commercial use permits for a 4-day period and charge \$10,000 per group per period. Applicants must meet the criteria for a scientific/educational permit, but these are not intended to apply to scientific researchers. Applications should be solicited two years in advance. Consider the desires of the permittee when deciding which period to issue the permit for.
5. Hold an auction, a raffle, or both each year, with the proceeds to go into a fund dedicated for sanctuary and refuge management or research.

Auction. Issue two permits to the highest bidder in an open auction. Permits would be for the same 4-day slot during a peak bear viewing period. Mention the auction on application forms and informational packets. Advertise internationally and have an international phone line during the auction. The permits would be transferable.

Raffle. Sell 500 \$25 raffle tickets, with no limit to the number that can be purchased by an individual. Raffle winner would be issued two permits for the same 4-day period. The raffled permits need not be for a peak period. The permits would be transferable.

6. Time periods subject to drawing permits should begin June 1, with a warning on the application form and information packet that bear viewing and weather conditions in early June are not as good as they are later.

7. Recommended fees and estimated revenue.

Permit Type	Recommended Fees		Estimated Revenue*	
	Application	User	Application	User
Resident	20	80	14,800	5,920
Nonresident	20	180	20,040	18,360
Alien	20	280	4,800	6,720
Standby	0	same as above	0	10,400+
SUBTOTAL			\$39,640	\$51,150
Commercial (1-3 permits)	0	10,000	0	10,000-30,000
Auction (2 permits)	0	10,000+	0	10,000
Raffle (2 permits)	25	0	12,500	0
SUBTOTAL			\$12,500	\$20,000-40,000
TOTAL (Application and User Fees) = \$123,290-142,790+				

\* Estimated revenue based on 4-day permits issued from June 1 to August 25, with 2,000 applicants, 200 regular permittees (residents = 37%, nonresidents = 51%, aliens = 12%), 130 standby visitors, and 500 raffle tickets.

8. The wildlife conservation tag should be required of all people who enter the sanctuary, including sport anglers and commercial fishermen.
9. The tag should cost \$10. This should be in addition to application and use permit fees.
10. Patches, pins, decals, hats, t-shirts or other mementos should be optional purchases. The department should produce a colorful brochure which includes an order form to let visitors order mementos. The same brochure could be mailed and passed out to tourists and Alaskan residents.
11. Work with guide-outfitters and lodges to determine a commercial user fee to cover costs of administering and monitoring the Kamishak River camping area. The goal is to have the users pay for any necessary management costs.
12. Sport anglers brought to the sanctuary by guide-outfitters and lodges should not need sanctuary access permits. Instead, the guide-outfitters and lodges should be required to submit an annual report, tallying the numbers of clients, fish caught and kept (by species), and first and last dates on the river.
13. Drawing permit winners should not be eligible to apply for a drawing or standby permit the following calendar year.

## **COMMERCIAL FISHERIES MANAGEMENT**

1. Transplant salmon stocks that will return to the Paint River between mid-July and late August, after bear numbers have peaked at McNeil Falls. Specifically, choose a sockeye stock that will return in mid- to late July (possibly from Crescent River). Choose chum and pink salmon stocks that peak slightly after the sockeyes, and after the McNeil River chum fishery is over (possibly Bruin Bay). If cohos are transplanted, choose a stock that returns in mid-August.
2. If necessary, the fish ladder or other means can be used to eliminate an unacceptable stock from the Paint River.

## **CHENIK CAMP AND COMMERCIAL FISHING**

1. Adopt the provisions of the Chenik agreement worked out with the seiners:
  - a) Avoid going dry in Chenik Lagoon while fishing. If not possible, remove all fish from nets. ADF&G will try to schedule openings following long closures on incoming tides.
  - b) Do not leave unattended vessels in the Chenik Lagoon. If absolutely necessary, clean your vessel completely, disinfecting the hold and removing all fish from nets.
  - c) Minimize spotter plane activity over the lagoon and the lodge in consideration of lodge guests. Consideration of guests' viewing experience is requested.
  - d) Minimize negative impact to bears in creek mouth. This is the viewing area utilized by lodge guests. Consideration of guests' viewing experience is requested.
  - e) Stay out of fresh water. Plunge [chase away from shore with poles] fish only below the level of tide (in saltwater).
  - f) Recreational hiking around the creek mouth and stream is not advised, due to possible negative bear/human interaction.

## **SPORT FISHING**

1. Clients should not be allowed to overnight in the Kamishak River camping area, but guide-outfitters may.
2. Department staff should visit the Kamishak River area during the sport fishing season.
3. Do not close the area above or below the Paint River fish ladder to sport fishing unless it cannot be managed by limiting the number of visitor permits or by including restrictions on the permits.

## **BEAR THRESHOLD CRITERIA**

1. Threshold criteria are an acceptable method for maintaining existing characteristics of the brown bear populations if their measurement is not highly subjective and where baseline information exists for comparison.
2. ADF&G should determine if a significant level of unacceptable change in bear age/sex ratios, abundance, distribution, movements, or behavior will occur in the sanctuary or refuge or will affect the bear viewing program at McNeil Falls. Activities in the sanctuary or refuge that may cause unacceptable changes shall be modified or, if necessary, discontinued.

## **BEAR VIEWING AREAS**

[Note: No consensus could be reached on bear viewing areas.]

## **BEAR-HUMAN INTERACTIONS**

1. An isolated bear attack or accidental injury inflicted on a human is likely and is not in itself grounds for the ADF&G to subsequently revise either the viewing program or the fisheries enhancement program.

## **MINERAL EXPLORATION AND DEVELOPMENT**

1. The Department of Natural Resources should not close the refuge administratively to new mineral entry.
2. Exploratory crews and other mining personnel must have bear safety training which stresses the special characteristics of habituated bears (from McNeil). Mining companies should pay the cost of training.

## **BEAR MARKING**

1. A limited number of bears that visit McNeil sanctuary may be tagged with visible markers, but only if tagging is critical to the long-term future of the viewing program. Invisible markers (such as internal radio or satellite transmitters) may be used if capturing and handling methods are not likely to affect subsequent bear behavior or visitor safety.

## **PERMANENT FACILITIES**

1. Maintain existing facilities associated with bear viewing programs at McNeil Cove and Chenik.
2. Allow one food cache and consolidate tent platforms in one area on Kamishak River.
3. Allow permitted structures associated with Paint River fisheries enhancement project.
4. Limited facilities (similar to those at McNeil Cove) may be constructed for a bear viewing program on lower Paint River.
5. New permanent facilities or tent platforms in the refuge should be evaluated on a case-by-case basis.

[Note: There was no consensus on allowing existing tent platforms.]

## **UPSTREAM LADDER**

1. A fish ladder may be built at the outlet of lower Paint Lake if consistent with the statutory purposes of the refuge, with the required permits and approvals and following an analysis of potential environmental impacts.

## **FOOD STORAGE AND GARBAGE**

1. The food storage and garbage requirements developed by ADF&G and the Department of Natural Resources for the Kamishak River Special Use Area should apply to both the sanctuary and refuge, at a minimum.

## **CAMPING**

1. In the sanctuary, camping should be allowed only in designated camping areas.
2. Open fires should be restricted to approved sites.

## **ANCHORAGE**

1. Use the provisions of the Chenik agreement for other saltwater anchorages.

## **AIRCRAFT**

1. Allow no improvements for landing or docking aircraft in the refuge.

## **OFF-ROAD VEHICLES**

1. Off-road vehicles should not be allowed in the sanctuary, except that CIAA staff can operate motorized vehicles on the access road at the Paint River fish ladder site.
2. Snowmachines can be operated in the refuge when there is adequate snow cover.

[Note: No consensus was reached on use of other off-road vehicles in the refuge.]

## **BOATS**

1. Boats may be allowed in the sanctuary on the Kamishak and Paint rivers and McNeil Lake, by permit.
2. Boats shall be allowed in the refuge.

## **STAFFING**

1. Sanctuary and refuge staff should be of a sufficient size to monitor activities occurring throughout the sanctuary and refuge, not just the McNeil bear viewing program.
2. Other state and federal agencies should be contacted to help monitor activities in the sanctuary and refuge.
3. Once each summer, on July 20, all commercial operators (including CIAA staff at the Paint River, Chenik Camp, and guide-outfitters) should be required to note the number of bears seen on that day and their locations and report them to the department.

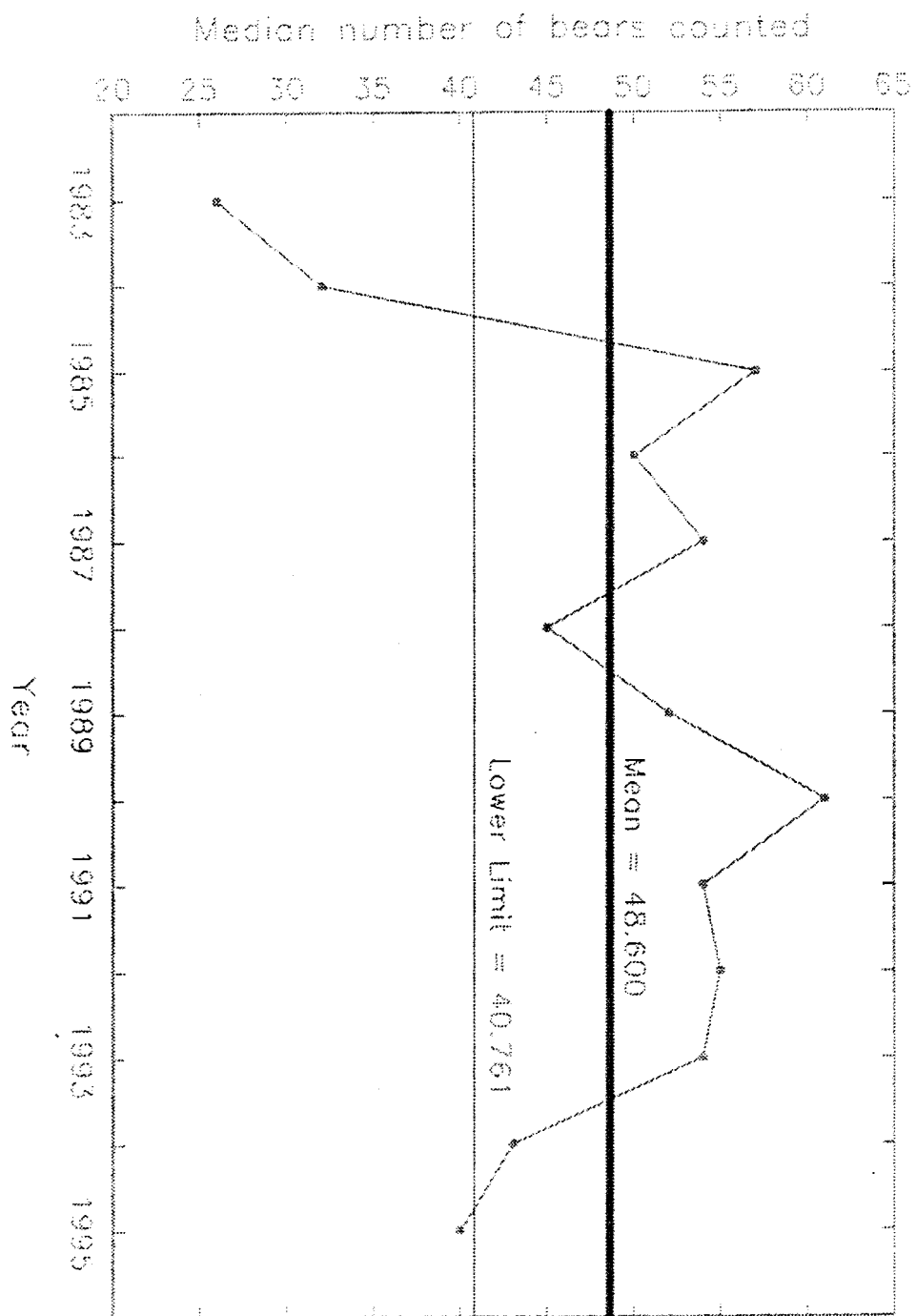
## **HUNTING AND TRAPPING**

1. Except for brown bears, hunting and trapping should be allowed in the refuge.

[Note: No consensus was reached on brown bear hunting in the refuge.]

## Appendix B

One-Sided Control Chart for Maximum Daily Bear Counts  
(7 highest counts) at McNeil River Falls ( $\alpha = 0.01$ ).





## Appendix C: Statistical Memoranda

### MEMORANDUM

### STATE OF ALASKA DEPARTMENT OF FISH AND GAME

TO: Rick Sinnott  
Wildlife Biologist II  
Wildlife Conservation  
Anchorage

DATE: July 29, 1993

FILE NO.:

THRU:

TELEPHONE: 267-2407

FROM: Earl Becker *EB*  
Biometrician  
Wildlife Conservation  
Anchorage

SUBJECT: Quality Control for  
Maximum Daily Bear  
Counts at McNeil  
River Falls.

The purpose of this memorandum is to introduce some basic quality control statistics and concepts and apply them to monitoring the quality of brown bear viewing at McNeil River falls. Larry Aumiller and his assistants have collected daily maximum bear counts at the falls since 1983. The department wishes to use this data to monitor the quality of bear viewing at the falls and possibly take corrective action if viewing quality is impacted by human activity.

If we visualize the yearly "average" of the maximum number of bears counted at the falls as being usually "stable", we can treat the historical data as fluctuations around some "average" population value with inherent variation. After calculating estimates of population "average" and within-year variation, we can set limits on these yearly values. If a value falls outside of these limits, it is unreasonable to explain it as natural variation in bear numbers ("white noise"). This method conclusively identifies years which had poor bear viewing; it does not identify whether the reason was environmental or man-made.

The approach outlined above is called a Shewhart control chart (Montgomery 1985), and is used to detect large shifts in a response from an average. Another quality control technique, called a cumulative sum control chart (CUSUM) (Ewan 1963, Wetherill 1977, Messina 1987) is used to detect drift from the average and can often detect changes before a Shewhart control chart would. CUSUM charts are twice as quick to detect changes of 0.5 to 2 SE than a Shewhart control chart, however, they are slower to detect large abrupt changes, therefore, we should use these 2 methods in tandem (Montgomery 1985). Some authors have suggested using a RUNS test with Shewhart control charts in place of CUSUM charts, but Champ and Woodall (1987) have shown that this approach is inferior to use of a CUSUM chart to detect slow drift changes.

At the current time only maximum bear counts are available. An "average" count of bears would be more robust, because missing a maximum, high daily count would cause a negative bias while an average has a chance to "balance out". A robust measure of "average" such as a median (50th percentile) or trimean ( $\text{trimean} = [25\text{th Percentile} + 2 \times \text{Median} + 75\text{th Percentile}] / 4$ ) (Hoaglin et al. 1983) would be less sensitive to extreme datum points which often occur in count data. Starting in 1993, data of this type will be collected, and control charts will be constructed when enough data have accumulated to obtain reliable estimates of "population average" and variance.

Before applying quality control techniques to the bear count data, we need to decide how to measure viewing quality using the maximum daily count data. I felt a median, due to its robustness against extreme observations, would be our best measure of "average". To date, I have tried using quality control charts on the following 3 statistics:

- 1) Yearly medians of daily maximum bear counts from the traditional peak viewing period (24 July to 2 Aug.) The data set was expanded for the years 1983, 88, 90, and 91 to ensure a sample size of 10 by using the closest, unused datum available to the missing data point in each of these years (Figure 1).
- 2) Yearly medians of daily maximum bear counts from data collected within 4 days of peak viewing (Figure 2).
- 3) Yearly medians of maximum bear counts from the 7 highest daily maximum counts (Figure 3).

Each of the above statistics measures viewing quality in a slightly different manner. Examination of yearly histograms (attached) of the maximum number of bears counted indicates that differences between years in statistic #1 may be due to low bear numbers or viewing peaks outside of the traditional peak viewing period. Some differences in statistic #2 may be due to viewing falling off sharply after a peak (ex. 1992) compared to other years. All 3 statistics measure viewing quality from a subset of the summer data. This will dampen out yearly differences due to environmental factors such as duration of salmon run and/or high water. I prefer statistic #3 because it is affected less by environmental variation than the other 2 statistics. I will limit my discussion on how control charts work to this statistic.

For each statistic, I took an arithmetic average of the yearly medians to obtain an estimate of the "population average" (target value) and bootstrapped (Efron 1982) each yearly median 2,000 times to obtain an estimate of the within-year variance. The average of these variances was used as an estimate of "population variance". A bootstrap procedure is a computer intensive resampling method used to estimate variance and was used because a formula for the variance of a median does not exist. Since we are mainly interested in a decrease in the quality of bear viewing, I will use 1-sided Shewhart and CUSUM control charts. Assuming normality, and using a mean of the variances as an estimate of variance, I constructed a lower 99%

confidence interval ( $\alpha=0.01$ ) for the "population average" (target value). When a data point is observed below this limit it is considered to be abnormal and not readily explained by random variation, and should be investigated to determine the cause(s) of this low count.

Because we will be making yearly decisions as to whether viewing quality is okay or abnormally low, I used a small  $\alpha$  to guard against a large experiment-wise error rate (Ostle and Mensing 1975). Alpha ( $\alpha$ ) is a 1-time measure of the probability of concluding a change has occurred when in reality no change exists (type I error), while the experiment-wise error rate measures the probability of making at least 1 type I error over the course x-number of decisions (tests). Small  $\alpha$  values result in large probabilities of failing to detect a change when such a change has really occurred (type II error). The choice of  $\alpha$  is guided by the consequences of a type I and type II error and the experiment-wise error rate. Using an  $\alpha$  of 0.01 will result in an experiment-wise type I error rate of 4.9% ( $1 - (0.99)^5$ ) for the 5 years that this system is expected to be employed. Using an  $\alpha$  of 0.05 would result in a large experiment-wise error rate, 22.6%, which is problematic given the possible economic costs associated with this type of error. The data for each statistic, the calculated mean of yearly medians and lower 99% confidence limits are given in Figures 1-3.

A CUSUM chart will be used to determine, in a timely manner, if the counts are drifting downward. It uses the following cumulative statistic:

$$S_m = (\text{median}_m - K) + S_{(m-1)},$$

where  $K = ((\text{mean target value} + \text{lower action limit})/2)$  is the reference value and  $m$  indexes year. This statistic coupled with a decision boundary determines if drift has occurred. If  $S_m$  is greater than 0, it is reset to 0 for our 1-sided case (Wetherill 1977), if it exceeds the decision boundary, then a change has occurred that can not be explained by "white noise". The decision boundary is a function of the reference value ( $K$ ) and the probability of a type I error in 1-tail ( $\alpha$  - in our 1-tailed case) (Ewan 1963, Wetherill 1977).

A Shewhart control chart for the median of the 7 highest maximum counts (statistic #3) on the 1983-1992 data sets results in a target value of 48.6 ( $SE=2.613$ ), and a 99% lower limit of 42.521 bears (Figure 3). Based on a reference value of 45.561 ( $(48.6 + 42.521)/2$ ) and a 1-tailed alpha of 0.01, the decision boundary of the CUSUM chart is -5.166.

As an example of how the Shewhart and CUSUM control charts would work together, I constructed a data set for the years 1993-2001. I used the observed 1992 datum (55 bears - based on median of the 7 highest counts) and assumed a 5% decline/yr from 1993-1998 and a stable population from 1998-2001. I introduced random

variation into the counts using the normal distribution to add or subtract "white noise" from the deterministic value to make the data more realistic. The resulting data are listed below and graphed in Figure 4.

Year	Observed Median	True Median	CUSUM
1993	51.327	52.250	0.000
1994	51.958	49.637	0.000
1995	46.463	47.156	0.000
1996	42.652	44.798	-2.909
1997	43.561	42.558	-4.908
1998	44.434	40.430	-6.035
1999	38.619	40.430	-12.977
2000	36.375	40.430	-22.162
2001	42.785	40.430	-24.938

Using the 99% lower limit of the Shewhart control chart we would first detect the decline in 1999 (Figure 4), because the observed median (38.619) is below the 99% lower limit (42.521). Using the CUSUM chart we would detect the change one year sooner, in 1988 (Figure 5), since that is the first year the CUSUM statistic exceeds  $h$  (-5.166). If the random variation ("white noise") added to the deterministic part of the 1997 data point was not positive, we would have detected the decline in 1997.

The slower the rate of decline (drift) the sooner the CUSUM chart will detect the change versus the Shewhart control chart. If a large abrupt change occurs, the Shewhart control chart will detect the change quicker than the CUSUM chart. For this reason, our decision rule is that a change has occurred if either control chart indicates a change. As Ewan (1963) points out, detection of a change will result in one of the following actions being taken:

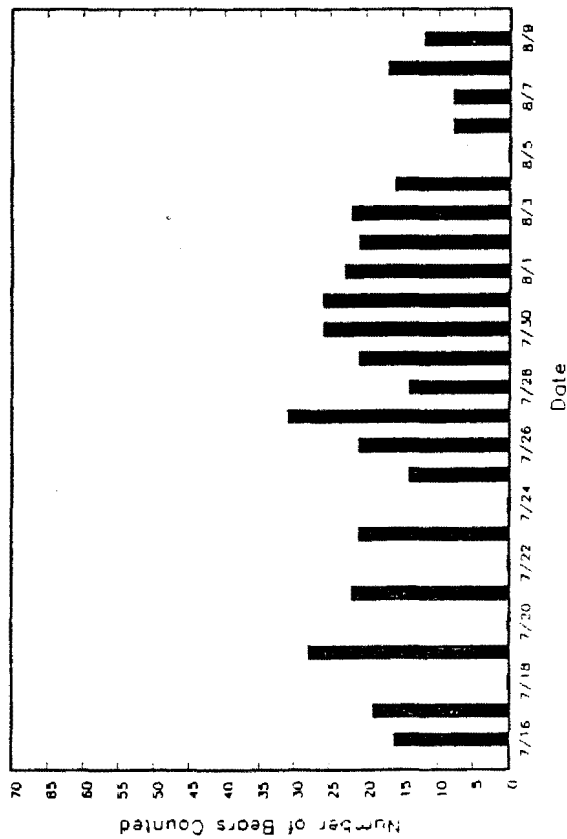
- 1) Direct Action - the physical alteration of some aspect of the process; or
- 2) Indirect Action - an attempt to find out why there has been a change ("get out of the chair and look").

He further points out that direct action requires a "fairly precise knowledge of cause and effect", and that "sleuthing" is required to find the probable cause with indirect action. Indirect action implies that a fairly precise knowledge of cause and effect is not known about the system. As this is the case with bear viewing, we will have to think about how sleuthing will determine whether man-made actions have caused a decline in bear viewing quality. To paraphrase Ewan (1963), having determined a change has occurred, some type of action must be taken, otherwise there is no point in obtaining these measurements (maximum bears counted). Since our decisions on this manner are going to be under heavy scrutiny, they need to be as defensible as possible. The use of quality control statistics to detect change is a highly defensible and non-subjective procedure which we can and should use in this decision-making process.

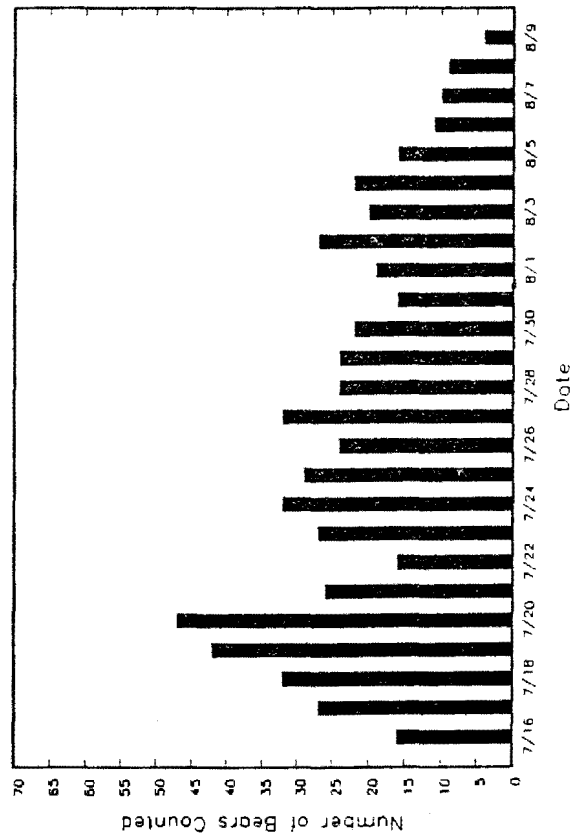
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- Wetherill, G. B. 1977. Sampling inspection and quality control. 2nd Ed. Chapman and Hall. New York, New York. 146 pp.
- CC: Ken Pitcher  
Larry Aumiller  
Colleen Matt  
Sterling Miller  
SuzAnne Miller  
Dave Anderson  
Karl Schneider

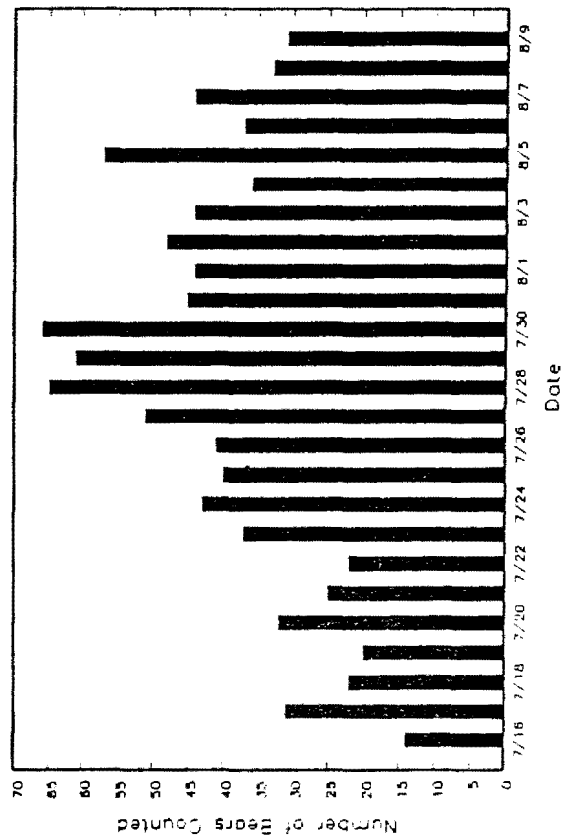
McNeil River Falls - 1983 Maximum Bear Counts



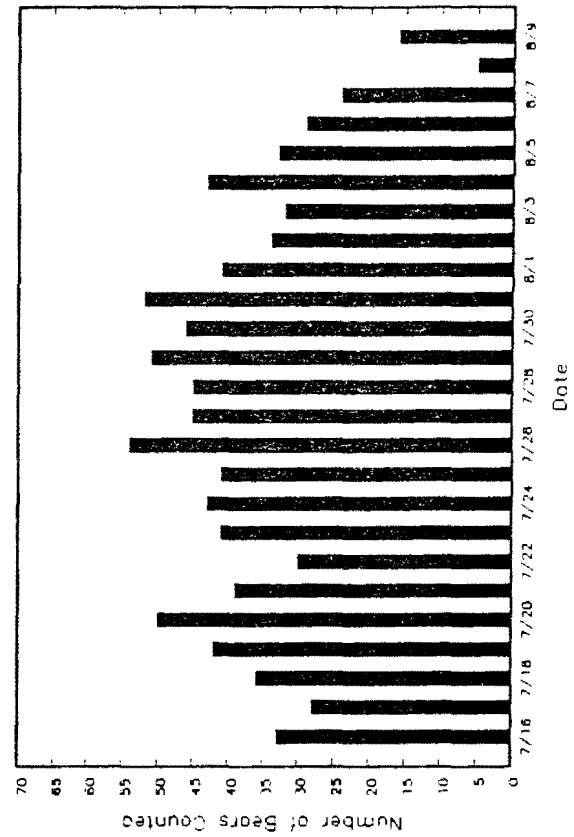
McNeil River Falls - 1984 Maximum Bear Counts



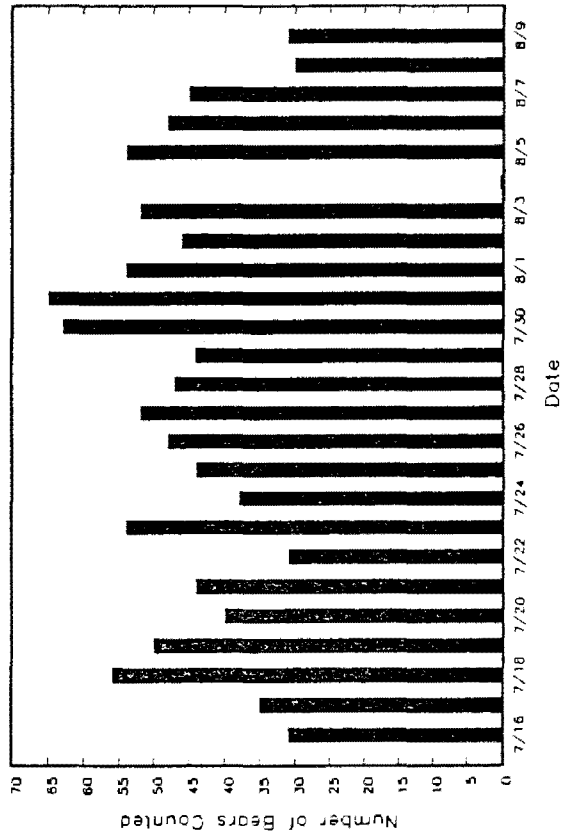
McNeil River Falls - 1985 Maximum Bear Counts



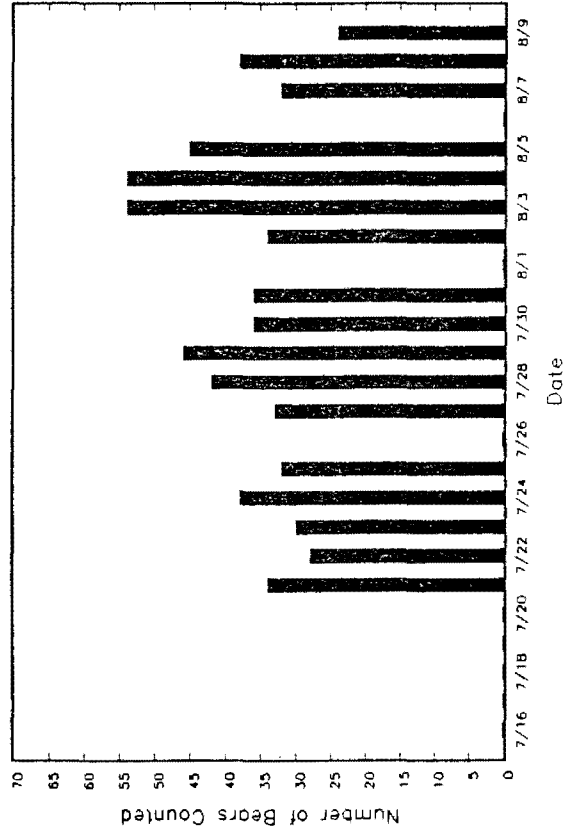
McNeil River Falls - 1986 Maximum Bear Counts



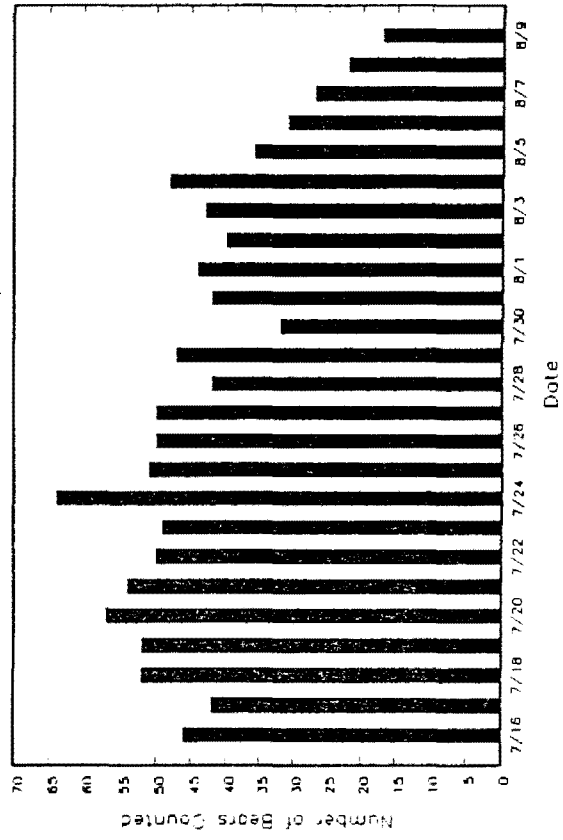
McNeil River Falls -- 1987 Maximum Bear Counts



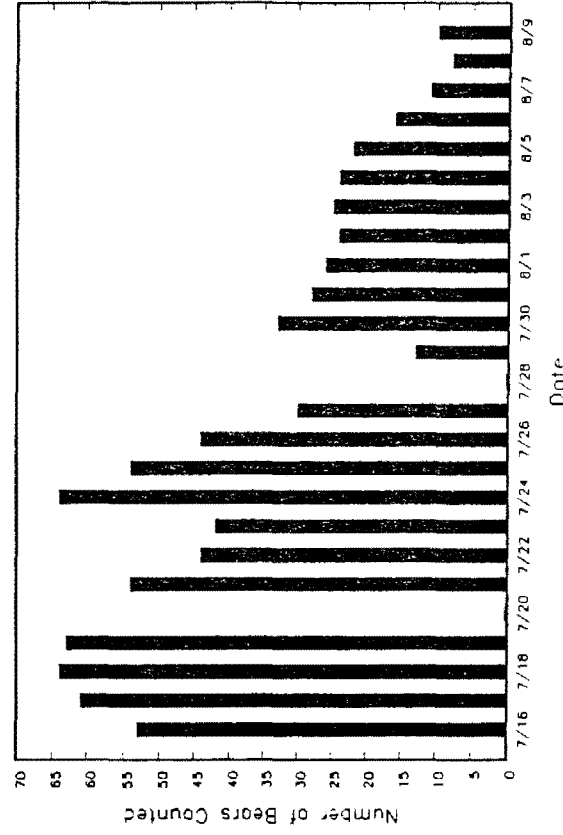
McNeil River Falls -- 1988 Maximum Bear Counts



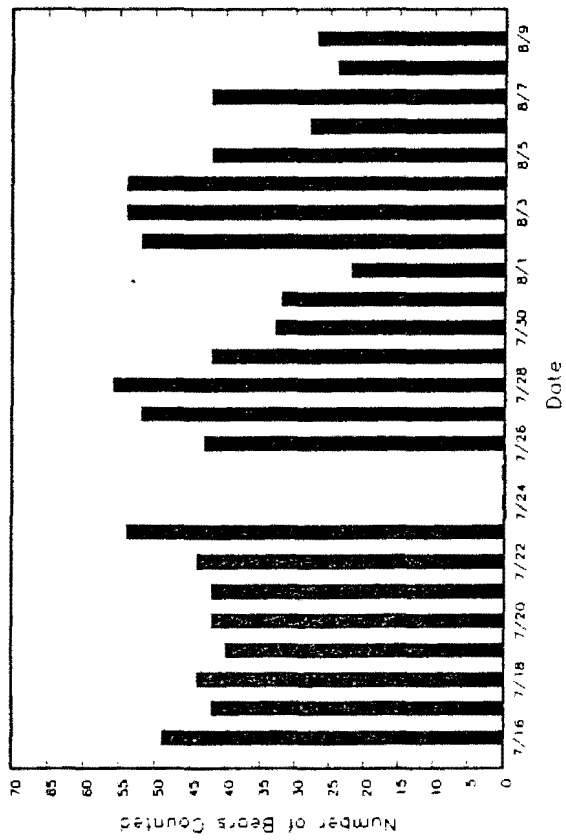
McNeil River Falls -- 1989 Maximum Bear Counts



McNeil River Falls -- 1990 Maximum Bear Counts



McNeil River Falls - 1991 Maximum Bear Counts



McNeil River Falls - 1992 Maximum Bear Counts

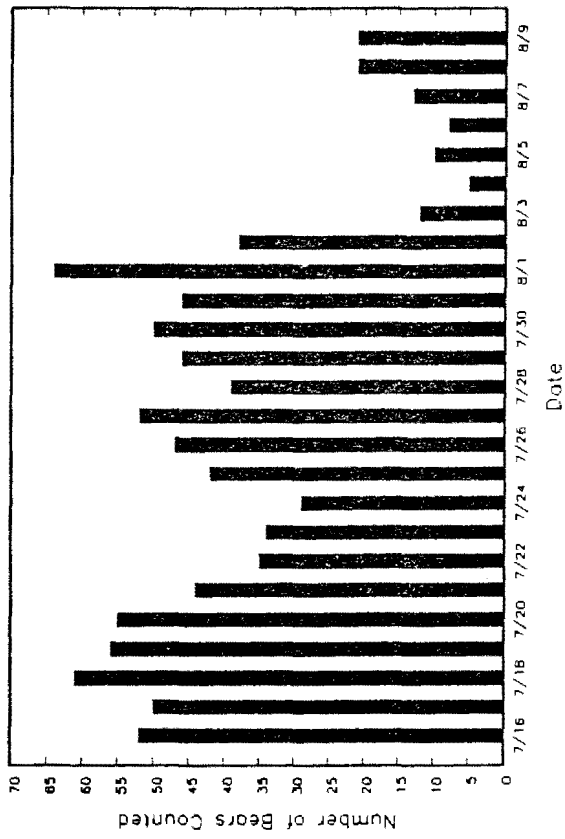




Figure 1. One-Sided Control Chart for Maximum Daily Bear Counts  
(24 July - 2 Aug.) at McNeil River Falls ( $\alpha = 0.01$ ).

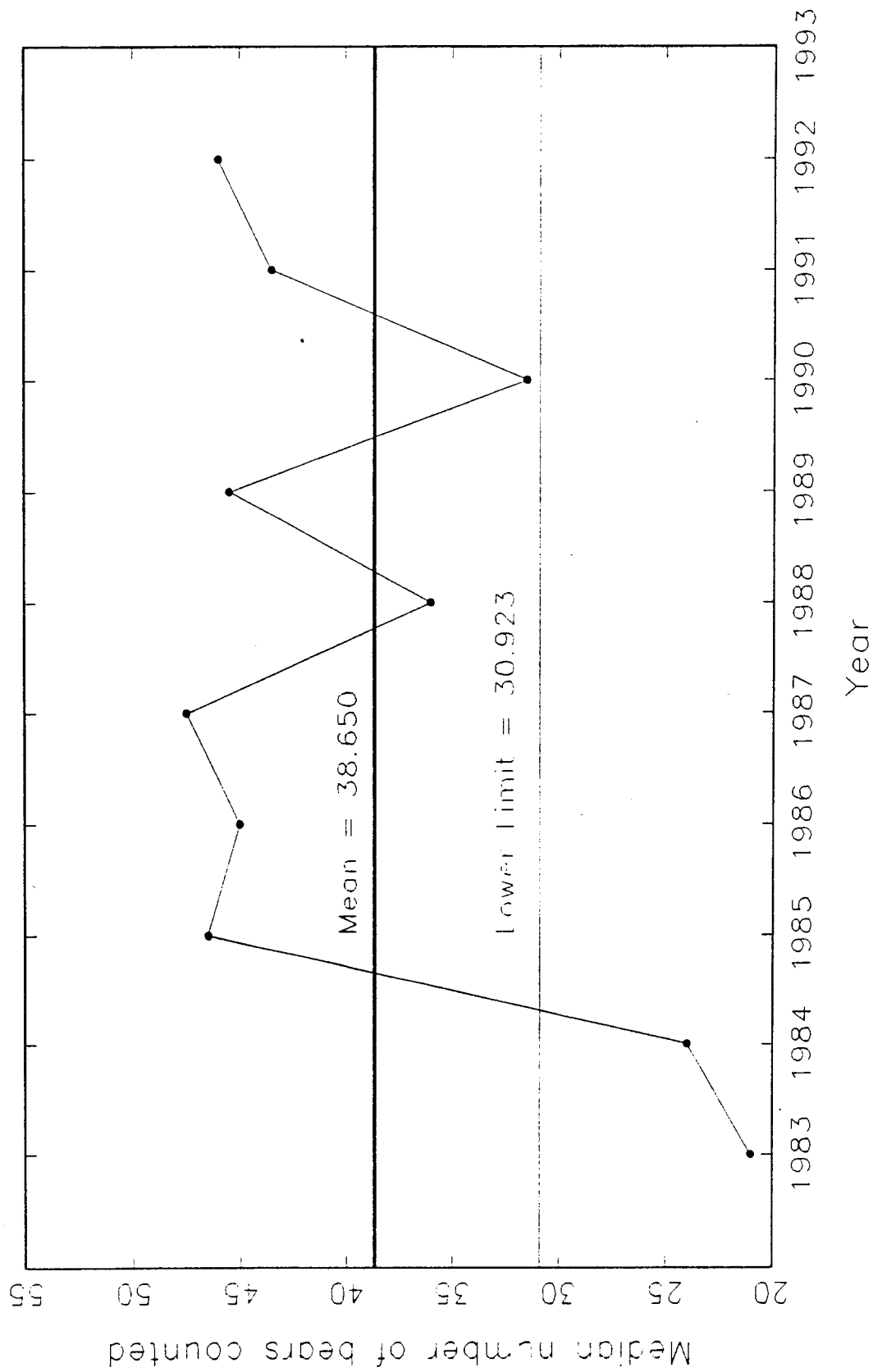


Figure 2. One-Sided Control Chart for Maximum Daily Bear Counts  
(w/in 4 days of peak) at McNeil River Falls ( $\alpha = 0.01$ ).

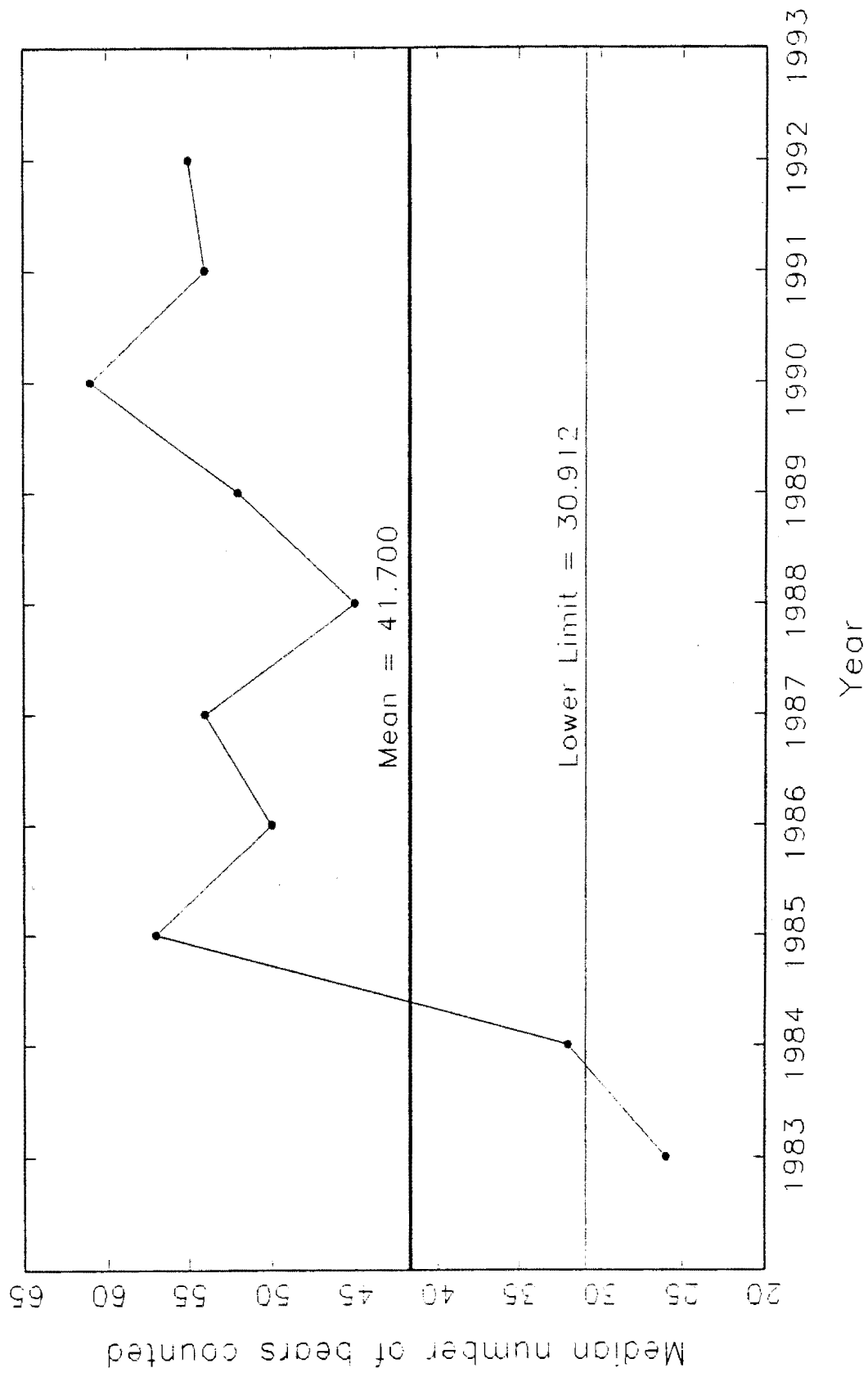


Figure 3. One-Sided Control Chart for Maximum Daily Bear Counts  
(7 highest counts) at McNeil River Falls ( $\alpha = 0.01$ ).

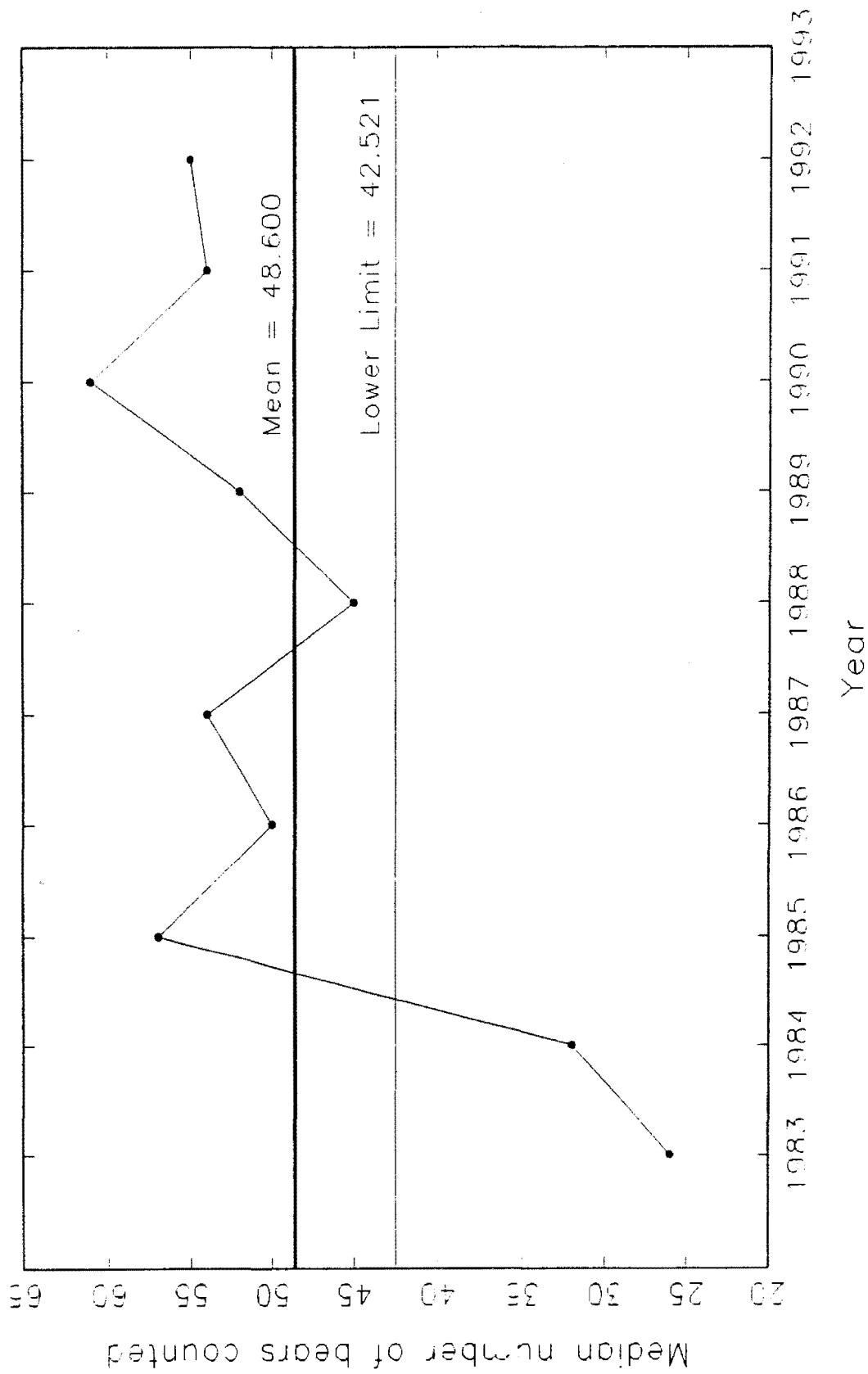


Figure 4. One-Sided Control Chart for Maximum Daily Bear Counts  
(7 highest counts) at McNeil River Falls ( $\alpha = 0.01$ ).

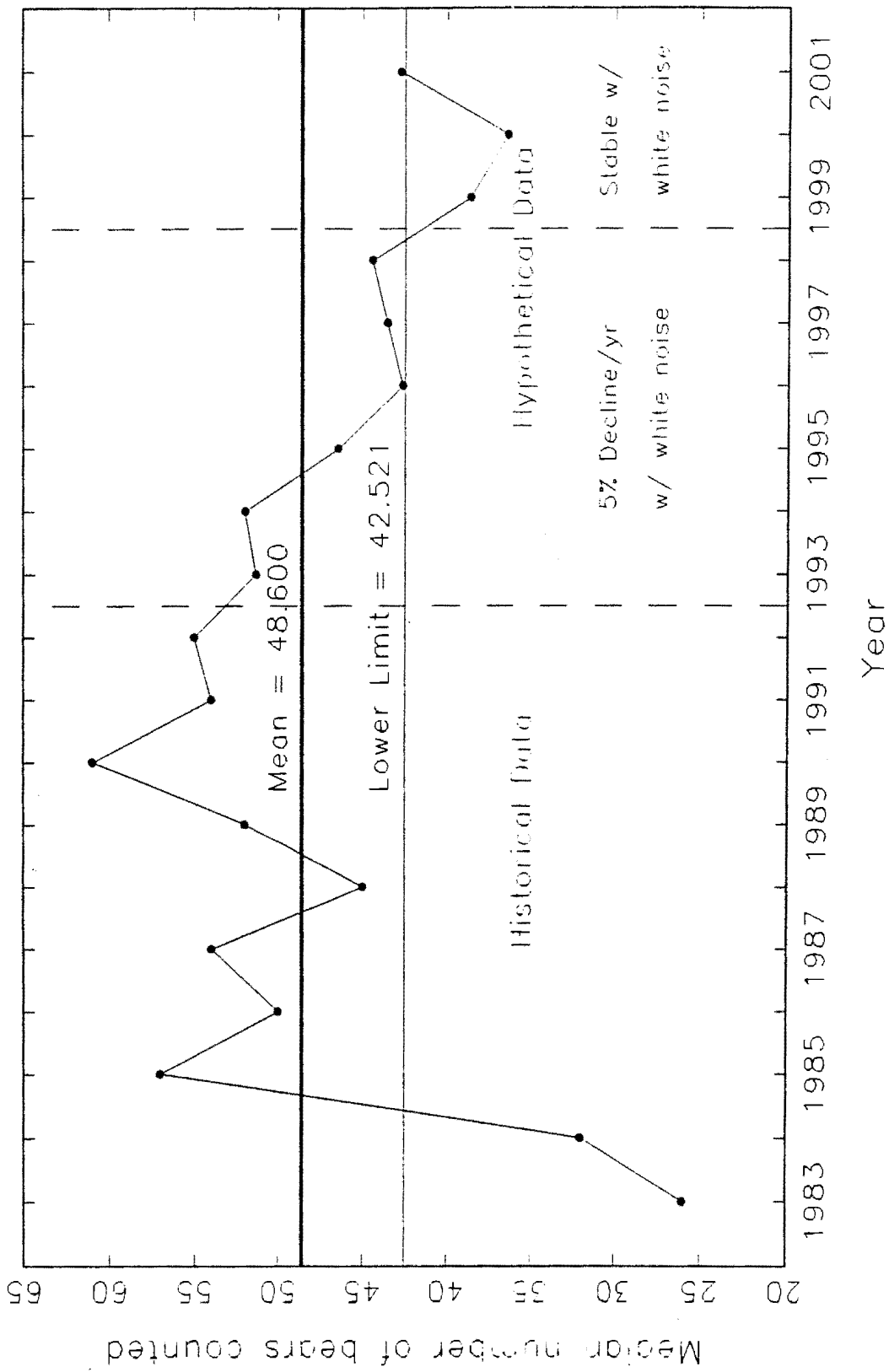
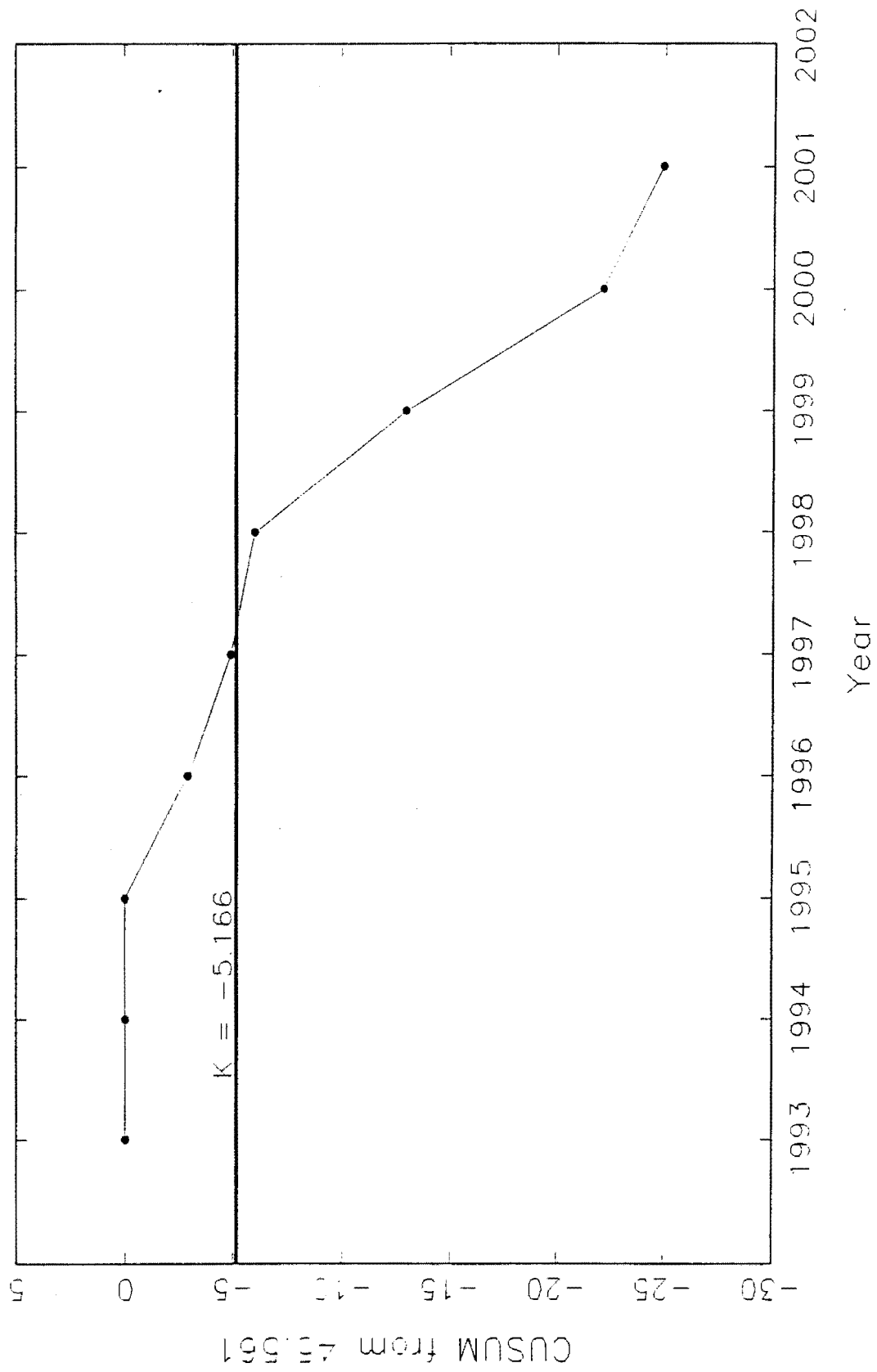


Figure 5. One-Sided CUSUM Chart for Maximum Daily Bear Counts  
(7 highest counts) at McNeil River Falls ( $\alpha = 0.01$ ).



# MEMORANDUM

## STATE OF ALASKA DEPARTMENT OF FISH AND GAME

TO: Rick Sinnott  
Wildlife Biologist II  
Wildlife Conservation  
Anchorage

THRU:

DATE: August 23, 1993

FILE NO.:

TELEPHONE: 267-2407

FROM: Earl Becker *EB*  
Biometrician II  
Wildlife Conservation  
Anchorage

SUBJECT: Addendum to  
Monitoring Bear  
Viewing at McNeil  
River Falls.

In my 29 July, 1993, memorandum, I proposed using both Shewhart and CUSUM quality control charts to monitor the quality of bear viewing at McNeil River Falls. In the process of setting up the monitoring protocol, I found references to papers on these techniques which might pertain to the monitoring program at the falls. The habitat librarian, Celia Rozen, was kind enough to obtain these papers for me. Based on this additional information, I propose we modify the lower limit on the Shewhart control chart, the limit (h) on the CUSUM chart, and K in the CUSUM statistic. The main advantage of these modifications is that we can set a type I error rate ( $\alpha$ ) for the combined Shewhart and CUSUM monitoring scheme and determine the ability of this scheme to detect given changes in bear viewing.

Lucas (1982) gives a detailed analysis of using combined Shewhart-CUSUM control charts to detect both large shifts and slow drifts in a process. Most importantly, he gives average run length (ARL) for various combinations of Shewhart limits, and CUSUM limits (h) and parameter K. Average run length pertains to the number of observations (years in our case) that it would take "on average" to obtain an out-of-control signal (significant Shewhart or CUSUM statistics). We would like large ARLs when the process is in control and short ARLs when the process is out-of-control. For the in-control situation, the probability of a type I error ( $\alpha$ ) is  $(1/ARL)$ . Assuming we desire an ARL of 3 or less when the process has shifted 2 SE (from 48.60 to 43.37 bears), and an  $\alpha$  of  $\approx 0.01$ , we would use table 2, part 3, in Lucas (1982) to obtain the parameter values for the Shewhart and CUSUM control charts. From this table we obtain a Shewhart lower limit of 40.761 bears ( $48.6 - 3 \times SE$ ), a CUSUM limit (h) of -7.839 ( $-3 \times SE$ ), and  $K=47.294$  ( $48.60 - 0.5 \times SE$ ).

ARL can be determined for different shifts in the process. The following table lists ARL for various shifts in bear viewing

given the above parameter values.

Reduction in Bear Viewing (SE)	Median # of Bears Observed	ARL
0.00	48.60	111.10
0.25	47.95	38.44
0.50	47.29	17.09
0.75	46.64	9.57
1.00	45.99	6.32
1.50	44.68	3.66
2.00	43.37	2.56
2.50	42.07	1.96
3.00	40.76	1.58
4.00	38.15	1.16
5.00	35.54	1.02

Extrapolating from the above table, we can determine ARL for any shift in bear viewing. Since we obtain yearly observations, ARL is the number of years, on average, it would take to detect a given shift.

To illustrate how this monitoring scheme would work, I will use the Shewhart-CUSUM monitoring system with the above parameter values on the hypothetical data set I created in my 29 July 1993 memorandum. Recall that we have a system with a mean of 48.60 bears ( $SE=2.163$ ), a new Shewhart limit of 40.761 bears, a new CUSUM limit ( $h$ ) of -7.839, and a new  $K=47.294$ . The hypothetical data and CUSUM statistic using these parameters are given in the attached figures (4&5) and are listed below.

Year	Observed Median	True Median	CUSUM
1993	51.327	52.250	0.000
1994	51.958	49.637	0.000
1995	46.463	47.156	-0.831
1996	42.652	44.798	-5.473
1997	43.561	42.558	-9.206
1998	44.434	40.430	-12.066
1999	38.619	40.430	-20.741
2000	36.375	40.430	-31.660
2001	42.785	40.430	-36.169

This monitoring system would detect a change 1 year earlier, in 1997 ( $CUSUM < h$ ), than the previous system. The Shewhart limit, 40.761, is lower in this system compared to 42.521 in the old system. However, the new values of  $h$  and  $K$  are more likely to detect shifts in the new system than the old values.

In conclusion, I urge the adoption of these new parameter values for our monitoring system because the type I error rate is known for the combined monitoring system and our ability to

detect shifts in the system can be determined from extrapolation on the above ARL table.

#### References

Lucas, J. M. 1982. Combined Shewhart-CUSUM quality control schemes. J. of Quality Technology 14(2):51-59.

CC: Ken Pitcher  
Larry Aumiller  
Colleen Matt  
Sterling Miller  
SuzAnne Miller  
Dave Anderson  
Karl Schneider  
John Westland



Figure 4. One-Sided Control Chart for Maximum Daily Bear Counts  
(7 highest counts) at McNeil River Falls ( $\alpha = 0.01$ ).

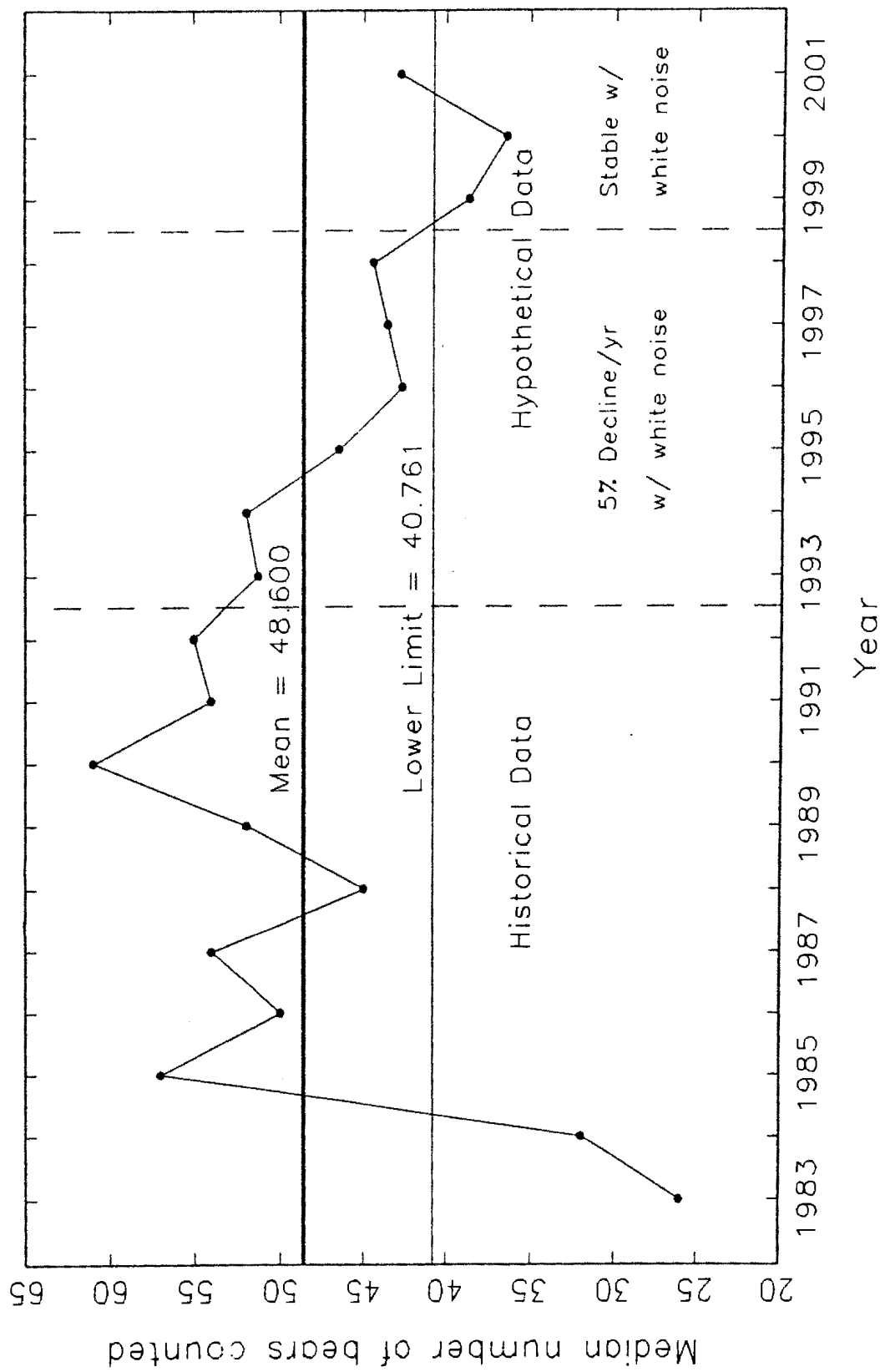
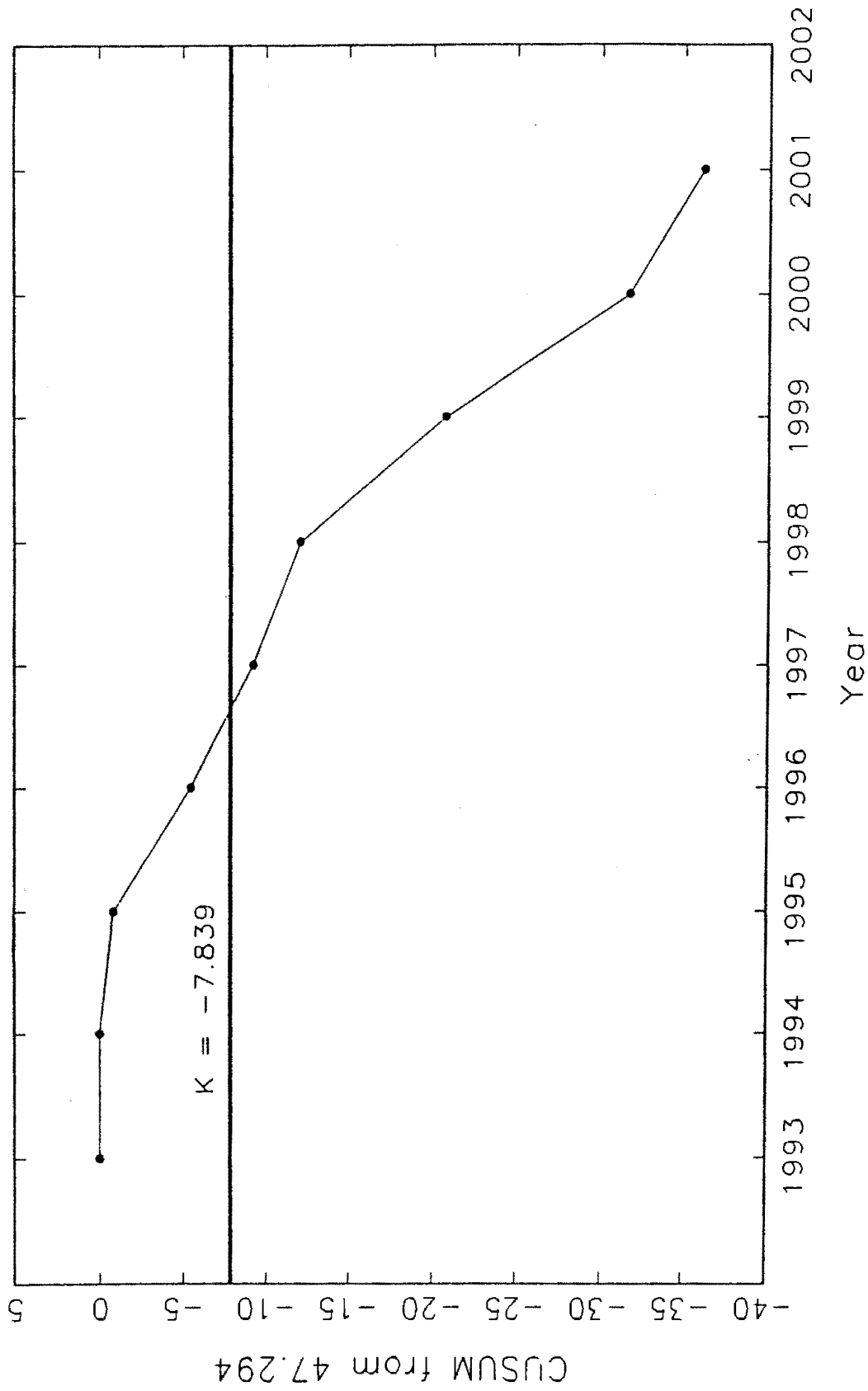


Figure 5. One-Sided CUSUM Chart for Maximum Daily Bear Counts  
(7 highest counts) at McNeil River Falls ( $\alpha = 0.01$ ).



**McNEIL RIVER STATE GAME SANCTUARY AND REFUGE**

Refuge  
Sanctuary

(Sanctuary and refuge include all adjacent tidelands.)

**Kamishak Bay**

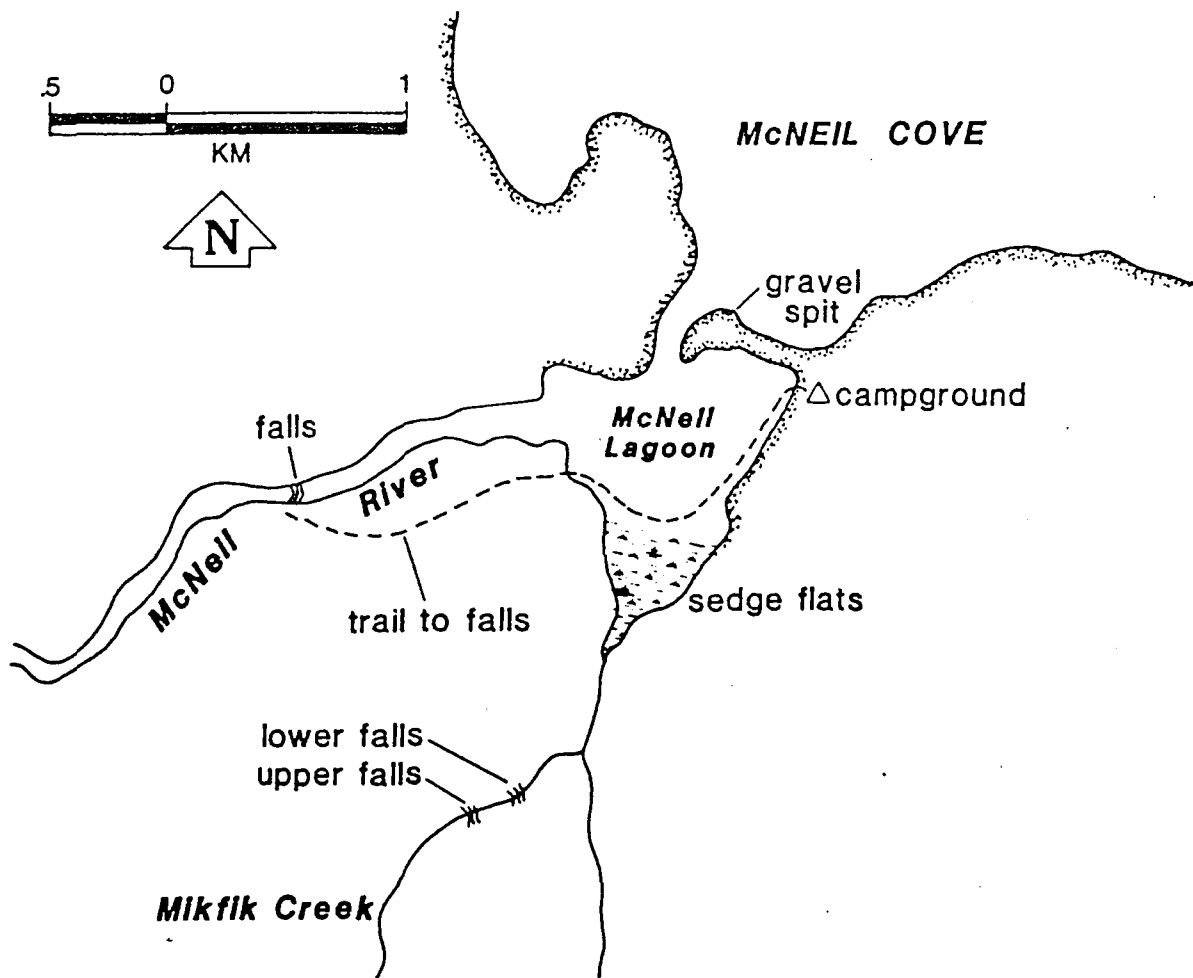
The map shows the McNeil River State Game Sanctuary and Refuge, which includes the McNeil River and its tributaries, the Kamishak River, and the McNeil River State Game Sanctuary. The sanctuary and refuge areas are shaded with diagonal lines. The boundary of the McNeil River State Game Sanctuary and Refuge is shown with a dashed line. The map also shows the McNeil River State Game Sanctuary and Refuge, which includes the McNeil River and its tributaries, the Kamishak River, and the McNeil River State Game Sanctuary. The sanctuary and refuge areas are shaded with diagonal lines. The boundary of the McNeil River State Game Sanctuary and Refuge is shown with a dashed line.

Sanctuary

(Sanctuary and refuge include all adjacent tidelands.)

## Kamishak Bay

## Appendix D: Map of the McNeil River State Game Sanctuary, McNeil River State Game Refuge, and Surrounding Areas



Appendix E: Map of McNeil Lagoon Area