

# Northwest Weather and Avalanche Center



## 2005-2006 Annual Report

*Report prepared by Mark Moore, Kenny Kramer and Garth Ferber*

A partnership between the USDA Forest Service, Washington State Parks and Recreation Commission, Washington State Snowpark and Snowmobile Programs, Washington State Department of Transportation, National Weather Service, National Park Service, Pacific Northwest Ski Area Association, USDA-FS Fee-demo Program, County Title II RAC Program, Friends of the Avalanche Center and others.



United States  
Department of  
Agriculture



Forest Service  
Pacific  
Northwest  
Region

**Cover Photo credits:**

This photo, taken on April 21, 2006, shows one of the large slab avalanche releases that occurred along Shuksan Arm near Mt Shuksan following the 40-50 inches of snowfall that arrived during the series of strong spring storms which moved over the region from the 13<sup>th</sup>-16<sup>th</sup> of April. Slab avalanches such as this involved all of the new snow from the recent storm, releasing on the ice crust that had formed during a period of higher freezing levels and sunny days earlier in the month. This snowfall also resulted in the avalanche fatality that occurred on nearby Mt Hermann (Stoneman chute), just west of Mt Baker ski area on April 18<sup>th</sup>. Photo courtesy Lief Hazelet.

Northwest Weather and Avalanche Center  
2005-06 Annual Report

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# NORTHWEST WEATHER AND AVALANCHE CENTER



A partnership between the USDA Forest Service, Washington State Parks and Recreation Commission, National Park Service, National Weather Service, Pacific Northwest Ski Area Association, Washington State Department of Transportation, Washington State Snowpark and Snowmobile Programs, USDA Forest Service Fee Demo programs, Title II RAC programs, Ski Schools, Friends of the Avalanche Center and others.

## ANNUAL REPORT—2005-2006 SEASON

Report prepared by Mark Moore, Kenny Kramer and Garth Ferber in May 2006.

***A Message From the Director***— Another winter is now fading into spring melt, but what a difference a year makes! The transition from record setting low snowfall and bleak images of dirt, rocks and mud covering much cherished Cascade terrain during the 2004/05 non-winter to above average powder days in 2005/06 where abundant snowfall covered most rocks and many trees was for the most part a wondrous progression. Unfortunately, two avalanche fatalities produced a downside to the winter's above normal snow depths. The intermittently heavy amounts of unconsolidated snowfall also resulted in three tree well fatalities in the early part of the season and a significant increase in overall avalanche incidents (many lucky travelers). But in general, this snowpack difference from the previous year represented a very positive step for most folks who use, work or recreate in the mountains.

The past season welcomed a new forecaster to the NWAC staff—namely Knox Williams, previously director of the Colorado Avalanche Information Center. Knox brought intensity, dedication and great knowledge, contributed much to our operation, made a great transition from continental to maritime snowpacks, and helped make forecasting enjoyable. In short, he was a true pleasure to work with, and he even learned to use the heretofore seldom mentioned (for him) R word (rain). We valued his presence on the staff and are sorry that his stay appears to be only a short one (Knox is retiring from all forecasting after an impressive career of accomplishment spanning the past 30+ years).

The season also brought significant enhancements and additions to the NWAC data network along with some challenges and frustrations. At Sunrise near Mt Rainier and Washington Pass, forecast staff collaborated with National Park Service and Washington State Department of Transportation cooperators to complete installation of new and more representative data sites along with more reliable communication links. This work allowed for more consistent access of Chinook Pass and Sunrise Knob data. Unfortunately, despite

significant effort to troubleshoot developing problems, harsh winter conditions resulted in unreliable radio links and a lack of weather data for both the new Washington Pass site and the older previously reliable sites at Mission Ridge ski area. Planned changes of both sites during the summer and fall of 2006 should hopefully make their information more dependable next winter. A planned new weather station installation at Lake Wenatchee this summer should add to the body of information available for the east slopes of the Cascades and aid both weather and avalanche forecasting efforts for nearby locations.

Record setting usage of all NWAC products and services on our web site ([www.nwac.us](http://www.nwac.us)) during this past winter (see below) attests to the value of the program and importance of our mission. Reception of over 4.1 million hits on data and forecast products represents a significant usage increase from any previous year. It is hard to believe that we received 20-30,000 hits/month on forecasts during this past winter season (and almost 1 million hits for the year) when only 10 years ago total access of forecast products averaged only 15-25,000 for the whole year. Along with continued strong educational efforts, this overall program success reflects well on our dedicated staff of professional weather and avalanche forecasters and on the cooperators whose past support has helped make this avalanche safety program what it is today. Unfortunately, in addition to the normal efforts to promote public safety through the daily forecasting and data network operations, an increasing amount of work continues to be dedicated toward maintaining program funding. Recent past funding efforts have been rewarded by expanded support from Washington State, the PNSAA, County Title II RAC and USFS Fee Demo programs, and such increases have helped to plug holes and minimize program cutbacks. However, current and projected reductions and/or flat support levels from several federal and state agencies continue to challenge the program and add to the gap resulting from federally mandate salary increases and flat or declining income levels. Such funding deficiencies may limit NWAC operations in the immediate future unless stable, long term funding solutions can be found.—*Mark Moore*, NWAC Director

## **NWAC MISSION STATEMENT**

Throughout its history, whether the winter is abundant or meager, early or late in arriving, NWAC staff and the NWAC program as a whole remain committed to a single mission: To reduce the impacts of adverse mountain weather and avalanches on recreation, industry and transportation in Washington and northern Oregon through data collection, forecasting and education. As in the past, this promotion of public safety been and is accomplished by providing cooperating agencies and the public with:

- \* Mountain Weather Data
- \* Mountain Weather Forecasts
- \* Avalanche Forecasts
- \* Education
- \* Applied Research and Technology

***How to get NWAC mountain weather and avalanche forecast information:***  
<http://www.nwac.us>

206-526-6677 (Seattle Hotline)  
503-808-2400 (Portland Hotline)

***How to reach us for other information:***

Northwest Weather and Avalanche Center  
7600 Sandpoint Way NE  
Seattle, WA 98115  
206-526-6164 (office); 206-526-4666 (messages)  
[nwac.sew@noaa.gov](mailto:nwac.sew@noaa.gov)

Note that a more complete version of this [mission statement](#) is available on our web site.

## **OPERATIONS SUMMARY**

Forecast staff at the NWAC are employed by the USDA-Forest Service from mid September through mid-June. The following is a summary of the main NWAC tasks during the 3 distinct parts of our season:

### **Pre-Season** (mid September to mid November):

- \* Attend and provide input and instruction at the International Snow Science Workshop (ISSW) or National Avalanche School (NAS). This next fall's pre-season commitment is [ISSW06](#) scheduled for Telluride, Colorado in early October, 2006.
- \* Finalize and initiate annual operating plan.
- \* Office preparation especially of forecasting and weather station computers.
- \* Weather data network installation, upgrades and repairs.
- \* Preliminary mountain weather forecasting for ski areas, WSDOT.

### **Winter Season** (mid November to mid April):

- \* Provide daily mountain weather and avalanche consultations to ski areas, WSDOT crews and other cooperating agencies, starting at 3:30 am, 7 days a week.
- \* Prepare and disseminate twice daily public mountain weather forecasts (7 am) and daily avalanche forecasts (9 am) 7 days a week; provide updates and special statements as necessary.
- \* NWAC weather station repairs; ensure reliable and highest quality data on the web site.
- \* Gather first hand snow pack information and snow pack information from others; integrate into avalanche forecasts.
- \* Provide avalanche awareness presentations as requested.
- \* Prepare and update web site pages with accident reports & statistics, climatological snowdepth and other educational information.

### **Post Season** (mid April to mid June):

- \* Continue to provide mountain weather and avalanche consultations as funding allows to cooperating agencies, such as WSDOT crews at Washington and Chinook passes.
- \* Issue special avalanche statements when necessary.

- \* NWAC weather station upgrades or repairs; continue to provide hourly weather data via web site.
- \* Prepare for annual meeting and issue annual report.
- \* Plan operations for next season.

## **INFORMATION EXCHANGE**

### **INCOMING INFORMATION:**

Through the winter NWAC forecasters rely on incoming information and data to make accurate assessments of current mountain weather and avalanche observations. This information comes from the following sources:

- \* **Observer Network:** The forecaster at the NWAC receives daily weather and avalanche observations via telephone from most ski areas, WSDOT crews at Stevens and Snoqualmie, and observers at Hurricane Ridge and Paradise on Mt Rainier.
- \* **Backcountry Observations:** The NWAC makes as much use as possible of available back country snow and avalanche observations via phone calls and e-mail messages, the new [FOAC Snowpack Information Exchange](#), and sources on the Internet such as the [Turns-All-Year.com](#) or the [Teton Gravity Research Forum](#) page.
- \* **NWAC Weather Stations:** The NWAC currently maintains or helps maintain 42 weather stations located at NPS, WSDOT and ski area sites at Hurricane Ridge in the Olympics and in many locations throughout the Cascade Mountains. These stations provide temperature, relative humidity, wind, precipitation and snowfall information automatically via phone and radio connections.
- \* **National Weather Service:** NWAC staff has access to all products and expertise of the Seattle WFO (Weather Forecast Office of the National Weather Service).

### **OUTGOING INFORMATION:**

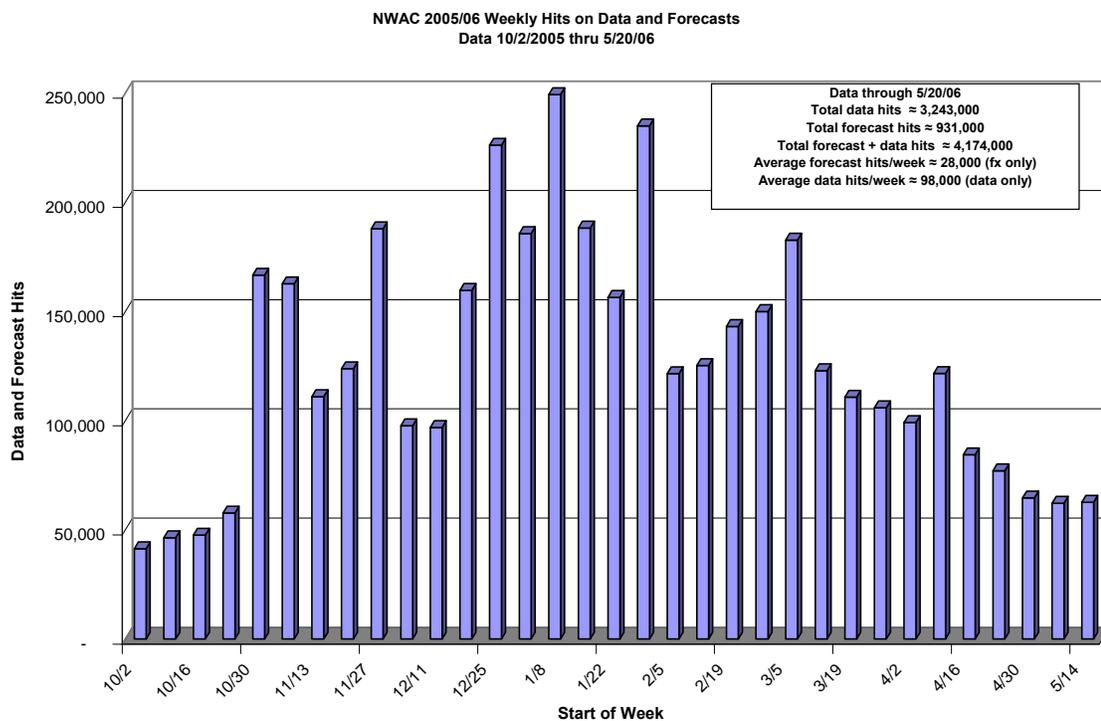
The NWAC distributes mountain weather and avalanche information via the following means:

- \* **Phone Consultations:** daily with most ski areas, DOT crews at Stevens and Snoqualmie Passes, and observers at Paradise.
- \* **Public Hotline Recordings:** in Seattle and Portland ~8050 calls this season (see chart below). While hotline accesses rebounded slightly from last years minimum during the bleakest of winters in some time, overall this number has gradually decreased as the Internet accesses increase. Also note that the mountain weather forecast recording—whose usage had decreased to less than 100 for the season—was discontinued last year after being in existence for over 20 years.
- \* **Internet:** This past season we had over 650,000 hits on the Mountain Weather Forecasts, 280,000 hits on the Avalanche Forecasts, 3,242,000 on the weather station data, with another 11+ million files served on the NWAC web site. As shown in Figure 1, weekly product access ranged up to 150,000-200,000 hits per week and peaked at around 250,000 (solely on data and forecast products). When viewing Figure 2 below, keep in mind that the NWAC web site became operational in 1996 for forecast access

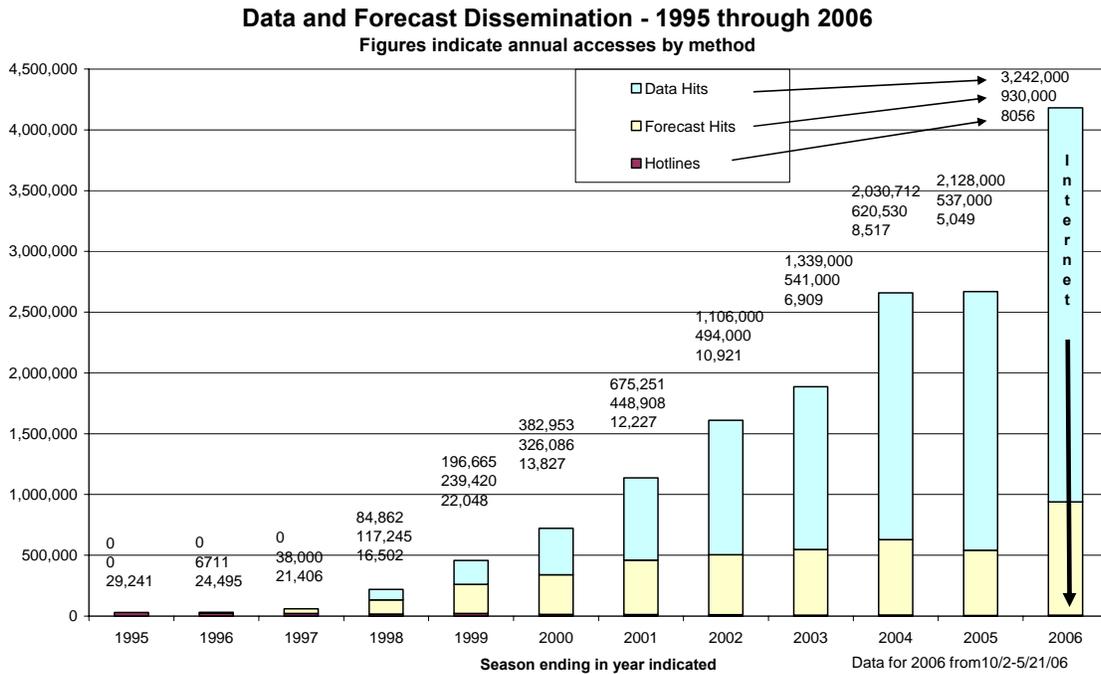
alone. Availability of and access to hourly weather data were added in 1998. Also note that the NWAC web site is only one method that can be used to access NWAC forecasts and data. Several other web portals download data and forecasts and make them locally available on other servers.

- \* **NOAA Seattle Weatherwire:** A total of twenty-three (23) Avalanche Warnings and/or Special Statements were sent to the media via the Weatherwire this season, right on the average of around 23/year.
- \* **Search and Rescue Assistance:** The NWAC provides weather and avalanche forecast assistance to County Search and Rescue teams every season.
- \* 17 years of **archived NWAC mountain weather station data** are available upon request from the Avalanche Center, and may be automatically available from the [Western Region Climate Center](#) at some point in the future. The NWS is also planning to automatically reformat much of the NWAC hourly data network data into SHEF code for more widespread display and access via an extensive variety of data services. Historical data from selected NWAC data sites is also available from both the University of Washington and the [Mesowest Data Network](#) operated by the University of Utah.

**Figure 1. Weekly forecast and data access on NWAC web site.**



**Figure 2. NWAC data and forecast dissemination over the past 11 years.**



### **30TH ANNIVERSARY OF NWAC FORECASTING**

Early this past season marked the 30<sup>th</sup> anniversary of forecasting by the Northwest Weather and Avalanche Center, which issued its first forecast on December 6, 1975. The center continues to be directed by one of the original forecasters—Mark Moore, who helped develop the NWAC along with Rich Marriott (now a well-known KING TV weather forecaster), Bud Reanier (a retired NWS lead forecaster), Dr. Ed LaChapelle (UW professor who was instrumental in guiding the research project from which the Center evolved), and Roland Emetaz (Forest Service Forester and Educator who spearheaded the participation of the USDA-Forest Service as the lead and administering agency). For complete details see the press release issued by the Mt Baker Snoqualmie National Forest at:

<http://www.fs.fed.us/r6/mbs/news/2005/nr-nwac-anniversary-120205.shtml>

### **2005-2006 Climate Prediction**

The long range 2005/06 winter forecast available at the [Climate Prediction Center](#) in later fall of 2005 indicated that the winter ahead would be much more normal than the bleak and dry winter experienced in the Northwest in 2004/05 (see [last year's annual report](#) for a more complete description). This prediction suggested that the past winter would range most probably from a neutral year to one influenced by a weak La Niña. Fortunately for the NW ski industry and those who use and recreate in the Olympics and Cascades, this overall forecast seemed to be borne out by a rather active snow season—much more typical of normal NW winters.

## **2005-2006 WINTER WEATHER AND AVALANCHE SUMMARY**

A very early start to the winter was seen this season and the NWAC one of its earliest starts to forecasting ever. We issued special statements on November 3-5<sup>th</sup> and began full forecasting services on 7 November.

The first storm cycle occurred during about the first 2 weeks on November. A storm cycle during that time caused about 4-8 feet of snowfall at sites near and west of the Cascade crest. Paradise reported 22 inches of new snow on 4 November. Mt Baker Ski Area had 18 inches on 6 and on 12 November. A couple of very close calls were seen near the Mt Baker ski area during this storm cycle. On 5 November an avalanche victim was recovered alive by beacon search after being buried about 3-5 feet for about 10 minutes. Another snow boarder was recovered alive by beacon search after being buried about 8 feet and found after about 10 minutes of searching and another 15 minutes of digging. The second victim claimed that when an avalanche probe hit him in the teeth, it was “the happiest moment of his life”.

For full reports on these 2 accidents visit the NWAC web site at [www.nwac.us](http://www.nwac.us).

Mother Nature then did an about face and provided a fair weather period with very warm temperatures in mid November. This caused a lot of snowpack consolidation and stabilizing, and allowed a widespread crust to form on the surface on the snowpack.

The second storm cycle occurred during about the last week of November and the first week of December. This storm cycle caused about 3.5-6.5 feet of snowfall at sites near and west of the crest, with the most at Mt Hood. Mt Hood Meadows and Timberline had about 3.5 feet of snow in 3 days from 2-4 December. Many avalanches were reported during this time. Up to 4-6 foot deep natural and explosively triggered slab avalanches were reported from Stevens and Mt Hood Meadows with a few crown heights reported up to 10 ft. These deep avalanches were sliding on some faceted and weak layers above the crust from mid November.

A nearly 2 week dry spell was seen in mid December. This was followed by several days of local freezing rain leading up to Christmas. This was less than ideal for the ski areas...

But then Mother Nature turned on the snow making machine with strong storm cycles from about Christmas to early February. The late December to early February period was the heart of the winter. There were 10 days with avalanche warnings between Christmas and early February. Here is a tally of snowfall for the period:

### **THE HEART OF THE WINTER**

25 December 2005 to 5 February 2006

**Table 1. Cumulative Snowfall from selected NW observation stations, late December 2005 to early February 2006.**

Location	Snowfall(inches)
Mt Baker	368
Stevens	241
Snoqualmie	215
Crystal	191

Paradise	339
White Pass	175
Mt Hood Meadows	258

The main storm cycles were late December to early January, mid January, and late January to early February. Many sites averaged near or over a foot of snow a day for several days in each of these cycles.

Multiple avalanche cycles and many avalanches (some very large) occurred during this period but remarkably and fortunately few avalanche accidents.

Two skiers in the Crystal Mountain ski area north back country on December 30<sup>th</sup> triggered a 1 foot slab avalanche and were carried through trees. This was on a northeast facing slope at about 6600 feet. One skier sustained face injuries and the other a broken lower leg.

A skier on Shuksan Arm in the Mt Baker back country was shallowly buried by an avalanche on January 11<sup>th</sup> with no details available. This was likely on a generally north facing slope at roughly 5000 feet.

Two skiers without transceivers were partly buried but rescued by other members of their party near Bennett Pass at Mt Hood on January 15<sup>th</sup>. This was on a 40-45 degree north facing slope at about 5000 feet.

A series of tree well accidents occurred in mid January. There were 2 fatalities at Mt Baker and 1 fatality at Stevens Pass. In each of these accidents a skier or snow boarder was either separated from their partners or by themselves and fell into air spaces near the bases of trees created by the heavy snowfall and tree boughs above. These accidents are a serious reminder to keep track of your partners at all times! In another close call a ski patroller at Crystal Mountain barely found his wife in time to rescue her from the same situation.

An upper ridge pattern set up over the Northwest February 6<sup>th</sup> to about the 20<sup>th</sup>. A lot of surface hoar frost and surface faceted snow developed during that time. A transition to some strong east winds created some local surface wind slab layers on February 16<sup>th</sup> and 17<sup>th</sup>. On February 18<sup>th</sup> some of these were triggered by back country skiers on west aspects near Paradise with one person caught but no injuries. See the photo below provided by back country skier Jerry White.



**Figure 3. Small slab avalanche near Paradise on Mt Rainier on February 18, 2006--fracture in Edith Basin just below Golden Gate. Photo courtesy Jerry White.**

The next significant storm came on February 23<sup>rd</sup> and 24<sup>th</sup> with 1 to 3 feet of new snow near and west of crest which was heaviest in the north Cascades. This caused an avalanche cycle and an avalanche warning issued by the NWAC. Many of the avalanches were running slightly above the crust in weak snow crystals from the previous cold fair weather. Natural avalanches hit the highways at both Stevens and Snoqualmie Pass late on February 23<sup>rd</sup>. On February 24<sup>th</sup> a ski patroller at Alpentel was caught but apparently uninjured in a self triggered 2 foot slab avalanche. Another patroller at Alpentel narrowly escaped a deeper 24-30 inch self triggered slab avalanche on February 25<sup>th</sup>.

A cut off upper low pressure pattern over the Northwest coastal waters from about February 25<sup>th</sup> to March 7<sup>th</sup> resulted in light amounts of snowfall.

The next major storm cycle and avalanche warning was seen during a 3 day period from about March 8<sup>th</sup> to 10<sup>th</sup>. Many sites picked up about 3 to 5 feet of snow during this storm.

Another cut off low pressure pattern set up over the Northwest coastal waters the rest of March and the first half of April. This caused heaviest precipitation to head primarily south of the region with periodic light or moderate amounts of snow and low snow levels in most Northwest areas. An exception was 40 inches of snowfall in 4 days at Hurricane Ridge March 22<sup>nd</sup> to 25<sup>th</sup>.

The NWAC received some photos of a slab avalanche triggered by skier on March 26<sup>th</sup> at Hurricane Ridge. This slide was on a NNW facing slope at about 5000 feet.



**Figure 4. Slab avalanche near Hurricane Ridge in the Olympics, March 26, 2006. The skier caught in the slab was fortunately stopped by a small tree near the center of the photo while the main slide debris continued down below out of the picture to the lower left. Photo courtesy Jason McGrath.**

A snowmobiler was killed on March 19<sup>th</sup> on Tiffany Mountain near Conconully, Washington. A climax 2-5 foot avalanche was triggered by a person riding on the upper part of the slope which caught 2 other riders below. See <http://www.nwac.us/accidents.htm> for complete details as well as photos of the incident.

The next of the few and far between storms came in mid-April. Mt Baker had 47 inches in 4 days with other sites further south in the Cascades receiving about 15 inches in 2 days. This resulted in an avalanche warning for the north Cascades and a significant increased danger further south. There were a apparently 3 separate close calls with some injuries on April 14<sup>th</sup> to 16<sup>th</sup> in or near the boundaries of the Mt Baker ski area (see [http://www.turns-all-year.com/skiing\\_snowboarding/trip\\_reports/index.php?topic=4535.0](http://www.turns-all-year.com/skiing_snowboarding/trip_reports/index.php?topic=4535.0))

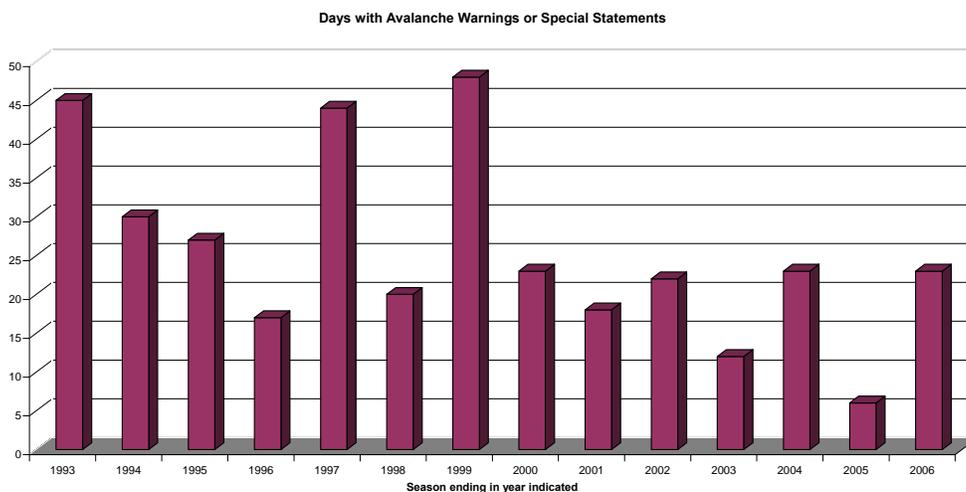
NWAC staff responded to the mid-late April storm episode with several avalanche warnings and appeals for recreationists to continue assessing snowpack stability and the potential for avalanching. Forecasters also arrived on site to personally sample the evolving late season snow structure—here is Garth in a snow pit near the Mt Baker ski area on 17 April.



**Figure 5. Forecaster Garth Ferber performs stability analysis on a north slope near Table Mtn adjacent to the Mt Baker Ski Area, 4-17-2006. Photo courtesy Joe Catellani.**

On April 18<sup>th</sup>, the day after the photo above was taken, a skier was killed in a self triggered 3.5 foot slab avalanche on an east-northeast facing slopes at about 5200 feet on Mt Herman near the Mt Baker ski area. For details visit <http://www.nwac.us/accidents.htm>.

NWAC regular forecasting ended for the season on April 24<sup>th</sup>, and the following graph shows how this season's forecasting related to other recent winters in terms of avalanche warnings issued.



**Figure 6. Annual days with Avalanche Warnings or Special Statements, 1993-2006.**

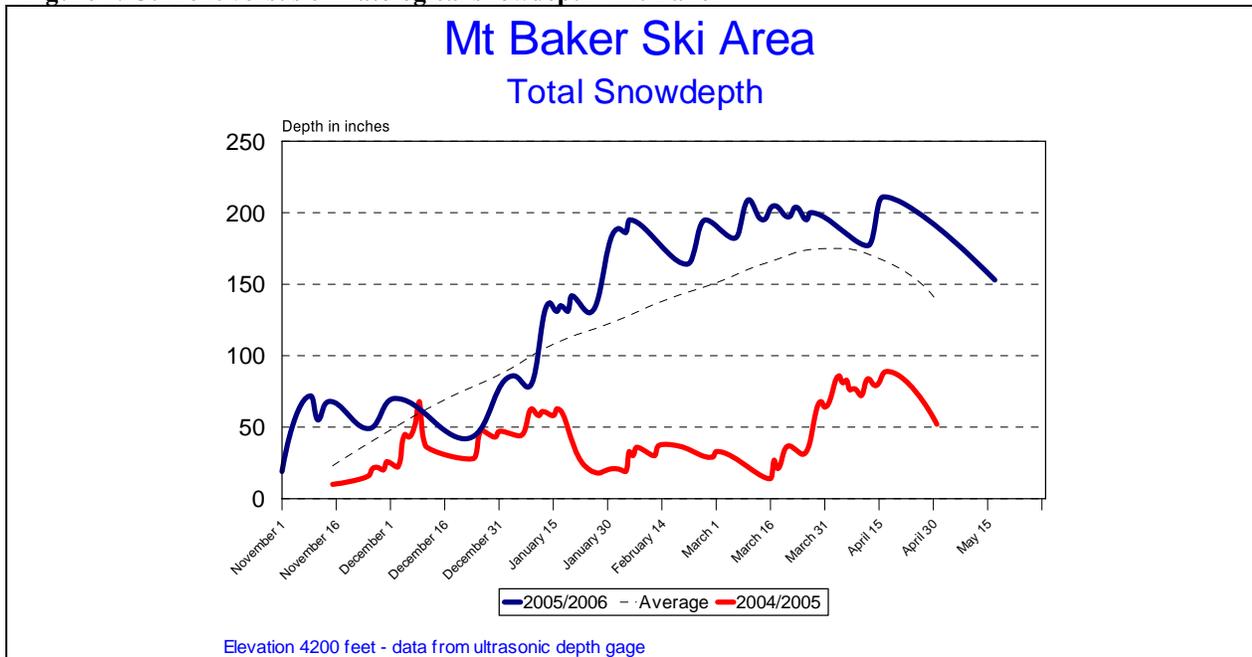
## 2005-2006 SNOW PACK

What a difference a year makes! The 2005-2006 season generally had snowfall well above normal and was a complete change from the terrible winter of 2004-2005.

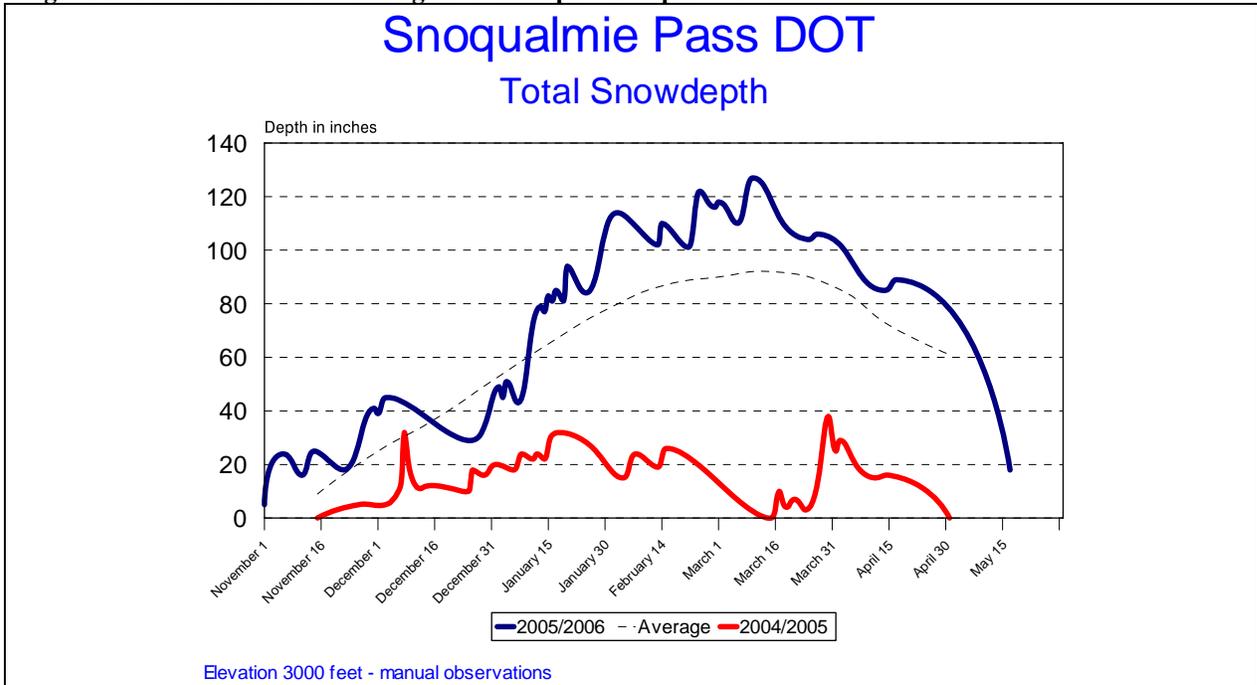
The main trends of the winter can be seen in each of the following charts. This includes:

- heavy snowfall in early November and the end of November
- mid December dry spell
- major storms of early, mid and late January (the Heart O The Winter)
- early to late February dry spell
- more intermittent but significant storms of late February to late March
- early April dry spell
- mid April storm especially at Mt Baker

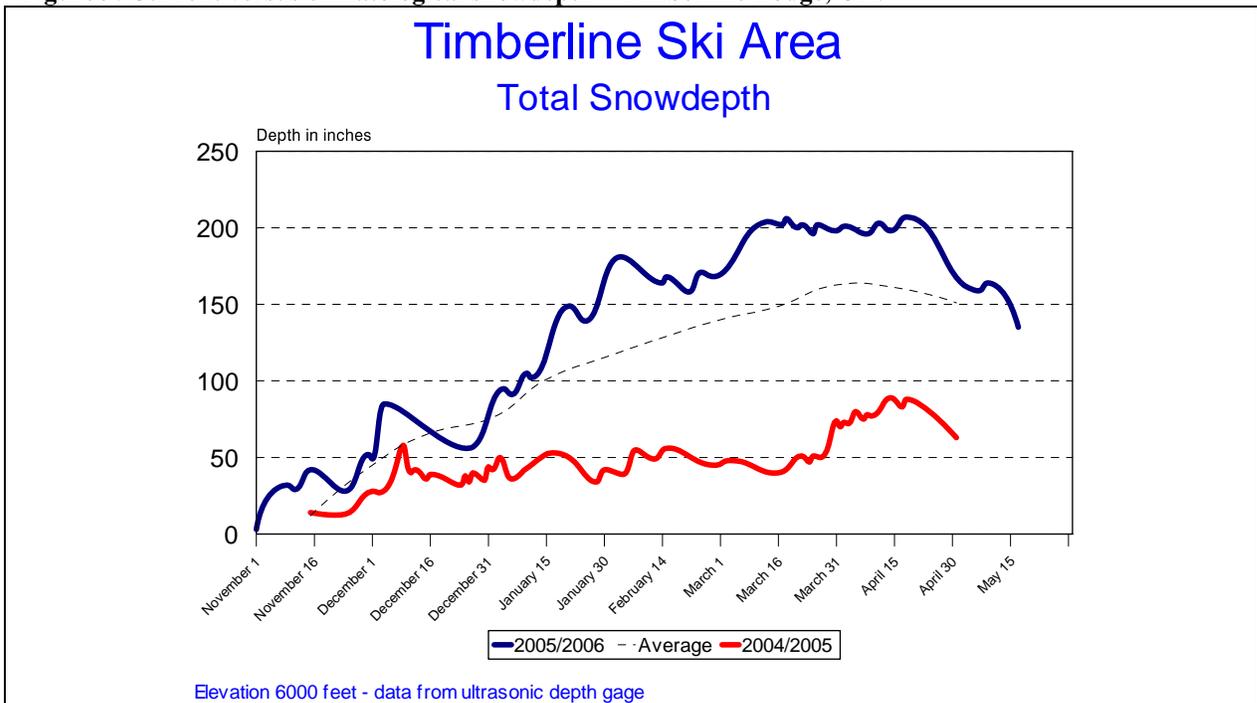
**Figure 7. Current versus climatological snowdepth--Mt Baker**



**Figure 8. Current versus climatological snowdepth--Snoqualmie Pass**



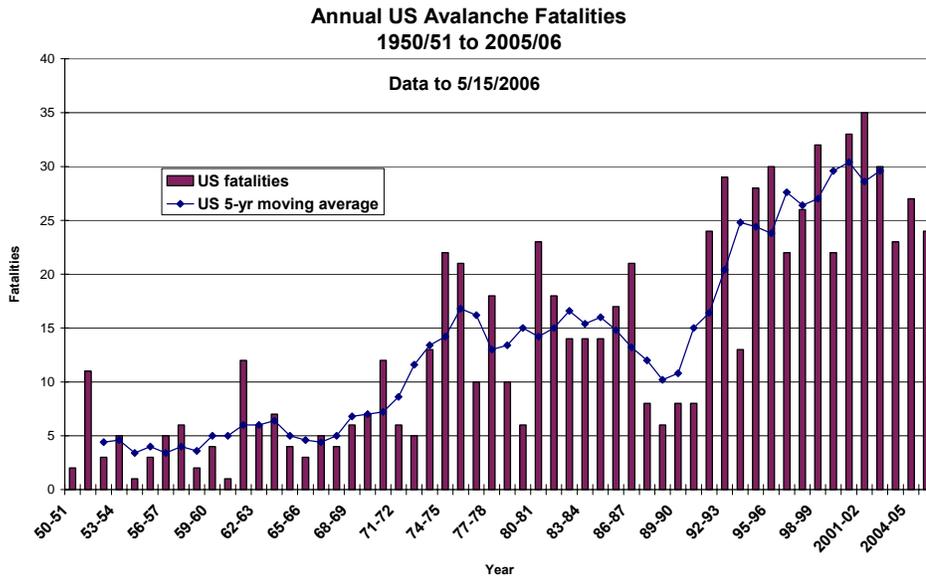
**Figure 9. Current versus climatological snowdepth—Timberline Lodge, OR.**



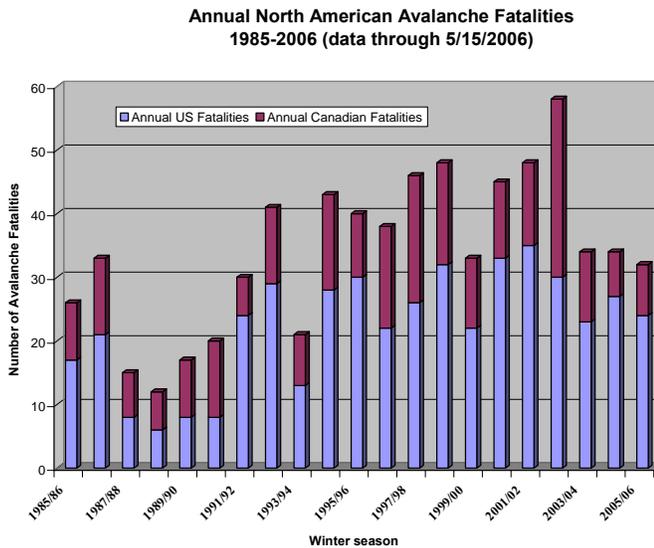
## **US AND NORTHWEST AVALANCHE ACCIDENT TRENDS**

The past winter and early spring once again produced many more avalanche accidents than any of us want to see, especially any of us who forecast avalanche danger in an attempt to reduce such life changing events. As indicated by the Figures below, the long term trend in avalanche

related fatalities in the US continues to be maintained at a relatively high level; for the past five years through May 5 of this year, 139 people lost their lives to snow in motion in the United States with over 200 deaths in the US and Canada combined. This is indeed unfortunate, especially since many if not most incidents were probably preventable through either increased awareness, application of knowledge, or reducing the human factors that are thought to play an increasingly important role in avalanche accidents.



**Figure 10. United States Avalanche Fatalities from 1950/51 through 2006: Annual and 5-year moving average valid through May 15, 2006.**

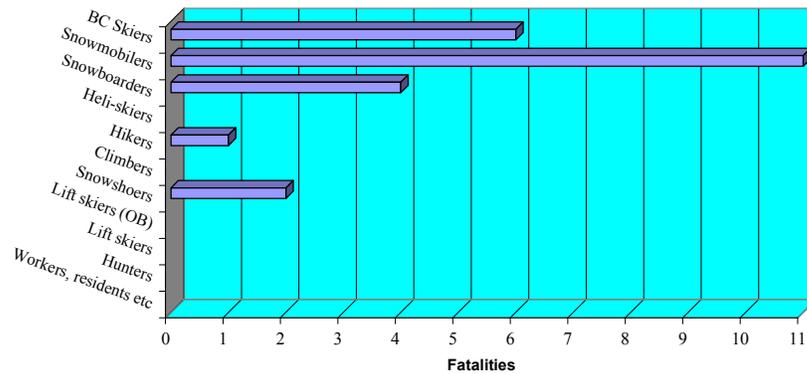


**Figure 11. North American (US and Canada) avalanche fatalities by year, 1985/96 to 2005/06. Data valid through 5/15/2006.**

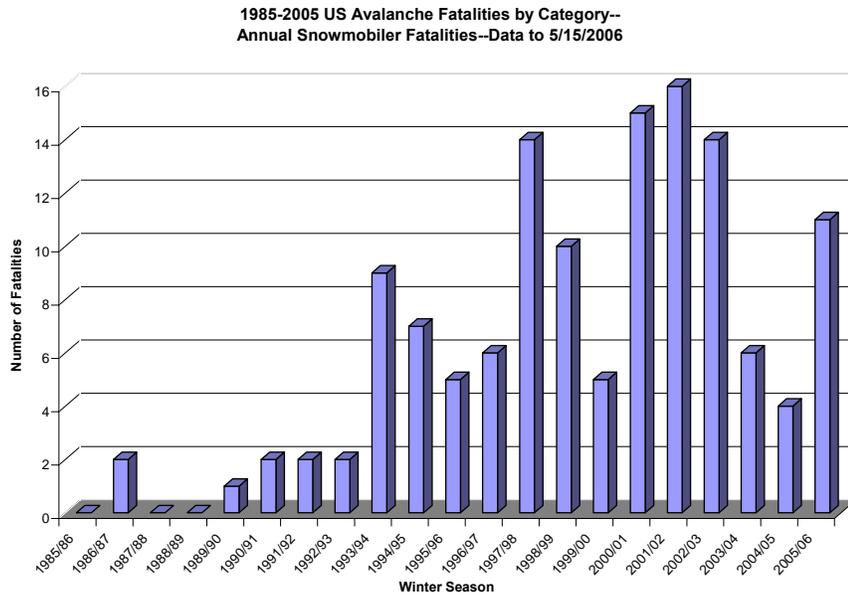
As shown by Figures 12 and 13, a relatively large majority of avalanche victims continue to be snowmobilers, both for this past season and for a large majority of the past 10+ seasons. This is

due to a variety of factors which include the huge amount of increasingly steep terrain that newer machines can easily cover, the added weight of human and machine that more effectively stress a potentially fragile snowpack, and the increasingly extreme maneuvers and huge air that many current riders seek and which may turn a marginally stable snowpack into an unstable one. However, by the increasing number of requests from the snowmobiler community for educational awareness talks about avalanche awareness, it is hoped that more and more riders are taking the time and effort to learn about avalanches, snowpack and terrain, and are either accepting or becoming more aware of the consequences and risk that typically accompany riding in extreme terrain.

**2005/06 US Avalanche Fatalities by Activity Category**  
**24 total to 5/15/2006--Data courtesy NWAC, CAIC and WAN**



**Figure 12. United States avalanche fatalities by category, 2005/06 season. Data valid through 5/15/2006.**



**Figure 13. Annual snowmobiler avalanche fatalities in the US, 1985-2006. Data valid through 5/15/2006.**

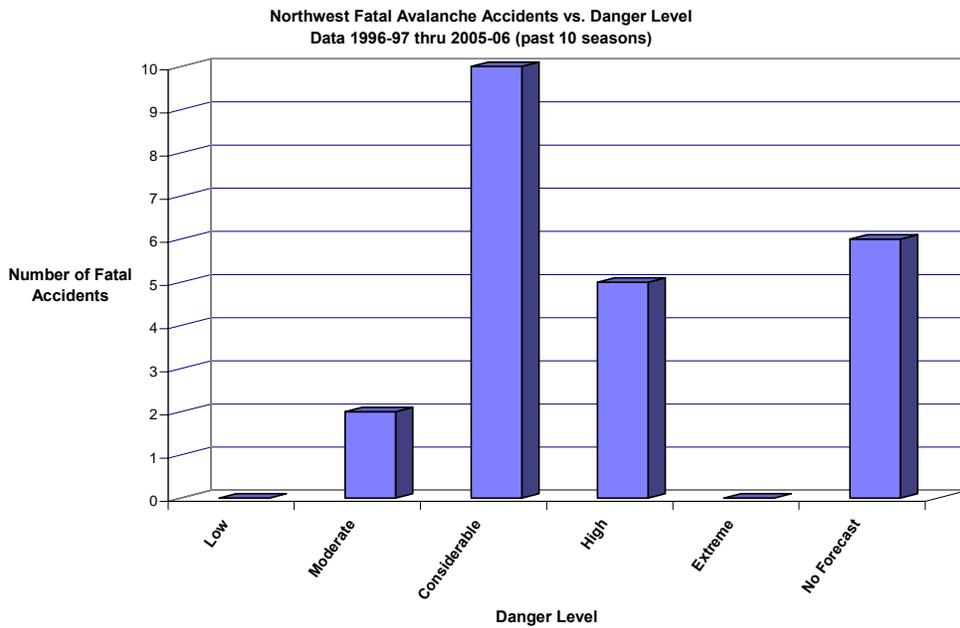
As evidenced by the annual avalanche fatalities by state table below, the distribution of fatalities in the US seems to favor those regions of the country where either weak layers are common and persistent (faceted snow), such as the Rocky Mountain states of Colorado, Wyoming, and Montana, or the intermountain region of Utah where high population areas exist in close proximity to the steep, potentially deep and often unstable snowpacks of the Uinta and Wasatch ranges. However, as indicated by the table Alaskan avalanche accidents are also common. This is due to a combination of factors such as abundantly steep terrain with a variety of weak layers exists immediately adjacent to a relatively large and adventurous population of Anchorage and surrounding communities, and the presence of unstable snowpacks often extend perilously close to sub-divisions. The relatively high Alaskan accident rate may also be attributed at least in part to the fact that the state has no avalanche centers that prepare and distribute regularly scheduled forecasts of potential avalanche danger. However, this may be changing shortly as the necessary funding to develop and operate such centers is expected to be forthcoming in the next state budget.

**Table 2. Annual US Avalanche Fatalities by state, 1985-2006.**

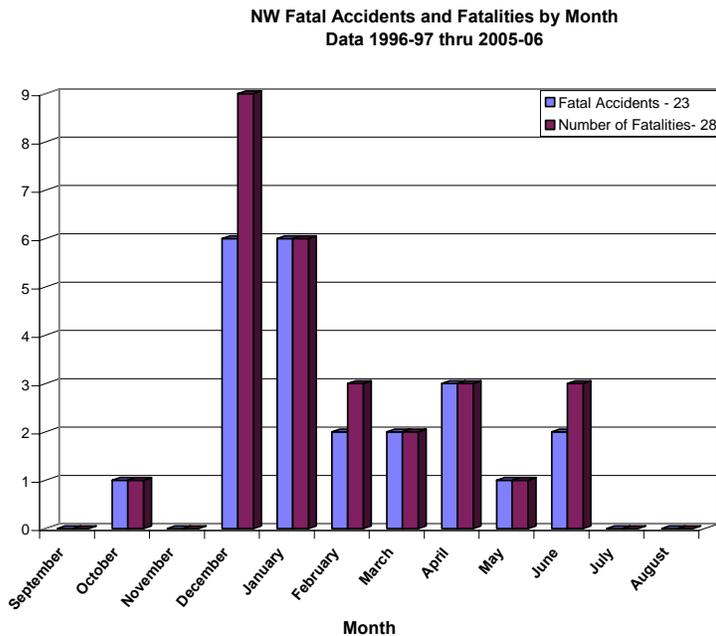
UNITED STATES AVALANCHE FATALITIES by STATE																								
1985/86 to 2005/06 (to May 15, 2006)																								
Winter Season																				21 Years				
State	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	Total	Avg	State
CO	4	11	5	4	4	6	9	12	1	9	7	1	6	6	8	4	6	6	3	5	4	121	5.8	CO
AK	0	6	2	0	1	1	2	7	2	6	8	4	3	12	5	4	11	4	3	1	4	86	4.1	AK
UT	5	2	0	0	1	0	5	3	1	5	2	6	2	5	2	6	5	1	4	8	3	66	3.1	UT
MT	2	1	0	0	1	0	1	1	6	3	3	1	7	2	2	7	9	4	0	3	4	57	2.7	MT
WY	2	0	0	0	0	0	2	1	1	1	3	2	1	2	0	7	2	7	1	0	2	34	1.6	WY
WA	2	0	1	0	0	0	2	0	0	1	0	5	2	3	1	3	0	1	7	2	2	32	1.5	WA
ID	0	1	0	0	0	0	0	2	0	0	3	3	3	0	2	0	1	3	4	3	4	29	1.4	ID
CA	2	0	0	0	1	0	2	1	0	2	0	0	1	1	0	2	1	1	1	3	1	19	0.9	CA
NH	0	0	0	0	0	1	0	0	0	0	3	0	0	0	1	0	0	2	0	0		7	0.4	NH
OR	0	0	0	1	0	0	0	1	2	0	0	0	1	1	0	0	0	0	0	0		6	0.3	OR
NV	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1		4	0.2	NV
NY	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0		2	0.1	NY
VT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1		1	0.1	VT
AZ	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0		1	0.1	AZ
NM	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0		1	0.1	NM
<b>TOTAL</b>	17	21	8	6	8	8	24	29	13	28	30	22	26	32	22	33	35	30	23	27	24	466	22.2	<b>TOTAL</b>

An analysis of the fatal avalanche accidents over the past 10 seasons by NWAC staff shows that a significant number of these incidents occurred in non-winter months and during times when normal daily forecasts were not available. While a relatively high percentage of recent (1996-2006) fatalities have occurred when the forecast danger levels were considerable or high, about 25% have occurred during times of the year when forecasts are typically unavailable.

**Figure 14. Northwest fatal avalanche accidents by danger level, 1996-2006.**



**Figure 15. Northwest fatal accidents and fatalities by month, 1996-2006.**



However, one thing is clear from all of the accident and fatality charts shown above: whether you are a snowmobiler, skier, snowboarder, snowshoer, climber or hiker, know that the accident statistics do not lie. If you recreate in the mountains when sufficient snow covers steep terrain you are at risk from avalanches. So be sure to:

- take some time to learn as much as you can about the threat posed by avalanches,
- be aware of the past, current and future weather trends whenever and wherever you venture into the mountains,
- don't plan for the snowpack structure or stability to meet your expectations,

- always check the snowpack structure no matter what the time of year the calendar indicates,
- plan your routes to minimize your exposure to potential avalanche danger
- check out the NWAC web site for [educational topics](#) and links to other snow, weather and avalanche sources,
- review and update your knowledge about avalanche factors,
- read some “cool” articles/books on avalanches over the summer,
- plan to attend an advanced or multi-day avalanche awareness training program in the future.

## **FORECASTING OPERATIONS**

The NWAC decided to try an experiment this season and Garth Ferber and Knox Williams created a “job-share” of Garth’s full time position for the October through April period of 2005-2006. Because this was a sharing of an existing forecast position, the arrangement resulted in no additional cost to the NWAC program while bringing in additional expertise. Knox brought a wealth of experience to the office being an experienced meteorologist and the former director of the Colorado Avalanche Information Center, the oldest and largest avalanche forecasting program in the United States. Our goal was to see if the additional forecaster allowed for more flexibility in our schedules. Knox also gave us some suggestions for improvements to the NWAC program, including enhanced daily contact with more NW ski area snow safety personnel.

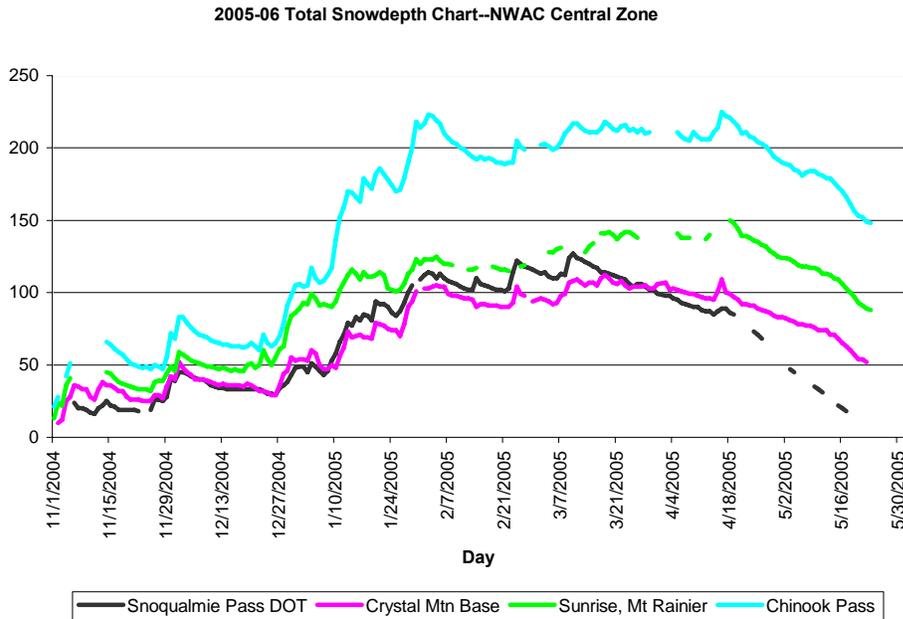
Overall the goals of this job sharing were met, with Knox’s contributions to the program an opportunity not to be missed. However, operationally the reduced hours for each member of the shared position were constraining in that it proved difficult to limit hours and still be able to do the work that the position demanded. Also, while the sharing was voluntary, the reduced salary proved to also be very challenging.

Knox added flair to a few of the forecasts this season with the inclusion of poetry snippets to describe the weather and snowpack, thus becoming our first weather poet! It was not long after Knox’s venture into the new world of avalanche poetry that Mark took hold of the Poetry baton. He never looked back! On numerous occasions he awoke in the midst of a forecaster’s short night of sleep inspired with rhyme. This happened often enough that readers began eagerly awaiting the next periodic poem. For those of you who may have missed these little gems of dialectic discourse please don’t miss “The Last Word” concluding this report. Several long-time users of the forecasts sent positive emails about the poetry, some stating that this or that person, who prior to the poetry did not read or understand much of the forecast, actually read, understood, learned from and looked forward to the next poetic epic. If this is indeed a way to reach out and spread the gospel of avalanche awareness, such artistic license may become more commonplace in NWAC’s future, provided forecasters are not accused of “rhyme time crime” or do not suffer future “prose close”, a terse verse variation of writer’s block.

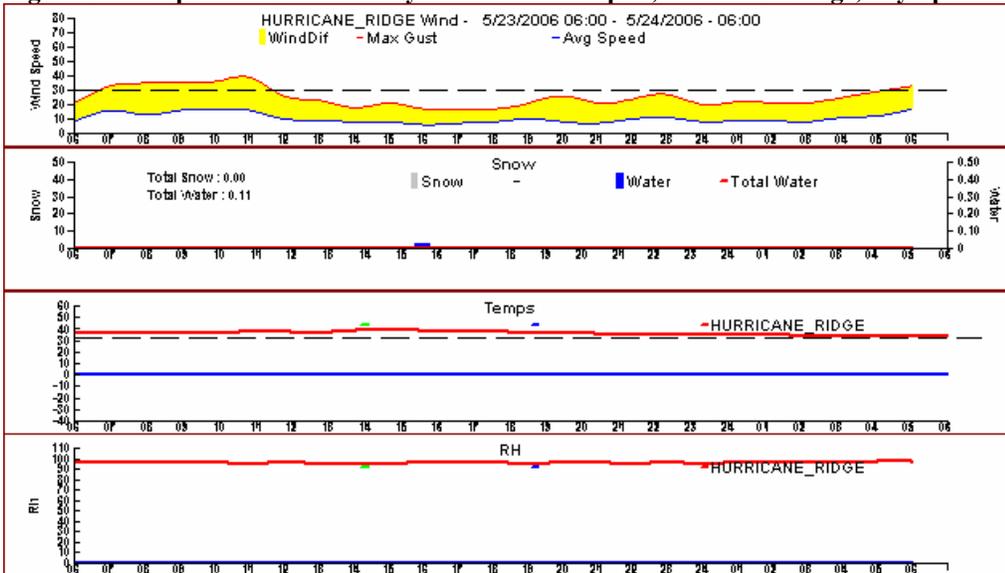
NWAC staff also completed a transition from paper and clipboard summaries for a variety of manual station weather and snow parameters to computer entry of such data via an interactive spreadsheet. The spreadsheet produced automatic plotting and graphing of daily snowdepth

data (see Figure 16 below), and made for much easier queries of past snowfall data. Also, an hourly data software package that automatically retrieves, archives and graphs a variety of hourly weather parameters finally came into its own late this past year, becoming much more stable and reliable after a final program bug was discovered. This package produced hourly weather plots (see below) which allow easy graphical recognition of recent weather trends.

**Figure 16. Sample data from automatic graphing program for station snowdepths--central zone.**



**Figure 17. Sample automated hourly weather station plot, Hurricane Ridge, Olympic Mountains.**



## EDUCATION

The NWAC provides avalanche awareness talks on request using slides or Powerpoint presentations. The table below lists the presentations for the 2005-2006 season which reached over 1200 persons.

**Table 3. 2006 Avalanche Education efforts by NWAC staff.**

DATE	GROUP	LOCATION	# ATTENDING	SPEAKER
17 Oct	Media Workshop	Seattle	100	Kramer
18 Oct	“	“	90	Moore
22 Oct	Snowmobile Show	Puyallup	30	Kramer
23 Oct	“	“	15	Ferber
24-28 Oct	National Avalanche School (NAS)	Snowbird, UT	180	Moore
24-28 Oct	NAS	Snowbird, UT	180	Williams
29 Nov	US Forest Service	Twisp	16	Moore
6 Dec	“	CleElum	37	“
13 Dec	Cascadia Wild	Portland	15	Emetaz
17 Dec	Holden Village	Holden	45	“
10 Jan	Olympia Mountaineers	Olympia	20	“
14 Jan	Scenic Area Discovery Center	The Dalles	15	“
“	NAI	Crystal Mtn.	15	Moore
17 Jan	REI	Tualitin	50	Emetaz
18 Jan	Bushwackers	Seattle	45	“
21 Jan	ASAP	Mt Baker	20	Kramer
26 Jan	FOAC	Seattle	50	Moore
28 Jan	NAI	Crystal Mtn.	40	“
“	Trout Lake Festival	Trout Lake	20	Emetaz
31 Jan	REI	Hillsboro	35	“
8 Feb	REI	Portland	40	“
23 Feb	US Forest Service	Trout Lake	20	“
23 Feb	“	Mountlake Terrace	15	Moore
4 Mar	“	Government Camp	25	Emetaz
9 Mar	REI	Eugene	10	“
14 Mar	Mountaineers	Tacoma	25	“
15 Mar	Mountaineers	Tacoma	50	Moore, Emetaz
14,15 Mar	NPS	Mt Rainier	10	Kramer
16 Mar	Hood River Community Education	Parkdale	10	Emetaz
20 Mar	NW Avalanche Forecasters	Snoqualmie Pass	25	Moore
2 Apr	Cub Scouts	Seattle	8	Ferber
?	Mountaineers	Everett	120 (4 sessions)	White
?	Private	Tacoma	20	“
<b>TOTAL</b>			<b>1,396</b>	

During the past 10 years these outreach efforts have reached over 15,000 people.

**Table 4. NWAC Avalanche Education Efforts by year, 1997-2006.**

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Persons	1178	1820	2440	1800	1800	2600	1486	1657	2858	1396
<b>TOTAL</b>	<b>15,777</b>									

## **2005-2006 WEATHER STATION NETWORK**

The following is summary of selected maintenance items and also some new projects that were accomplished on weather stations within the NWAC data network this past season:

**Alpental Ski Area** - repaired a bad radio connection for the upper station and worked with ski area personnel to correct a bad phone line for the mid-station; replaced total snow depth sensor.

**Chinook Pass DOT** –added batteries to the Chinook weather station and rewired power supply lines.

**Crystal Mountain Ski Area** – repaired and replaced the 24-hour depth gage at the base of the ski area; installed a radio and new coax cable for as a back-up link for accessing Chinook Pass data (rather than through the previously intermittent Sunrise site).

**Holden Village**—prepared a daily weather spreadsheet for this site, cooperated with Holden Village personnel and National Weather Service to establish a daily weather, snow and avalanche report from this site along the Cascade east slopes above Lake Chelan. While the daily data did not normally arrive until after forecasts had been issued, this still provided NWAC forecasters with periodic updates of heretofore unavailable information on snow, weather and avalanche conditions at mid and upper elevations in the north-central Cascade east slopes.

**Mazama** - replaced the Campbell data-logger, air temperature, relative humidity sensor, total snow depth and repaired the wind speed and direction. Most of these problems were due to a faulty power supply.

**Mt Baker Ski Area** - replaced malfunctioning precipitation gage (TWICE!), added a power surge protector, repaired faulty relative humidity sensor, and replaced both snow depth sensors.

**Mt St Helens Volcanic Monument** - repaired a wind speed instrument problem and moved the precipitation gage to a new improved location that resulted in much more reliable precipitation readings (no more faulty tips due to high winds).

**Stevens Pass Ski Area (Brooks and Daisy Chairs)** – assisted snow safety personnel with troubleshooting and programming a new weather station at the top of the Daisy Chair. Also replaced the Brooks chair temperature-relative humidity instrument.

**Stevens Pass DOT (Grace Lakes)** – replaced the Grace Lakes total snow sensor.

**Sunrise, Mt Rainier NPS**– repaired the automated cumulative precipitation gage at Sunrise and with the help of Qwest and the Park fixed the phone and spread spectrum radio link that ties the local radio network together.

**Timberline Ski Area**- replaced the Campbell data-logger, the 24 hour and total snow depths, the wind direction sensor and the temperature controller unit that provides heat to keep the sensors free of ice.

**Washington Pass DOT** - one of our most exciting projects this fall was completion of two new weather stations at Washington Pass. A completely new station was installed at 6630' about a mile north of the pass with wind speed and direction, temperature and relative humidity. We also overhauled the existing precipitation site near the overlook at 5500' and that site has new temperature, relative humidity, precipitation, precipitation gage temperature and total snow depth instruments. We are planning with WSDOT radio technicians to improve communication capabilities with this station for next season.

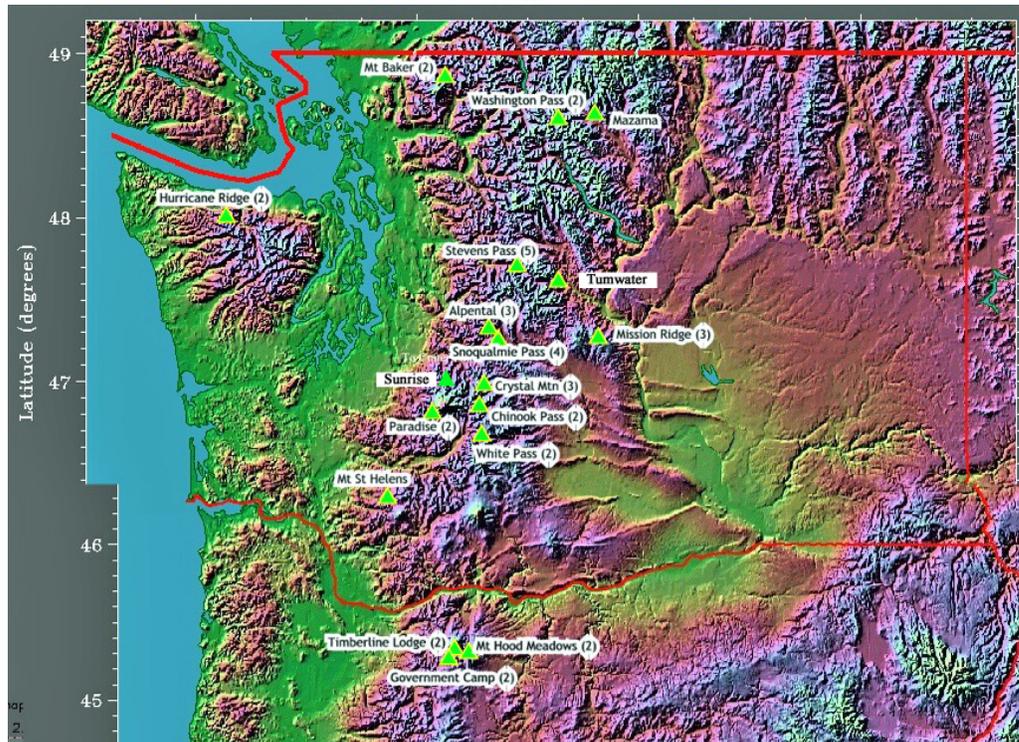


**Figure 18. New wind site above Washington Pass**

**White Pass Ski Area** - replaced a malfunctioning precipitation gage and a malfunctioning wind speed instrument.

Below is a map showing weather stations maintained or partly maintained by the NWAC.

**Figure 19. Map of the mountain weather stations managed and maintained or partly maintained by NWAC staff.**



### **SNOWBASH!**

The FOAC (Friends of the Northwest Weather and Avalanche Center) held their annual Snowbash at the Tractor Tavern in Ballard on 11 November. The Snowbash has been held each fall now for the past several years and raises awareness of the NWAC and funds for the mission of the FOAC. The event was well attended with a couple hundred snow enthusiasts, a blue grass band, raffle, plenty of beer consumed, and plenty of decibels raised too!

The Friends also helped with organization of a *Cinco de Mayo* event at the new *BackCountry Essentials* store in Bellingham. This was a joint fundraiser for *Conservation Northwest* and the NWAC with the purpose of enhancing both environmental and avalanche awareness. The spring bash was well attended and included several piñatas, local brews, and salsa sampling (and rating) from a variety of local vendors, as well as short messages from both *Conservation NW* and NWAC representatives.

### **FUTURE PLANS**

#### **Mt Baker ski area –**

Planned new installation of a much needed upper mountain station to include, ridge-top wind speed and direction as well as temperature and relative humidity sensors. Two way communications to station via either phone line or RF link to base station (planned fall 2006)

#### **Washington Pass –**

In collaboration with WSDOT, install radio repeater site to improve radio connection to the new weather sites installed at Washington Pass during the fall of 2005. These stations link to a base station at the top of Flag Mountain above Mazama, WA and provided intermittent data throughout the season.

### **Central Washington Cascades –**

Planned new east slope station near Stevens Pass planned for fall 2006. A site near Lake Wenatchee has been identified and approved, located at Lake Wenatchee State Park as well as a potential ridge site on Dirty Face Ridge (above northwest shore of Lake Wenatchee). This station would greatly enhance the forecasts and real-time conditions for the east slope areas where several snowmobile accidents have recently occurred.



### **Mission Ridge Ski Area –**

Convert stations from RF link to land line connections to ensure more reliable access to the data. During the 2005-06 season the data was mostly unavailable from Mission Ridge as a result of unresolved radio connection problems. This left a large hole in the information available along the east slopes.

### **Mt Rainier National Park (Camp Muir) –**

Begin installation of a new FreeWave spread spectrum radio accessed weather station at Camp Muir, Mt Rainier National Park. If all goes as planned, installation of this 10,000 ft. elevation site may be completed in late summer or early fall of 2006.

### **Mt Rainier National Park (Paradise wind site) –**

Remove old wind station on Jackson Visitor Center in late spring of 2007 in preparation for planned Park removal of the JVC in the summer of 2007. Install new phone accessed wind site in small grouping of firs immediately to west of JVC. Cooperate with Mt Rainier NPS on

installation of tower, AC power and new phone lines for operational status in winter of 2007/08.

### **Precipitation Gage Development –**

Collaborate with Phil Taylor of Taylor Scientific on developing a new all season precipitation gage with versions for either electric or propane heat. Presently there are no commercially available propane heated precipitation gages, while the electrically heated gages currently used have become increasingly expensive to both purchase and maintain. They have also been very susceptible to the at times intermittent power surges common at remote sites adjacent to ski areas. It is also hoped that Taylor Scientific will complete a prototype of a new internally heated and robust propeller style wind speed and direction sensor this summer. NWAC is cooperating with the manufacturer and plans to test such a sensor as soon as it becomes available.

## **NWAC BUDGET AND FUNDING**

An increasing array of funding challenges continues to result in an uncertain future for NWAC forecast and data service responsibilities. Although the USDA-Forest Service (NWAC's administering agency) recognizes and highly values the continuing contributions and commitment of all cooperators who support Avalanche Center operations, anticipated shortages in future funding levels from a variety of sources have dictated that the Forest Service develop contingency plans for eventual closure of the Center. From all current estimates, it appears that the majority of state and federal agencies helping to support the Center are faced with uncertain and overall declining budgets, and it is unrealistic to expect increasing shortages to be filled by either the private sector or donations. This rather grim economic situation has resulted in a difficult budget / management decision within the USDA-Forest Service regarding the future of the Avalanche Center. As it stands now, if expected monetary shortages for NWAC operations in Fiscal Year 2007 (winter of 2006/07) and Fiscal Year 2008 (winter of 2007/08) are not resolved soon with a stable longer term funding solution, current Mt Baker Snoqualmie National Forest reorganization plans call for reduced operations of the NWAC over the next two winters (2006/07 and 2007/08) with subsequent closure of all Avalanche Center Operations in the fall of 2009.

Despite this potentially bleak picture, the Forest Service and NWAC staff will continue to do all that is possible to ensure future normal operation of the Avalanche Center. NWAC staff has just recently concluded making presentations for several Title II grants and are expecting to receive both monetary and capital equipment support from the Friends of the Avalanche Center. As a result of these funds and an increase in Washington State Department of Transportation (WSDOT) support in FY07 (ongoing allocation in the Washington State Supplemental Transportation Budget), we hope that our long and mutually beneficial relationship with our cadre of cooperators will continue well into the future. While budgetary concerns remain challenging, we remain optimistic that funding efforts will be fruitful in providing necessary monies to support a full and normal program in FY07 and beyond.

When viewing the budget projections for FY06 and FY07 shown below, note that these were developed with the additional following assumptions:

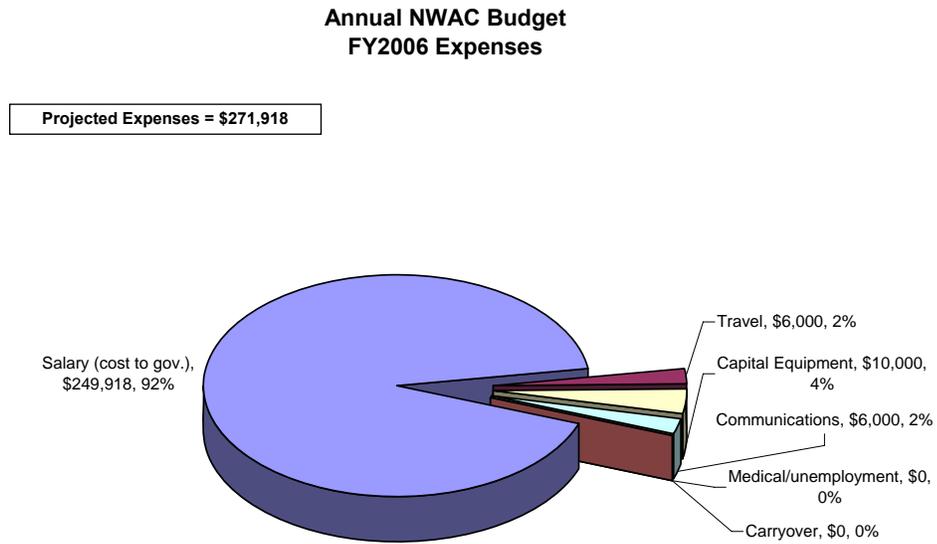
- \* No carryover funds are expected from FY06 to FY07
  - \* Flat support levels are expected to continue from the Forest Service for the foreseeable future.
  - \* Support levels should increase by at least \$35,000 from FY06 to FY07; this is the amount contained within the WSDOT State Supplemental Transportation Budget. Furthermore, it is expected that this \$35,000 will be added to the already agreed upon \$10,000 within the regular Department of Transportation Budget, resulting in an annual on-going allocation of \$45,000 from WSDOT.
  - \* After a significant decline in support levels during FY05 when Crater Lake NP ended its contributions to the program due to decreased overall funding of the Park, a further substantial decrease in National Park Service support was avoided in FY06 by both Mt Rainier and Olympic NP agreeing to continue their support for one more year. While continued flat Park Service support is projected for FY07, this is a very large unknown.
  - \* In FY06, NWAC received \$31,509 from Title II/RAC programs (North MBS, Snohomish, South MBS and Kittitas). This was approximately \$20,000 over the previously projected amount at the cooperator meeting in June of 2005, and helped prevent large shortfalls this fiscal year. Recent discussions with RAC representatives indicate that Title II support for NWAC may be around \$21,000 for next fiscal year and while still tentative (final approval is sometimes not received until late summer or early Fall) this is the projected amount shown below for FY07
  - \* Unemployment and Medical costs for forecast staff should remain at \$0.
  - \* Salaries are projected to increase at approximately +3%/year.
  - \* FOAC is expected to contribute \$5,000 toward capital equipment in FY06 and while they may increase this support level in FY07, the projection for their contribution in FY07 remains flat.
  - \* No matter what the final level of program funding turns out to be, all normal forecast and data services will be provided for as long as funding allows (this “all or nothing” program operation has been previously agreed upon with cooperators as the best way to meet future monetary shortages)
  - \* As projected expenses for FY06 slightly exceed projected income, this currently “unfunded” amount of approximately \$7,150 (~2% of the total budget) will hopefully be resolved through small savings within communication and travel, along with transfer of some additional salary toward fire related programs over the summer and early fall.
- Furthermore, in order to achieve continued operation of the Center in FY07 with no additional sources of revenue (other than those previously indicated):

- \* Capital equipment expenditures will remain flat or decrease.
- \* Travel and communication costs will remain flat or decrease.
- \* Unless shortfall is recovered, overall program operation will be reduced by the amount of anticipated shortfall.
- \* Any shortfalls will result in truncated forecast seasons, with mid-late season forecast operation curtailed by approximately 1 month for each \$25,000 of shortfall (or two weeks for each \$12,500 of shortfall).
- \* These ramifications will be discussed at the annual cooperator meeting.

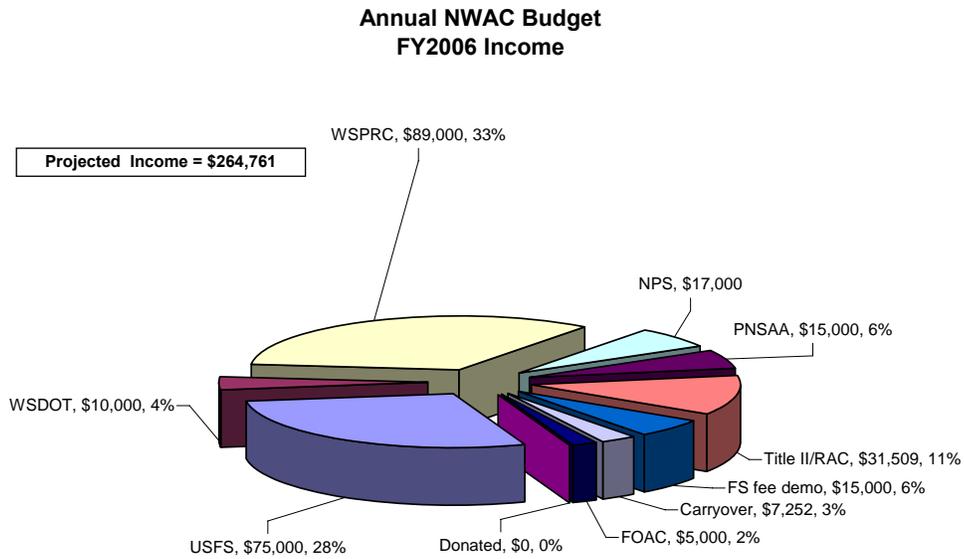
**Table 5. Sources of Funding for FY06 and FY07; Total direct and indirect NWAC funding.**

<b>NWAC Budget—Sources of Funding</b>			
<b>Funding Source</b>	<b>[Direct Support]</b>	<b>FY06</b>	<b>FY07</b>
		<b>[projected]</b>	<b>[projected]</b>
<b>Federal</b>		<b>\$114,252</b>	<b>\$107,000</b>
	USDA-Forest Service	\$75,000	\$75,000
	National Park Service	\$17,000	\$17,000
	USDA-FS Fee Demo	\$15,000	\$15,000
	USDA-FS Carryover	\$7,252	\$0
<b>Washington State</b>		<b>\$99,000</b>	<b>\$134,000</b>
	Parks and Recreation Commission (includes State General Fund \$)	\$79,000	\$79,000
	Department of Transportation	\$10,000	\$45,000
	DOT spring forecasting	\$0	\$0
	Snowpark Program	\$4,000	\$4,000
	Snowmobile Program	\$6,000	\$6,000
<b>County</b>		<b>\$31,509</b>	<b>\$21,000</b>
	*Title II/Resource Advisory Comm.	\$31,509	\$21,000
<b>Private</b>		<b>\$20,000</b>	<b>\$20,000</b>
	PNSAA	\$15,000	\$15,000
	FOAC	\$5,000	\$5,000
	Other private	\$0???	\$0???
<b>TOTAL</b>	<b>[Direct Support]</b>	<b>\$264,761</b>	<b>\$282,000</b>
<b>Estimated In-Kind Support (+3% in FY07)</b>		<b>\$171,096</b>	<b>\$179,986</b>
<b>[Indirect support]</b>	USDA-FS (~30% of direct cont)	\$22,500	\$22,500
	WSDOT (obs + equip support)	\$21,430	\$22,073
	NPS (obs + equip support)	\$5,145	\$5,299
	NWS (office costs + product access etc)	\$62,325	\$64,195
	PNSAA (obs, power, phone etc)	\$7,112	\$7,325
	All (one time cost for data support)	\$56,887	\$58,594
<b>GRAND TOTAL [DIRECT + INDIRECT]</b>		<b>\$435,857</b>	<b>\$461,986</b>
<b>* Additional funds have been requested for FY07 but are not known currently</b>			

**Figure 20. NWAC—Projected FY06 Expenses**



**Figure 21. NWAC—Projected FY06 Income**



## **NWAC STAFF**

- \* **Mark Moore** – Director and forecaster at the NWAC since 1977. Focal point for budgeting, avalanche accident information, web site management and development, computer and weather station management. Old weather station guru.
- \* **Kenny Kramer** – Forecaster at the NWAC since 1990. Focal point for AWIPS (Automatic Weather Information Processing system) maps and macros, Resource Advisory Committee proposals.
- \* **Garth Ferber** – Forecaster at the NWAC since 1993. Focal point for weather station programs and data, forecast products, FOAC Snow Pack Information Exchange.
- \* **Knox Williams** – Meteorologist and former director of the Colorado Avalanche Information Center (retired), Knox was persuaded to come to the Northwest for a season to expand his expertise as a mountain meteorologist. He found the experience interesting, challenging and rewarding as he dealt with easterly pass flows, inversions, convergences and the gamut of precipitation from snow to rain, including freezing rain.

## **THE LAST WORD**

*Here I am at the office, and to my increasing surprise-  
The seasons are changing, before my startled eyes.  
What last week was winter-like, windy and cold,  
Has become almost summery with a ridge so bold.*

*The once dominant trough along the west coast,  
Has become a strong high, bringing warming to most.  
And the old upper low is no longer splitting,  
It's moved some other place where it's happily sitting.*

*The snow may have stopped but it hasn't departed,  
So continue awareness from wherever you started-  
For most steeper snow packs, its preferred resting place,  
Is way down in the valleys where it can settle in place.*

*High freezing levels, sunshine, or warm spring rain,  
High clouds that amplify radiational gain-  
The snowpack doesn't care why it's weak or unstable,  
Or if travelers are careless when they could be more able.*

*Just remember in Northwest mountains in spring,  
Safety is truly a relative thing-  
For until snow melts into lupine and clover,  
It ain't over 'til it's over.*

- Mark Moore, from the last regularly scheduled forecast for the season on April 23, 2006.